



**Faculty of Economics-Skopje
Ss. Cyril and Methodius University in
Skopje**



ECONOMIC AND BUSINESS TRENDS SHAPING THE FUTURE

International Scientific Conference, Skopje,

14-15 November 2024

**5th International Scientific Conference
Economic and Business Trends Shaping the Future**

November 14-15 2024

Online Conference Proceedings

Edited by:

Nikolina Palamidovska-Sterjadovska, PhD

Published by

Faculty of Economics-Skopje, Ss. Cyril and Methodius University in Skopje

Bul. Goce Delcev 9V, 1000 Skopje, Republic of North Macedonia

www.eccf.ukim.edu.mk

Edition: 5th

Publication type: e-book

Available at: <https://repository.ukim.mk/handle/20.500.12188/31999>

Published: Skopje, December 2024

ISSN: 2671-3705

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CONSUMER AWARENESS OF FOOD WASTE REDUCTION - A SYSTEMATIC LITERATURE REVIEW FOLLOWING THE PRISMA STATEMENT

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ABSTRACT

This paper examines the role of social marketing in reducing food waste, focusing on consumer behaviour and awareness of its harmful effects. A systematic literature review (SLR) evaluates studies analysing marketing campaigns' relationship with food waste reduction. Increasing awareness and changing behaviour through marketing campaigns can significantly reduce food waste. This paper analyses relevant literature to present key findings and recommendations for effectively targeting consumers with communication strategies to reduce food waste. In addition, it explores recommendations for implementing point-of-sale activities and direct communication with consumers to promote sustainable food systems.

Keywords: Social marketing, Consumer behaviour, Food waste, Communication strategies.

JEL classification: M30, M31, Q56.

1. INTRODUCTION

Food waste leads to significant economic losses, and its reduction can positively impact overall production, GDP, and employment (Campoy-Muñoz *et al.*, 2017). Food waste poses a significant challenge to sustainability, as it squanders resources like energy and water, accelerates climate change, and exacerbates global inequality (Närvänen *et al.*, 2020).

Previous studies indicate that excess food and consumer behaviour are the primary causes of food waste in developed countries (Hodges *et al.*, 2011; Janssens *et al.*, 2019). Therefore, the key starting point for responsible consumption is awareness—both in behaviour and attitude—of its impacts (Paužuolienė *et al.*, 2022). Behavioral change is essential to reduce household food waste and move toward a more sustainable future (Barker *et al.*, 2021).

Marketing accelerates change, and its influence on economies and societies worldwide is undeniable (Webster and Lusch, 2013; Sutinen and Närvänen, 2022). Previous research suggests that marketing contributes to reducing food waste at the consumer level through strategies such as labelling use-by dates, packaging and design elements, pricing strategies, and communication that highlights the harmful effects of food waste (Aschemann-Witzel *et al.*, 2016). In particular, social marketing represents a key subcategory that achieves these effects

for social dynamics issues. It aims to develop and integrate marketing concepts with various approaches to influence behaviours that benefit individuals and communities for significant social good (iSMA, 2013). As a tool of social marketing, awareness campaigns can help consumers grasp the importance of environmental issues, including food waste, and its negative impact on the economy and society (Attiq *et al.*, 2021).

Through a systematic literature review (SLR), this paper addresses key questions linking marketing campaigns to encouraging consumers to reduce food waste.

The goal of this paper is to explore the role of social marketing in reducing food waste by examining consumer behaviour and awareness through a systematic literature review (SLR). It evaluates the effectiveness of marketing campaigns in promoting behavioural changes to reduce food waste and provides key recommendations for enhancing communication strategies. The paper contributes to the understanding of how targeted marketing interventions can raise awareness, influence consumer behaviour, and promote sustainable food systems while identifying gaps for future research on long-term campaign impacts.

2. METHODS

To achieve the paper's aim, the SLR method was employed. This approach facilitates a comprehensive and clear presentation of existing literature in a specific area (Tranfield *et al.*, 2003) and aids in providing information and synthesizing knowledge on the research topic, while also identifying existing gaps in the literature and opportunities for future research (Bhattacharya *et al.*, 2021). The presentation of data from this analysis adheres to the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page *et al.*, 2021). Originally developed for health research, the method is also utilized in other fields, including marketing studies (Huurne *et al.*, 2017; Lim *et al.*, 2021), research on food waste management (Kasavan *et al.*, 2022; Rolker *et al.*, 2022; Srivastava *et al.*, 2023) and the food waste reduction process (Simões *et al.*, 2022; Hartmann *et al.*, 2021; Brennan *et al.*, 2021).

2.1. Defining the research problem and outlining the procedure

This paper aims to highlight new possibilities in social marketing that drive practical changes (Sutinen, 2022). To define the research problem, a literature review was conducted, which helped refine the objectives and select keywords for a search list (Badger *et al.*, 2020). The paper seeks to address the following research questions:

1. How current is the topic of marketing as a strategy for addressing food waste?
2. What is the most commonly used terminology in relation to marketing interventions for reducing food waste, and how is it categorized?
3. Does marketing effectively change consumer behaviour to reduce food waste?

The research procedure in this paper, following the principles outlined by Gossen *et al.* (2019) is divided into three basic phases: review planning, review implementation, and reporting (dissemination).

In the planning phase, the focus of the literature review is determined by defining key themes. The process continues with the use of software to identify published publications based on keywords. Following the detailed processing and analysis of the data approaches for defining and implementing the concept for presentation and dissemination are developed.

During the review, criteria for the selection and rejection of published papers are established, as detailed in Table 1.

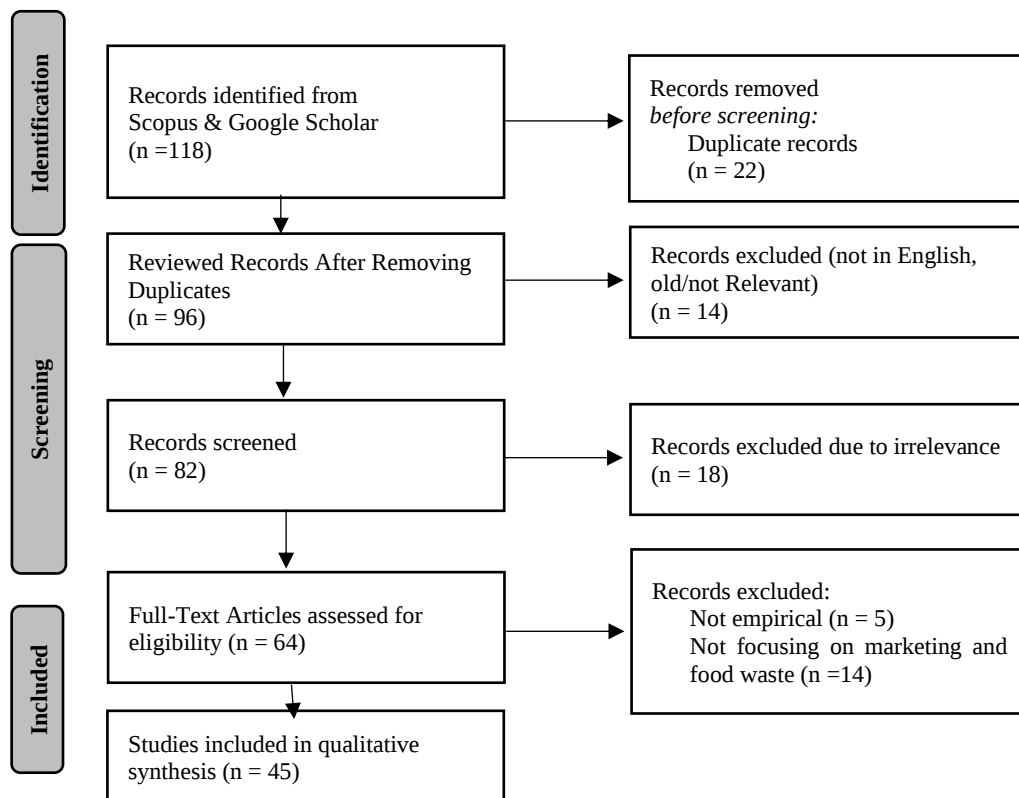
Table 1: Database Search Criteria

Criteria	Inclusion of Sample	Exclusion of Sample
Search Scope	SCOPUS & Google Scholar	Other databases
Source	Peer-reviewed journal articles, book chapters, conference papers, and relevant online publications	Any other source, e.g., dissertations
Type of Research	Empirical and conceptual papers	No exclusion
Time Period	Publications from 2007 to June 2024	Publications before 2008
Search Parameters	Search terms appear in the title, abstract, or keywords provided by the author	Search terms do not appear in the title, abstract, or keywords provided by the author
Language	English	Any other language

(Source: Adapted according to Gossen et al., 2019)

Key features associated with the systematic review are addressed, including the frequency of publication, place of publication, and key terms. The key findings and conclusions are then presented. In conducting the systematic review, the preferred reporting guidelines for systematic reviews and meta-analyses, namely the PRISMA method (Moher et al., 2009), are utilized. Figure 1 illustrates the PRISMA protocol for selecting literature included in this paper's analysis.

Figure 1: Chart overview of studies included in the systematic review based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) principles



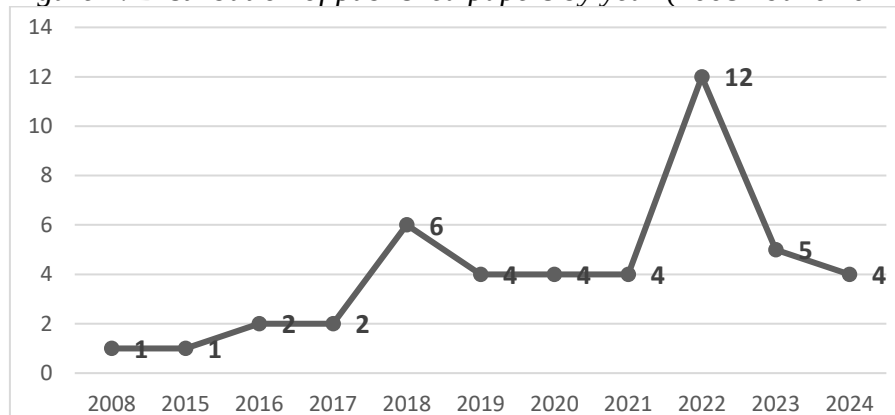
(Source: Adapted according to Moher et al., 2009)

To identify existing literature in the field, the Harzing Publish or Perish software was employed. We selected all published papers from the SCOPUS and Google Scholar databases to compile a comprehensive database of publications. The search was conducted in two phases:

- Phase One: Papers containing the term “food waste reduction campaigns” were identified.

- Phase Two: Papers containing the term “food waste marketing” were searched. The analysis included 118 publications from the period 2008-2024 (see Figure 1). Following a detailed review of the literature, 45 relevant papers were selected. During the filtering process, we excluded non-English publications, older papers, those lacking empirical results, and papers not directly related to the topic. Data Mining software, Orange, which offers a visual programming framework with an emphasis on interactive and creative combinations of visual components was utilized for processing and visual presentation of the data (Demšar *et al.*, 2004). The results indicate a growing interest in studies related to marketing activities aimed at reducing food waste. Since 2008, the number of papers published has increased generally, with a notable surge in the last three years, particularly in 2022. Further research on this topic is anticipated to be published in 2024.

Figure 1: Distribution of published papers by year (2008 - June 2024)



(Source: Authors' analysis)

The analysis presented in Figure 1 includes works relevant to the processing of this SLR. The preliminary results highlight the timeliness of addressing food waste and employing marketing approaches as methods to improve the situation, thereby addressing **Research Question 1**. Existing research underscores the importance of establishing public commitments and goals (Schmidt, 2016) as well as conducting information campaigns to enhance awareness of food-related issues (Soma and Maclaren, 2020).

Table 2 presents a list of papers included in the analysis. In addition to scientific journals, the table features research from conferences, university textbooks, and relevant online publications.

Table 2: Publication sources of analysed papers

Scientific journals	Number
Journal of Cleaner Production	4
Journal of Food Products Marketing	3
Resources, Conservation and Recycling	3
Social Marketing Quarterly	3
Journal of Social Marketing	2
Waste Management	2
Sustainability (Switzerland)	2
African Journal of Hospitality, Tourism and Leisure	1
Australasian Journal of Environmental Management	1
Australasian Marketing Journal	1
Environmental Science and Pollution Research	1
European Journal of Marketing	1

the term “waste”. Other commonly used terms include “consumers”, “social”, “campaign”, “marketing” and “behaviour”.

In that context, Table 3 illustrates the frequency of the most commonly used words, such as “food” which is frequently connected with the terms “waste” and “consumer”.

*Table 3: Frequency of most used words in papers subject to this SLR**

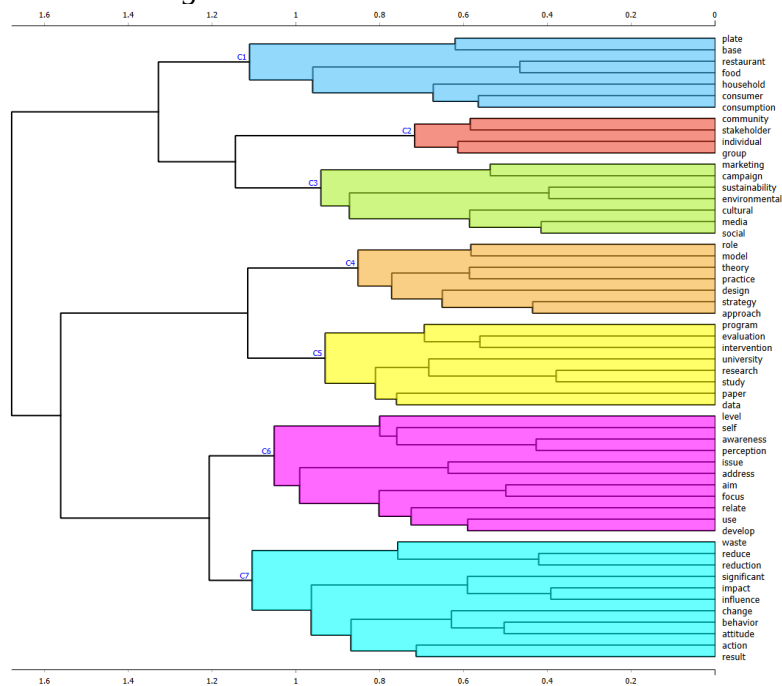
Phrase	Freq.	Phrase	Freq.	Phrase	Freq.
food	404	Approach	26	attitude	18
waste	346	Sustainability	24	Self	18
consumer	139	Base	23	plate	17
social	117	Strategy	22	theory	17
reduce/reduction	116	Intervention	21	design	17
campaign	112	Significant	21	perception	17
marketing	99	Focus	21	data	16
behavior	73	Group	21	aim	16
study	67	Consumption	20	result	16
change	42	Develop	20	individual	16
Use	40	Issue	19	program	16
awareness	33	Stakeholder	19	action	15
research	33	Model	19	university	15
media	33	Role	18	address	15
impact	31	Practice	18	cultural	15
household	28	Evaluation	18	restaurant	15
environmental	27	Community	18	influence	15

*Words irrelevant to the topic, such as conjunctions and adverbs, are excluded from the analysis.

(Source: Authors' analysis)

By grouping the terms, a logical distribution of clusters is observed. Cluster 1 (C1) includes words related to food waste in the catering sector. Cluster 3 (C3) centers on marketing and campaigns addressing sustainability and environmental issues. The final cluster focuses on terms related to behavioural change intentions that aim to reduce food waste (see Figure 3).

Figure 3: Hierarchical Term Clusters



(Source: Authors' analysis)

3. DISCUSSION

As the paper primarily focuses on the awareness and impact of the marketing campaigns on changes in consumer behaviour, it is expected to employ primary research methods and techniques (e.g. Susilo *et al.*, 2022; Aschemann-Witzel *et al.*, 2016; Muposhi and Musavengane, 2023) as well as other research mechanisms (e.g. Hodgkins *et al.*, 2019; Rybanská *et al.*, 2022). Surveys are widely used in academic marketing research because certain topics are best studied by directly asking consumers questions (Hulland *et al.*, 2018). While statistical data are particularly useful for identifying the magnitude of a specific problem, qualitative data provide greater insight into root causes and processes (Granot *et al.*, 2012). Case studies (e.g. Calvo-Porrá *et al.*, 2017), focus group research (e.g. Kansal *et al.*, 2022), observation (e.g. Pinto *et al.*, 2018) and other methods have also been employed in the papers. All the papers emphasize the pressing issue of excessive food waste. The growing problem of food waste from consumers, which significantly impacts both the economy and the environment, is highlighted (Jenkins *et al.*, 2022; Zamri *et al.*, 2020). In addition to its negative environmental effects, food waste also adversely affects food businesses by increasing costs (Chen and Jai, 2018).

Final consumers are the focus of numerous studies, and the SLR indicates that they are generally considered key contributors to food waste (Aschemann-Witzel, 2018). Per capita, consumers in Europe and North America waste approximately 95-115 kg of food per year (Silchenko *et al.*, 2019). The research analysed in Wansink's (2018) study shows that most consumers are not highly motivated to change their food waste behaviours, suggesting that relying solely on education and personal willpower may not be effective in the short or long term. Understanding the seriousness and causes of food waste among consumers is crucial for educators addressing this complex issue (McCoy, 2019).

One study included in the SLR indicates that concern for food waste is linked to a reduced tendency to waste food and that consumers who prefer organic products exhibit significantly different attitudes compared to those with a more conventional approach (McCarthy and Liu, 2017). Similarly, Chen and Jai (2018) found that consumers with a higher level of socially responsible consumption are more proactive in preventing food waste when dining out. In fact, adopting a lifestyle with environmental awareness is identified as the most effective factor in shaping consumer behaviour toward food waste (Szakos *et al.*, 2021).

Another study explores the correlation between consumers' religious affiliation and their relationship with food waste. It presents findings indicating that negative attitudes toward food waste are positively associated with traits such as conscientiousness, frugality, and religiosity (Kutlu, 2022). When designing campaigns to reduce food waste among consumers, it is important to consider factors such as their attitudes and beliefs about others' opinions, their motivation to conform, their confidence in their ability to control their behaviour, and the resources available to them (Wastutiningsih and Aulia, 2023).

Price policies, which offer significant to moderate reductions, positively influence consumers' pro-environmental attitudes. However, research indicates that among consumers with higher monthly incomes, reduced prices and other economic incentives are less likely to impact decisions to reduce food waste (Aschemann-Witzel *et al.*, 2016).

According to Szakos *et al.* (2021), behavioural components should be considered when designing prevention campaigns. Another study highlights the importance of understanding consumer perceptions to create effective educational campaigns addressing food waste issues (Hao *et al.*, 2022). Communication campaigns are more effective when tailored to specific consumer segments, with messages incorporating culturally relevant emotional and moral appeals (Kansal *et al.*, 2022). Kutlu (2022) points out that segmentation is often overlooked as a marketing tool in food waste campaigns and seeks to identify potential market segments for social marketing efforts. Research by Kansal *et al.* (2022), based on data from 90 participants

in nine focus groups, finds that the cultural and religious backgrounds of specific Asian communities significantly influence their food behaviour. Additionally, research across three different consumer segments suggests that policymakers and companies should target marketing messages to reduce food waste, tailored to the characteristics (similarities and differences) of each target group (Aschemann-Witzel *et al.*, 2016).

Tailoring messages and selecting appropriate media to communicate with target groups willing to change their food waste behaviour is crucial for campaign effectiveness (Pearson and Perera, 2018). Research by Aschemann-Witzel (2018) reveals that female respondents are more engaged with various food-related issues, and there is a positive relationship between commitment to food-related matters and the level of education. Previous studies highlight the need to address food waste behaviour among younger demographics, emphasizing the importance of guiding young people on proper food handling and measures to reduce waste (Hodgkins *et al.*, 2019). Childhood education and awareness-raising should be central activities, as they can instil habits before routines leading to excessive food waste become deeply entrenched in individual behaviour patterns (Szakos *et al.*, 2021).

The **third research question** addresses whether marketing leads to changes in consumer behaviour aimed at reducing food waste. Alongside increasing awareness of the food waste problem, various interventions are emerging to address it. One of the most commonly used interventions is marketing awareness campaigns, which provide information and advice to motivate households to reduce their food waste (Soma *et al.*, 2021).

Research by Sawasdee *et al.* (2020) demonstrates that green marketing significantly reduces food waste generation. Social marketing plays a crucial role in initiating and encouraging socio-cultural changes (Sutinen, 2022). A previous systematic literature review concluded that marketing experts have a unique opportunity to reduce food waste by implementing small changes in product packaging, promotion, pricing, and distribution systems. This perspective is supported by research from Lee *et al.* (2024), which found that a marketing mix co-designed by stakeholders, including restaurants and consumers, effectively reduced food waste by nearly half during a pilot project. Participants in a study conducted in Australia reported that increased promotion, greater exposure to communication messages, and more frequent advertising would enhance their perception of the need to reduce food waste (Hodgkins *et al.*, 2019). Additionally, most focus group participants indicated feeling more motivated to reduce food waste after being exposed to a food waste awareness campaign (Soma *et al.*, 2021).

Furthermore, another study highlights that the effectiveness of a campaign is significantly enhanced by the availability of additional materials to the public (Shu *et al.*, 2023). By leveraging digital technologies and marketing expertise, retailers can motivate suppliers to reduce waste and encourage consumers to adopt sustainable purchasing and consumption behaviours (Zhang *et al.*, 2022).

4. CONCLUSION

Through a systematic literature review, this paper analyses the effects of marketing campaigns on raising awareness of food waste reduction. There is a noticeable growing trend in research in this area, driven primarily by the scientific community's recognition of food waste as a serious economic, environmental, and social problem that demands change.

The papers analysed in this study frequently include terms such as “food”, “waste”, “consumer”, “sustainability”, “reduction”, “campaign”, “marketing”, “behaviour” and “change”. The results indicate that marketing campaigns can effectively influence consumer behaviour. Previous research underscores the importance of targeting consumers based on segmentation according to their characteristics.

This paper also identifies certain challenges and limitations, such as insufficient data on the long-term effects of campaign implementation and the lack of standardized methodologies in research, which complicates the comparison and synthesis of results.

Overall, the systematic literature review demonstrates that social marketing, through targeted campaigns, has the potential to significantly reduce food waste by altering consumer behaviour. However, to achieve sustainable results, it is essential to implement integrated and long-term strategies that consider the cultural and social aspects of consumers.

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DECODING SOURCE CREDIBILITY: HOW IT INFLUENCES TRUST IN INFORMATIVE BRAND-RELATED CONTENT AND CUSTOMER PURCHASE INTENTIONS

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EXTENDED ABSTRACT

Purpose As influencers build their follower base by sharing content in a particular niche (Lou and Yuan, 2019; Saima and Khan, 2020), influencer credibility greatly affects followers' perceived trust in brand-related content they share on social media (Lou and Yuan, 2019). Brand content can be categorized in various ways (Coelho *et al.*, 2016; Luarn *et al.*, 2015; Tafesse and Wien, 2017). Different categorizations proposed by multiple authors (Coelho *et al.*, 2016; Luarn *et al.*, 2015; Tafesse and Wien, 2017) identify one common type of brand-related content: informative content. Hovland and Weiss (1951) highlight the significance of the message source's credibility in enhancing the persuasiveness of the message. Influencers, seen as credible sources of information, effectively inspire shopping aspirations (Ohanian, 1990; Van der Walddt *et al.*, 2009). Influencers' posts serve as marketing signals to their followers i.e. potential customers given that a marketing signal is a piece of information that a customer can request and process with minimal effort (Nafees *et al.*, 2020; Bloom and Reve, 1990). According to market signaling theory, the one who presents or represents the product to others also represents a type of marketing signal (Nafees *et al.*, 2020; Bloom and Reve, 1990). Thus, influencers, or influential individuals (Batra *et al.*, 1996), by demonstrating the use of a product (Spry *et al.*, 2011) become marketing signals themselves. The effectiveness of these marketing signals is heavily reliant on the credibility of the signal sender (Herbig and Milewicz, 1996). Furthermore, source credibility is comprised of several dimensions, including expertise, trustworthiness (Hovland *et al.*, 1953), and attractiveness (McGuire, 1985). Ohanian (1990) defines credibility as a combination of trustworthiness, expertise, and attractiveness. Lou and Yuan (2019) add an additional dimension i.e. similarity. Also, Xiao *et al.* (2018) emphasize a four-dimensional structure focusing on expertise, trustworthiness, likability, and similarity. By incorporating a five-dimensional credibility construct this research represents a unique approach to determining the influence of source credibility on customer's trust in informative brand-related content and the influence of trust in brand-related content on customer's purchase intentions. The paper is the first to use the following source credibility dimensions: trustworthiness, attractiveness, expertise, likability, and similarity. Therefore, the main motivation of this paper is to address the research gap on how influencers' credibility affects followers' trust in informative brand-related content and their subsequent purchase intentions, particularly by examining the comprehensive five-dimensional construct of source credibility, which has not yet been thoroughly explored in previous studies. The focus is on trust in informative brand-related content since social media users primarily use social networks to

receive information (Edwards *et al.*, 2002; Muntinga *et al.*, 2011) and brand-related content shared by influencers on social networks includes information about the product (Lou and Yuan, 2019). Having in mind previously elaborated, the purpose of this study is to investigate the effect of each source credibility dimension on customers' trust in informative brand-related content and their purchase intentions. We propose the following research hypotheses:

H1: Influencers' attractiveness positively affects trust in informative brand-related content.

H2: Influencers' trustworthiness positively affects trust in informative brand-related content.

H3: Influencers' expertise positively affects trust in informative brand-related content.

H4: Influencers' likability positively affects trust in informative brand-related content.

H5: Influencers' similarity positively affects trust in informative brand-related content.

H6: Trust in informative brand-related content positively affects purchase intentions.

Design/methodology/approach An online questionnaire was distributed to a purposive sample of social media users in North Macedonia. From the 380 initial responses, the final sample was refined to 307 respondents who follow influencers on social media. To test the hypotheses, we conducted a quantitative analysis of the collected data using structural equation modeling (SEM) in two phases: confirmatory factor analysis (CFA) for the measurement model and structural model testing using AMOS version 20.0. Structural equation modeling (SEM) evaluates structural relationships among various concepts or constructs, represented by multiple variables within a single integrated model (Malhotra *et al.*, 2017). This methodology is especially prevalent in marketing research, as it enables the testing of market behaviour models (MacLean and Gray, 1998). To minimize the risk of common method bias (CMB) in the results, Harman's single-factor test was conducted, as suggested by Podsakoff *et al.* (2003) and Fuller *et al.* (2016). This test analyses the unrotated factor solution for the variables. The results indicate no dominant factor, as the single-factor solution accounts for less than 50% of the shared variance. The internal consistency of the measured variables was confirmed by calculating the Cronbach's α – coefficient for each variable (values above 0.7 as recommended by Hair *et al.*, 2010). When conducting confirmatory factor analysis the focus is on squared multiple correlations, standardized covariance residuals, and standardized regression coefficients (Hair *et al.*, 2006). All coefficients from the confirmatory factor analysis verified that the model aligns with the collected data. Table 1 presents the standardized regression coefficients and estimates for the hypothesized relationships.

Table 1: Structural model estimates

	Estimates
H1: Attractiveness → Trust	-0.064ns
H2: Trustworthiness → Trust	0.277***
H3: Expertise → Trust	0.069ns
H4: Likability → Trust	0.483***
H5: Similarity → Trust	0.123***
H6: Trust → Purchase intention	0.418***
Notes: The estimates are standardized, and the level of significance is $p < 0.05$	

(Source: Authors' calculations)

Findings According to the values in Table 1, four out of six hypotheses are confirmed. Hypotheses H1 and H3 are rejected, indicating that attractiveness and expertise do not impact customers' trust in informative brand-related content. Statistically significant relationships are found for H2, H4, H5, and H6. Likability has the strongest positive relationship with trust, followed by trustworthiness. Similarity, while the weakest of the three, still significantly influences trust. Finally, trust in informative brand-related content positively affects customers'

purchase intentions. The findings partially align with the findings of Lou and Yuan (2019) that an influencer's trustworthiness and similarity to their followers positively impact followers' trust in the influencer's branded posts, which in turn enhances purchase intentions. However, while Lou and Yuan (2019) have demonstrated the effect of attractiveness on trust, our research does not support this hypothesis. This could be because, in informative brand-related content, the emphasis is on the information itself, making physical appearance have little to no impact on the perceived value of the information. Moreover, key findings of the research of Xiao et al. (2018) include that trustworthiness is the most significant factor in determining perceived information credibility, and the similarity between the influencer and the audience, particularly in attitudes, enhances the audience's perception of the influencer's credibility. This aligns with Hovland *et al.* (1953), who identified similarity as a key component of source credibility, significantly influencing the persuasiveness of the message. Xiao *et al.* (2018) also suggest that while likability may not be the most significant factor, it enhances the overall appeal and trustworthiness of the influencer, thereby affecting trust in the brand content. Cheung *et al.* (2009), observed that trustworthiness in electronic word-of-mouth communications positively correlates with perceived credibility, ultimately influencing consumer attitudes and behaviours. On the other hand, several papers confirm that the relevance of attractiveness and expertise is minimal, with expertise showing virtually no impact on trust (Wiedmann and Von Mettenheim, 2020; Wang and Scheinbaum, 2018) as suggested by our research. Finally, when it comes to purchase intentions studies have shown that trust in brand-related content significantly boosts purchase intentions. Lou and Yuan (2019) found that credible influencer messages enhance consumer trust, subsequently influencing purchase intentions. These findings highlight the essential role of trust in driving customer purchases (Lou and Yuan, 2019; Liu *et al.*, 2019) as our findings confirm.

Originality/value Although social media influencers have become a communication tool for brands, there is still a lack of research on how these influencers impact their followers' perceptions of the promoted brands (Castillo and Fernández, 2019). Having in mind the brief literature review presented in this paper, no other studies previously focused on the five-dimensional construct of source credibility. Previous studies (Hovland *et al.*, 1953; McGuire, 1985; Ohanian, 1990; Xiao *et al.*, 2018; Lou and Yuan, 2019; Bogoevska-Gavrilova and Ciunova-Shuleska, 2022) have used the two, three, or four-dimensional source credibility construct. Furthermore, this is the first study, as known by the authors, to focus only on informative content. Previous research studies (Ducoffe, 1995; Lin and Hung, 2009; Lou and Yuan, 2019; Pollay and Mittal 1993; Petrovici and Paliwoda, 2007; Van-Tien Dao *et al.*, 2014; Wolin *et al.* 2002; Bogoevska-Gavrilova, 2021) investigated predominantly informative and entertainment content value. The findings from this paper offer valuable insights for marketing managers working with influencers. Specifically, our findings indicate that if brands aim to enhance customers' trust in product information shared on social media and subsequently boost purchase intentions, they should collaborate with influencers who are perceived as trustworthy, likable, and similar to the target audience.

Keywords: *Source credibility theory, Influencer marketing, Trust in informative brand-related content, Purchase intentions.*

JEL classification: *M31, M37.*

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THE IMPACT OF ATTITUDES TOWARD GREEN ADVERTISING ON BRAND IMAGE AND CONSUMER PURCHASE INTENTIONS

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EXTENDED ABSTRACT

Purpose The purpose of this study is to examine the potential positive relationship between attitudes toward green advertising and consumer purchase intention and its influence on shaping the brand image of green products. By investigating these relationships, the research aims to provide insights into how attitudes toward green advertising can effectively drive consumer behaviour and contribute to the development of a strong, sustainable brand image. Green marketing is used as an alternative strategy to meet consumer needs and as a form of concern for environmental sustainability (Genoveva and Samukti, 2020). According to Chen and Chang (2012), green marketing also reshapes market rules by expanding product offerings and influencing nearly all of a company's activities. These include product modifications, changes in production processes, updates to product packaging, and adjustments in advertising (Ulfiah *et al.*, 2023). Based on the Theory of Planned Behaviour by Ajzen (1991), the combination of attitudes toward behaviour, subjective norms, and perceived behavioural control guides the formation of intention, and thus intention is assumed to be an antecedent of actual behaviour (Conner and Sparks, 2005). This research focuses specifically on the dimension of attitudes as the primary internal determinant guiding customer choice. By isolating this aspect, the aim is to provide a more reliable assessment of customers' internal motivations, which are crucial in understanding decision-making processes. The previous research results, as conducted by Nagar (2015), suggest that people tend to behave in ways consistent with their attitudes. Kotler *et al.* (2016) added that brand image is the perception and belief held by consumers, as reflected in the association embedded in consumer memory. If a product has a good image, then consumers will use the product. Researchers describe the brand image in terms of brand benefits, which are the "personal value" consumers associate with a brand, based on what they perceive the product's attributes will do for them, as noted by Nagar (2015). Alamsyah *et al.* (2020) suggest that increased awareness of green products can enhance a company's brand image, particularly through effective advertising strategies. In this regard, green advertising not only influences brand image but also plays a significant role in shaping consumers' intention to purchase ecological (green) products. Intention to purchase ecological products is conceptualized as a person's likelihood and willingness to give preference to

products with ecological characteristics over other traditional products in one's purchase considerations (Ali and Ahmad, 2012). In another case, Chan (2001) defines the intention to purchase this type of product as "consumers' behaviour towards a specific type of eco-friendly product to express their concern for the environment". In the context of environmentally friendly products, the basic consumer motivation can be reviewed from the information on environmentally friendly products owned by consumers (Rashid, 2009). Patel and Chugan (2015) highlighted the importance of advertisements focusing on the product's green features, as consumers are more likely to purchase items that offer personal relevance and benefits, rather than those that simply make green claims. Previous studies have confirmed that green advertising can improve consumer purchase intention (Davis, 1994; Haghjou *et al.*, 2013; Kong *et al.*, 2014; Alamsyah *et al.*, 2020; Amallia *et al.*, 2021; Chaniago and Nupus, 2021; Ramadhan *et al.*, 2024) and affect brand image (Nagar, 2015; Chaniago and Nupus, 2021) From here, we propose the following research hypotheses:

H1: Attitudes toward green advertising positively affect brand image.

H2: Attitudes toward green advertising positively affect purchase intention.

Design/methodology/approach The questionnaire used in this study was adapted from Kong *et al.* (2014). To test the hypotheses, we employed multiple linear regression in SPSS on a sample of 69 respondents. To validate the factors as conceptualized in the literature, we assessed construct validity through exploratory factor analysis (EFA) using principal component analysis with Promax rotation. Three factors were extracted, purchase intention (4 items), green brand image (3 items), and attitudes toward green advertising (2 items), accounting for 74.680% of the variance. One item from the green advertising factor was removed due to cross-loading issues. All retained items in the EFA model exhibited standardized factor loadings above the recommended threshold of 0.5, as suggested by Hair *et al.* (2010). Additionally, Cronbach's alpha coefficients for purchase intention (0.862), brand image (0.763), and green advertising (0.634) indicate strong internal reliability, with values above the 0.7 threshold recommended by Hair *et al.* (2010), though the green advertising coefficient, while below 0.7, is still considered acceptable according to Griethuijsen *et al.* (2014). Normality, linearity, and homoscedasticity were confirmed through the examination of standardized residual plots (Tabachnick and Fidell, 2012). Moreover, the variables adhered to acceptable values for VIF and Tolerance (Hair *et al.*, 1995), and the Durbin-Watson test indicated no autocorrelation in the residuals from the regression analysis (Durbin and Watson, 1971).

Table 1: Linear regression model coefficients

	Standardized Beta coefficients
H1: Attitudes toward green advertising → Brand image	0.339***
H2: Attitudes toward green advertising → Purchase intention	0.491***
Notes: The coefficients are standardized with $p < 0.05$ as a level of significance	

(Source: Authors' calculations)

Findings We created two models to apply multiple linear regression: the first model explores the relationship between attitudes toward green advertising and purchase intention, while the second model investigates the impact of attitudes toward green advertising on brand image. Both overall models are statistically significant. The R square and Adjusted R square values show that attitudes toward green advertising account for 24.1% and 22.9% of the variation in

consumers' purchase intention, respectively, and 11.5% and 10.2% of the variation in brand image. According to the p-value for both regression models, we confirm hypotheses H1 (p-value = 0.004) and H2 (p-value = 0.000). The standardized beta coefficients, as presented in Table 1, indicate that attitudes toward green advertising have the most significant positive impact on purchase intention (0.491), followed by its effect on brand image (0.339). This is supported by the findings of Davis (1994), who believes that environmentally-themed corporate advertising improves both the environmental reputation of companies and their product image, thereby increasing consumers' intent to purchase their products. According to H1 of this research, there is a significant relationship between attitudes toward green advertising and brand image, as also found in previous studies (Nagar, 2015; Chaniago and Nupus, 2021). Therefore, as mentioned in Nagar (2015), initiative by the firm in the form of green advertising, communicating its environmental concerns to the consumers is likely to spill over to the sponsor brand, leading to a positive opinion about the brand's image, as confirmed by our results. Amallia *et al.* (2021) confirmed the positive relationship between green advertising and purchase intention, stating that an increased frequency of advertisements can enhance potential consumers' engagement with the ads and increase their knowledge of environmentally friendly products, influencing purchasing decisions based on advertising content. However, the results of the present study contradicted the study by Kong *et al.* (2014), who found that green advertising did not significantly influence green purchase intention. Instead, Kong's research identified green corporate perception, eco-labels, and product value as the three most significant determinants of green purchase intention.

Originality/value The results provide a comprehensive understanding of how attitudes toward green advertising affect consumer behaviour and influence the intention to purchase eco-friendly products by building a positive brand image. Extensive research has been conducted to investigate the impact of certain factors on purchase intention, including green marketing, brand image, advertising, and price (Ramadhan *et al.*, 2024); perception of green products, which is conceptualized as a multidimensional variable comprised of green corporate perception, eco-label, green advertising, green packaging, and green product value (Kong *et al.*, 2014). Alamsyah *et al.* (2020) reviewed the positive correlation among green advertising, green brand image, and customer green awareness of environment-friendly products and their impacts on purchase intention, while Patel and Chugan (2015) pointed out that environmental knowledge, company image, product feature improvisation, and ethical impact are the aspects of green advertising that had positive significant influences on consumers green purchase intention. As well, some researchers have investigated the direct relationship between brand image and purchase intention (Kong *et al.* 2014; Ramadhan, *et al.*, 2024), or the influence of green marketing on consumers' purchase decisions mediated by brand image (Genoveva and Samukti, 2020; Chaniago and Nupus, 2021; Ulfiah *et al.*, 2023;). Research has primarily focused on the impact of green advertising on purchase intention (Davis, 1994; Haghjou *et al.*, 2013; Kong *et al.*, 2014; Alamsyah *et al.*, 2020; Amallia *et al.*, 2021; Chaniago and Nupus, 2021; Ramadhan *et al.*, 2024) or the effect of brand image on purchase intention (Kong *et al.*, 2014; Ramadhan *et al.*, 2024). However, there is a research gap regarding the direct influence of attitudes toward green advertising on brand image keeping in mind that the research base that has explored the relationship between green advertising and brand image is scarce (Nagar, 2015; Chaniago and Nupus, 2021). Therefore, the originality of this study is grounded in its focus on attitudes toward green advertising as a driving factor that shapes the brand image and consequently influences the purchase intention of eco-friendly products. However, further research may be conducted by examining a particular type of green advertisement, such as online advertising and social media activities. The results provide valuable insights for marketers, encouraging them to continue investing in environmental responsibility and developing effective advertising strategies for their products. Therefore, to create a favourable

attitude toward eco-friendly products, more intensive marketing communications, and green advertising strategies should be employed.

Keywords: *Green advertising, Purchase intention, Brand image.*

JEL classification: *M31.*

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EXPERIENCE ECONOMY IN CULTURAL INSTITUTIONS: AROUSAL TO CUSTOMER LOYALTY

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EXTENDED ABSTRACT

Purpose The present research, which builds upon Pine and Gilmore's (1999) experience economy framework, aims to investigate the relationship between the four dimensions of the experience economy - education, entertainment, escapism, and esthetics - and their impact on arousal and customer loyalty. Certain industries are growing significantly in today's global economy due to the rising demand for experiential consumption (Oh *et al.*, 2007). This trend reflects a shift towards an experience-driven economy, where consumers prioritize unique experiences over traditional products and services (Pine and Gilmore, 1999; Oh *et al.*, 2007) a prerequisite for competitive advantage in the event industry (Manthiou *et al.*, 2011). Research on the experience economy highlights its four key dimensions: education, entertainment, escapism, and esthetics. The literature on arousal's impact on loyalty in the experience economy reveals several significant findings. The experience economy dimensions significantly influence consumer arousal and loyalty (Alan *et al.*, 2016; Girish and Chen, 2017; Brzovska *et al.*, 2020). Moreover, Kastenholtz *et al.* (2017) extended this framework to rural tourism, demonstrating that the esthetic dimension strongly influences arousal and satisfaction, which are critical for loyalty. Their findings align with Pine and Gilmore's (1999) assertion that creating memorable and engaging experiences is crucial for competitive advantage. Quadri-Felitti and Fiore (2013) examined wine tourism, concluding that the esthetic dimension of the experience economy is the most influential in creating positive memories and destination loyalty. Manthiou *et al.* (2014) also investigated the experience economy four-dimensional concept when it comes to memory vividness and loyalty at festivals, and their results show that entertainment and esthetics significantly impact loyalty, emphasizing the need for memorable experiences. Alan *et al.* (2016) found that cognitive assessments and emotional responses, including arousal, play crucial roles in shaping store loyalty in retail settings. Their study suggests that positive emotional arousal, directly and indirectly, affects consumer loyalty. Finally, Girish and Chen (2017) demonstrated that arousal significantly influences satisfaction and loyalty in festival contexts, highlighting the importance of creating authentic and engaging experiences to foster attendee loyalty. Brzovska *et al.* (2020) found that educational and esthetic experiences positively impact arousal and memory in the wine industry. Another study by Brzovska *et al.* (2023) also explores how the dimensions of Pine and Gilmore's experience

economy (education, entertainment, escapism, and esthetics) affect consumer loyalty in cultural institutions. The research reveals that esthetics and entertainment significantly enhance memory, boosting loyalty, and education and escapism contribute to the overall experience (Brzovska *et al.*, 2023). These studies collectively underscore the pivotal role of arousal and emotional engagement in enhancing customer loyalty across various sectors. By understanding how these dimensions influence consumer behavior, businesses can better design and market their experiences to build stronger customer relationships. Based on this we propose the following hypotheses:

H1: Education has a positive influence on the arousal of visitors to cultural institution events.

H2: Entertainment has a positive influence on the arousal of visitors to cultural institution events.

H3: Esthetics has a positive influence on the arousal of visitors to cultural institution events.

H4: Escapism has a positive influence on the arousal of visitors to cultural institution events.

H5: The arousal of visitors to cultural institution events has a positive influence on their loyalty toward the institution.

Design/methodology/approach To conduct this study, an online survey was conducted using snowball sampling, yielding 224 responses. After screening the data, 222 responses were deemed valid. The survey questionnaire measured respondents' perceptions of the four experiential dimensions, arousal, and loyalty to a specific cultural institution. Structural equation modeling (SEM) was used to analyze the data and determine the strength and direction of the relationships between the variables. SEM combines factor analysis and multiple regression to examine measurement and structural model components (Hair *et al.*, 2006). Using a two-stage approach (Anderson and Gerbing, 1988), confirmatory factor analysis (CFA) validated the measurement model and assessed the structural model to examine hypothesized relationships. The standardized regression coefficients and estimates of the hypothesized relationships are presented in Table 1.

Table 1: Structural model estimates

	Estimates
H1: Education → Arousal	0.009ns
H2: Entertainment → Arousal	0.42***
H3: Esthetics → Arousal	0.533***
H4: Escapism → Arousal	0.075***
H5: Arousal → Loyalty	0.925***
Notes: The estimates are standardized, and the level of significance is $p < 0.05$	

(Source: Authors' calculations)

Findings Based on data presented in Table 1 we can conclude that four out of five hypotheses are supported, as indicated by the p-value at a significance level of 0.05. The study results indicate that the relationship between arousal and customer loyalty is positive and the strongest in the model, resulting in accepting H5. Regarding the relationships between the four experiential dimensions and arousal, it is evident that esthetics has the strongest positive impact (H3 is confirmed), followed by entertainment (H2 is confirmed). H4 is also confirmed meaning escapism has also a significant impact on arousal, while education is not significantly related to arousal (H1 is rejected). These findings indicate that prioritizing visually appealing and aesthetically pleasing experiences that are entertaining can boost arousal and, in turn, foster loyalty. The study also emphasizes the significance of crafting engaging and entertaining experiences to stimulate arousal in consumers.

Originality/value This study contributes to the existing literature on the experience economy by providing empirical evidence of the relationships between different experiential dimensions

and consumer behavior. The findings highlight the pivotal role of esthetics, entertainment, and escapism in enhancing visitor arousal within cultural institutions, which subsequently fosters customer loyalty. Esthetics was found to be the most important factor influencing arousal. This means that attractive environments deeply engage visitors' senses and emotions. This finding agrees with Quadri-Felitti and Fiore (2013), who concluded that esthetics is crucial for creating positive memories and building loyalty in wine tourism. Similarly, Manthiou *et al.* (2014) discovered that esthetics significantly affects how vividly people remember festivals and their loyalty to them, highlighting the importance of creating memorable experiences. Entertainment also had a strong positive effect on arousal. This supports the findings of Manthiou *et al.* (2014), who showed that entertainment significantly boosts loyalty by enhancing visitor experiences. Escapism also positively influenced arousal, although not as strongly as esthetics and entertainment. This aligns with Girish and Chen (2017), who found that escapism contributes to genuine and engaging experiences, which in turn increase attendee satisfaction and loyalty in festival settings. Education did not have a significant effect on arousal, which was unexpected. This differs from studies like Kastenholz *et al.* (2017), who found that educational experiences do influence arousal and satisfaction in rural tourism. Furthermore, this suggests that in cultural institutions, simply providing information or learning opportunities might not create strong emotional responses that lead to loyalty. It highlights the need to combine educational content with esthetic and entertaining elements to enhance its impact. This idea aligns with Brzovska *et al.* (2020), who discovered that educational and esthetic experiences positively affect arousal and memory. The originality of this study lies in its focus on cultural institutions and events, areas that have been largely overlooked in prior research in the context of the experience economy, which has predominantly concentrated on tourism and wine tourism settings, with limited attention to its implications for cultural institutions or events (Oh *et al.*, 2007; Kastenholz *et al.*, 2017; Brzovska *et al.*, 2020; Quadri-Felitti and Fiore, 2012; Mehmetoglu and Engen, 2011; Manthiou *et al.*, 2011; Manthiou *et al.*, 2014). By identifying which dimensions have the most significant impact on arousal and loyalty, businesses can optimize their experiential offerings better to meet the needs and preferences of their target audience. This research provides valuable insights for marketers and businesses aiming to create engaging experiences that enhance arousal and drive customer loyalty in cultural institutions.

Keywords: *Experience economy, Cultural institutions, Arousal, Customer loyalty.*

JEL classification: *M31.*

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GEN Z PERCEPTIONS ON GOVERNMENT GAMIFICATION INITIATIVES TO REDUCE SHADOW ECONOMY IN NORTH MACEDONIA

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ABSTRACT

This study examines the role of the MojDDV app, a gamification initiative designed to increase fiscal transparency and curb the shadow economy in North Macedonia, by engaging citizens in reporting their purchases through receipt scanning. Leveraging the Unified Theory of Acceptance and Use of Technology (UTAUT) model, this research investigates how the constructs of Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions impact Generation Z's intention to use MojDDV. The UTAUT model is implemented to understand factors that drive or hinder app adoption, ultimately aiming to identify how gamification can incentivize responsible fiscal behaviour and transparency. Data was collected via a structured questionnaire, and multiple regression analysis was conducted to determine the relationships between these constructs and intention to use. The findings reveal that Facilitating Conditions and Social Influence are significant predictors of intention to use, underscoring the importance of resource accessibility and social encouragement in fostering app engagement. While both Performance Expectancy and Effort Expectancy are positively associated with intention to use, their effects are not statistically significant. This suggests that providing practical support and leveraging social networks may be more impactful for adoption than user expectations of ease and performance. These insights recommend that policymakers focus on enhancing facilitating conditions and social influence mechanisms to boost the effectiveness of gamification initiatives like MojDDV. Future studies could examine

additional factors that affect app engagement and employ longitudinal methods to assess changes in user behaviour over time. This research contributes to a deeper understanding of how gamification strategies can support fiscal transparency efforts, offering valuable guidance for developing public sector innovations aimed at reducing the shadow economy.

Keywords: Gamification, Shadow Economy, MojDDV, North Macedonia.

JEL classification: H26, D83, O33.

1. INTRODUCTION

According to IMF (How to Manage VAT refunds, IMF, April 2021) “the VAT is a consumption tax borne by the final consumers of goods and services (in most cases, households). By design, the VAT-unlike retail sales tax (RST)-is collected at all stages of the production-distribution chain, including on intermediate transactions. However, VAT is only paid on the value added at each stage”. The most widely used approach is to ensure that the VAT falls only on final consumption (the invoice-credit method). According to this method, taxpayers can credit input VAT they have paid (and shown on their purchase invoices) against output VAT they have collected (and shown on their sales invoices). VAT is one of the most important taxes in the world, both in terms of its global adoption and revenue-generating potential. Over 30% of global government taxes are collected at the central and federal levels in over 160 nations (WoRLD 2019). VAT is an appealing tax due to its ability to generate large government revenue and self-enforcement capacity. In many countries, some provisions enable taxpayers to claim refunds, after meeting several sometimes very strict requirements. When taxpayers seek these refunds, payments are frequently delayed or not received. These issues are not the product of VATs, but more of the inadequate legal and institutional frameworks, as well as limited administrative ability, that cause VAT refund fraud.

1.1. MojDDV application

At the beginning of 2019, the Parliament adopted the Law on the return of part of the value-added tax to citizens and it came into effect on July 1, 2019. The Law was amended several times¹. The main idea of the Law is to provide partial return of the paid value-added tax by the physical persons after buying good/services for which they were given a fiscal bill with clearly stated amount of the paid tax that was issued by the seller with the proper unique bar code². According to the last revision of the Law, 20% of the paid tax on goods/services produced in the country can be returned to the customer, and 10% of the paid tax on the rest of the goods and services. The reimbursed sum for one trimester should not exceed 2100 denars (approximately 35 Euros). The maximum amount of a single bill should not exceed 30000 denars (approximately 500 Euros). The only way to get the reimbursement is by scanning the code in the application on a mobile phone or PC (MojDDV). The Public Revenue Office (PRO) should pay the money within 60 days from the end of the quarter. To register an account, one should be older than 15 years, have an ID issued by the Republic of North Macedonia, and have a banking account. According to the government, the main reason for the adoption of this law is the reduction of tax evasion. Therefore, an increase in the registered turnover through fiscal systems of equipment is expected, as well as an increased collection of taxes, that is, a reduction in tax evasion by taxpayers. According to the PRA, there are more than 500000 registered users (523.673), and for the total period of 4 years more than 120 million Euros were

¹ Official Gazette of the Republic of North Macedonia no.133/19,275/19,244/20,65/23

² Law on registration of cash payments

given back to the citizens. 523.673 In the first quarter of 2024, 22,670,713 fiscal receipts were scanned, and a total turnover of 11,423,978,620 denars was achieved, with a calculated total VAT of 1,241,434,628 denars (Akademik, 2021).

1.2. The rationale behind the project MojDDV

As mentioned, the main idea behind the project of tax return by use of MojDDV is to decrease tax evasion. Other possible consequences such as social, political, or even influence on macroeconomic aggregates (demand, inflation) are rarely mentioned and/or investigated by government officials. There are numerous theories that deal with the rationale of tax morale and tax evasion. The concept of “tax morale” can be defined as a moral obligation and a belief in a better society by paying taxes (Frey and Torgler, 2007). Tax morale measures attitudes toward paying taxes, unlike tax evasion, which measures actual behaviour. In the authors’ opinion, the theory that can explain tax evasion practices in the country is the theory of unexpected benefit. The main idea of this theory is that in a risky and uncertain situation of being caught and sanctioned for tax non-compliance, individuals happen to behave contrary to the assumptions of the model of expected benefit. McGee (2008) has concluded that the major argument in favour of tax evasion is that governments are susceptible to corruption and the tax system is unfair. By increasing the responsibility, political stability, and the absence of violence, as well as by the efficiency of the government, the rule of law, and control over corruption, trust in governmental institutions and legal systems will increase,

The relative tax revenues to GDP ratio is a simple measure of assessing the level to which taxes stimulate the national economy, and it is also used in combination with other metrics with the purpose of measuring the level of government oversight over its economic resources. In the last decade, this ratio is between around 20%, which is less than in EU countries. According to the abovementioned estimates, that means that the Republic of North Macedonia suffers losses of 9.9% of the GDP or 14.5%, which is 102 million euros annually due to the low tax morale (numbers that can go even higher in the Republic of North Macedonia if we take into consideration the likely lower level of tax morale as a result of the lack of trust in the state and local institutions). The shadow economy in the Republic of North Macedonia, which represents a rooted issue and continues to be a significant challenge, is something that CEA (2012) has studied, and the results indicate that it is present with over 30% of the GDP in 2016. The IMF has also come up with a 38% share of the shadow economy in the GDP.

The idea that a strong state with the ability to enact laws and a population that supports the system confirms the relationship strong state and less tax evasion. Strong and institutionally well-organized states are also thought to have a lower shadow economy and higher rates of tax compliance. People who have faith in their governments have demonstrated higher levels of tax morale than people who do not.

Tax morale is higher among citizens who view fiscal redistribution as a fundamental component of democracy and society as a whole—that is, those who believe taxes from the wealthy should be collected to support the impoverished. Active participation in decision-making, especially at the local level, is associated with higher tax morale, a sense of ownership, and increased accountability to the community and society.

Transparent policies and procedures that govern the processes in budget execution and reflect its strategic planning—in which the government aligns its goals with the resources from the budget—are expected to be part of the public finance system. The more informed the constituents are, the more influence they have in fostering the legislators to enact the best possible social policies. More specifically, one of the things that affects tax morale is mistrust of the establishment. Tax morale may suffer because of careless tax revenue spending if people consistently believe that their money is being misappropriated by the government.

The Government of the country through the Ministry of Finance is following the so called Public Fiscal Management Reform Program (PFM) and it is mentioned that progress has been achieved in number of areas, but many areas for improvement remain works in progress. The PRO and the CA (Customs Administration) account for all central government tax revenues and SSC (Social Security Contribution) and for 91.3% of total revenues collected in the Budget of the Republic of North Macedonia (taxes only 56%). After performing design and redesign of the main business processes, the PRO has been developing the Integrated Tax Information System (ITIS). The system has several core modules (Registration, Filing and Service Management, Accounting, Payments, and Refunds, Debt management, Assessments, Legal, and Audit). Within the PRO, a contact center has been opened, offering a combination of communication channels and development solutions aimed at full customer service to all taxpayers (citizens and businesses) in realization of their tax rights and obligations.

Types of taxes and contributions which fall in public revenues in the RNM are as follows: personal income tax; profit tax; value added tax; excise duties; Customs – import duties; compulsory social security contributions (three funds); and property taxes (local taxes). The general value added tax rate is 18%, while the preferential rate of 5% is applied to certain goods and services. The value added tax is represented with the largest share of (almost one half) 45.2% in the total tax revenues for 2019, i.e. 25.5% of the overall budget revenues. In the Republic of North Macedonia, the share of tax revenues in the gross domestic product (GDP) is around 17% (which has been almost constant for two decades) compared to the larger shares in the EU countries, ranging between 25-50%. This is the minimum level considered by the UN as necessary for achieving the Millennium development goal. 42 For a comparison, the OECD countries tax revenues share in the GDP is approximately 35%. In the case of RNM the indirect tax is dominant, i.e. around 80% falls onto consumption taxes (VAT), while in the EU personal taxes have a bigger share.

To increase interest in the project, the Ministry of Finance introduced another game at the end of 2019 that lasted for one year. By scanning each fiscal account through the MojDV application, every adult citizen was a potential winner of one of 3,852 awards in total of half a million Euros by awarding 10 daily awards – 4 out of 1,000, 3 out of 2,000 denars and 3 out of 3,000 denars. The rest of the scanned accounts received serial numbers that entered the monthly cycle for 15 prizes of 100,000 denars (1600 Euros), as well as for the two premiums of 3,000,000 denars (50000 Euros). To participate in the prize game, the person had to be registered on the e-Personal tax system and be a user of the MojDV application. The drawing of the daily awards was carried out by an electronic random generator. The winners of daily prizes receive notice immediately after the account scan and the others received will receive a message with educational-information content. The drawing of the prizes from 100,000 denars and premiums of 3 million denars was broadcasted live immediately after the draw from Lotto 7 and Joker extraction. According to the Ministry, citizens who scan fiscal accounts than had threefold benefits: the possibility of receiving one of the cash prizes up to 3,000,000 denars, the second VAT refund and third – to contribute to the fight against the grey economy. In presenting the prize game former Minister of Finance Nina Angelovska pointed out that MojDDV #MyAward was created for best practices of prize games in other countries for addressing the grey economy (PRO, 2022). With the prize game citizens receive motivation to demand and scan fiscal accounts and thus influence the reduction of tax evasion that is harmful to the economy.

1.3. Research background

Gamification—the application of game mechanics in non-game contexts—has emerged as an effective approach to improve user engagement and motivation across diverse fields, including

public administration (Hassan and Hamari, 2020). Studies indicate that gamification in government services can increase civic participation and compliance by making public interactions more engaging and rewarding (Wijaya and Sutomo., 2023). In fiscal policy, gamification techniques have been applied to encourage tax compliance and reduce the shadow economy by involving citizens in an interactive, reward-based system that fosters accountability and transparency (Muller, 2020).

The shadow economy- comprising unreported economic activity-poses significant challenges for governments globally, often undermining tax revenue and fiscal transparency (Medina and Schneider, 2021). In North Macedonia, estimates place the shadow economy at approximately 30-40% of GDP, which impacts tax morale, defined as the moral obligation to pay taxes for societal benefit (Torgler, 2020). Gamified applications like the MojDDV app aim to address these challenges by using rewards to reinforce the perceived benefits of tax compliance and fiscal responsibility. According to a study on gamification and fiscal initiatives, reward mechanisms and social incentives significantly increase voluntary tax compliance, especially among younger populations (Halkos *et al.*, 2020).

The Unified Theory of Acceptance and Use of Technology (UTAUT), developed by Venkatesh *et al.* (2003), serves as a foundational model for understanding technology adoption in various fields, including public sector gamification. This model identifies Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions as key determinants of intention to use technology. Research demonstrates that these constructs are particularly relevant for understanding user' behaviour intention in digital government services, as factors like social endorsement and resource availability strongly influence adoption rates. The UTAUT framework has been successfully applied to analyse the effectiveness of gamification initiatives in other governmental contexts, highlighting its relevance in assessing MojDDV's impact on user engagement and tax compliance (Abu-Shanab and Al-Sayed, 2019).

When examining Generation Z's interaction with MojDDV, it is critical to consider this cohort's digital preferences and engagement patterns. Generation Z, known for its preference for intuitive, socially integrated digital platforms, often responds positively to gamified experiences that align with their values, such as transparency and efficiency. Studies reveal that gamification can be especially effective in engaging audiences in government initiatives, as peer influence and streamlined user experiences directly affect their likelihood of participation (Guerra *et al.*, 2024).

The aim of this research is to examine the intention of Generation Z to engage with the MojDDV app through the UTAUT framework, specifically focusing on how Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions contribute to app adoption. By understanding these factors, this study provides insights into how gamified government initiatives like MojDDV can enhance fiscal transparency, increase tax compliance, and engage a digital-native population in reducing the shadow economy.

2. LITERATURE REVIEW

In recent years, governments worldwide have increasingly turned to innovative solutions to address complex challenges, such as the shadow economy. One such innovative approach is the use of gamification—a strategy that applies game design elements in non-game contexts to engage users and solve problems. Gamification has been shown to effectively motivate behaviour change, enhance engagement, and improve both educational outcomes and business processes (Hamari *et al.*, 2014; Deterding *et al.*, 2011). In the context of public governance, gamification can play a crucial role in encouraging compliance and participation in civic duties (Mollick and Rothbard, 2014). However, the application of gamification also can have limited effectiveness, since it may require changes in government policies (Nepal *et al.*, 2015).

North Macedonia, like many countries, faces challenges related to the shadow economy, particularly tax evasion. To address these issues, the government introduced the "MojDDV" app—a gamified initiative aimed at reducing undeclared economic activities by incentivizing citizens to scan their purchase receipts, thus promoting transparency and accountability in transactions. This approach not only aids in capturing more fiscal information but also engages citizens directly in governance processes, potentially altering their perceptions and behaviours toward tax compliance (Thomson *et al.*, 2005).

Generation Z, defined as individuals born from the late 1990s to the early 2010s, represents a significant segment of the population that is particularly adept at using technology and engaging with digital platforms (Seemiller and Grace, 2016). Understanding how this demographic interacts with gamified government initiatives is crucial for evaluating the effectiveness of such strategies. Research suggests that Gen Z values transparency, engagement, and digital connectivity, characteristics that may influence their responses to gamification in a governance context (Williams, 2015).

The MojDDV effort provides a chance to examine these processes. Through analysing Gen Z's perspectives and involvement with MojDDV, we may acquire valuable knowledge on the capacity of gamification to tackle governance obstacles and improve the efficiency of policies. This study seeks to address the lack of research in the literature by specifically examining the perspectives of young individuals toward gamified initiatives undertaken by the government. The study enhances our understanding of how individuals from Generation Z engage with and perceive gamified systems in governmental settings, providing a more detailed perspective.

Gamification has been increasingly adopted in public governance as a tool to enhance citizen engagement, improve public service delivery, and promote transparency and compliance. The core idea is to apply elements typical of game playing (e.g., point scoring, competition) to other areas of activity, often to increase user engagement and participation (Hamari *et al.*, 2014). Studies have shown that when gamification is effectively implemented, it can significantly enhance the motivation and engagement of citizens towards governmental programs (Mollick and Rothbard, 2014). For instance, Thom *et al.* (2016) observed that gamification strategies could transform mundane tasks, like tax filing or following governmental regulations, into more engaging and less cumbersome experiences, thereby potentially reducing avoidance behaviours.

The shadow economy consists of those economic activities that are not monitored by government institutions and, therefore, escape taxation and regulation (Schneider *et al.*, 2010). North Macedonia, like many transition economies, has struggled with a sizable shadow economy, which affects fiscal stability and equitable growth. Researchers argue that one of the effective ways to combat this issue is through enhancing fiscal transparency and engaging citizens directly in monitoring economic activities (Williams and Schneider, 2016). The MojDDV app represents such an effort by incentivizing the formalization of transactions through receipt scanning.

Gamification in the public sector has been applied in various contexts to improve compliance and transparency. For instance, the "Taxman" initiative in Brazil used game elements to encourage tax compliance among citizens. The initiative saw a significant increase in tax revenues as citizens were motivated to engage with the tax system more actively (Alm and Torgler, 2011). Similarly, in South Korea, a mobile application named "Check Your Receipt" was introduced to reduce tax evasion by allowing users to scan receipts and enter a lottery. This initiative led to a notable increase in the issuance of receipts and improved tax compliance (Choi and Park, 2013).

Generation Z, having grown up with digital technology, exhibits distinctive behaviours and preferences in their interaction with digital platforms, including government services. According to Seemiller and Grace (2016), Gen Z values transparency, speed, and convenience

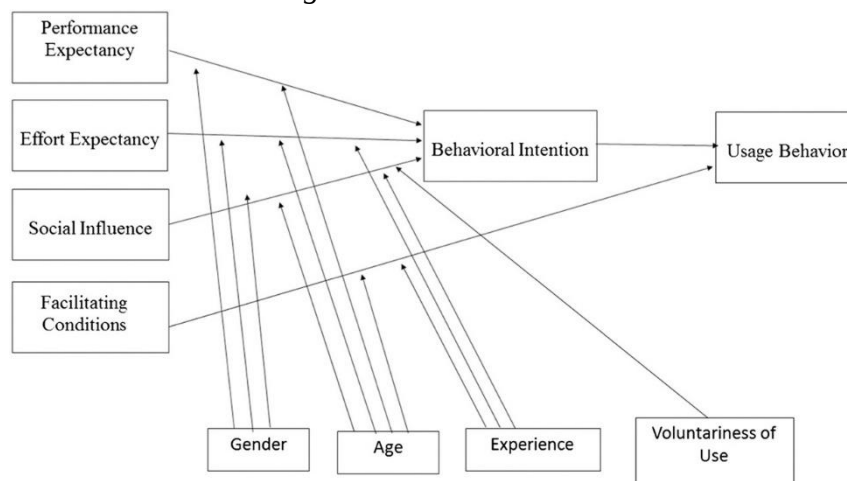
in their digital interactions. Research by Smith (2017) indicates that this generation is more likely to engage with digital platforms that offer immediate rewards and feedback, characteristics that are inherently aligned with gamification principles. This suggests that gamification strategies, such as those used in the MojDDV initiative, could be particularly effective with this demographic.

The effectiveness of gamification in improving tax compliance has been a subject of interest among researchers. Studies such as those by Hallsworth *et al.* (2017) indicate that even small, gamified elements, such as competitions or simple rewards, can lead to increased tax compliance. The underlying psychological mechanisms—increased attention, motivation, and satisfaction—suggest that gamified approaches could reshape how citizens perceive and engage with tax-related responsibilities (Hamari, 2017). Moreover, the literature on gamification emphasizes the importance of user-centric design. Kankanhalli *et al.* (2012) found that when gamification elements are tailored to the preferences and motivations of users, the engagement levels significantly improve. This aligns with the findings of Mekler *et al.* (2017), who noted that personalized gamification elements, such as setting personal goals and receiving immediate feedback, enhance user satisfaction and performance.

Building on the theoretical foundation laid out in the literature review, this study seeks to empirically investigate the perceptions and intentions of Generation Z towards the MojDDV app, a gamification initiative aimed at reducing the shadow economy in North Macedonia. The literature suggests that gamification can significantly enhance engagement and compliance, particularly among younger demographics who are more accustomed to digital interactions and gamified environments.

The Unified Theory of Acceptance and Use of Technology (UTAUT), as shown in Figure 1, was developed by Venkatesh *et al.* (2003), as a comprehensive model that integrates elements from various technology acceptance models. It aims to explain user intentions to use an information system.

Figure 1: UTAUT Model



(Source: Venkatesh et al., 2003)

The following hypotheses were outlined for testing:

H1: There is a positive relationship between Performance Expectancy and intention to use MojDDV among Generation Z in North Macedonia.

H2: There is a positive relationship between Effort Expectancy and intention to use MojDDV among Generation Z in North Macedonia.

H3: There is a positive relationship between Social Influence and intention to use MojDDV among Generation Z in North Macedonia.

H4: There is a positive relationship between the presence of Facilitating Conditions and the intention to use MojDDV among Generation Z in North Macedonia.

3. METHODOLOGY

This study employs a quantitative research design to investigate Generation Z's perceptions and intentions toward the MojDDV gamification initiative aimed at reducing the shadow economy in North Macedonia. The research utilizes the Unified Theory of Acceptance and Use of Technology (UTAUT) model as the primary framework for evaluating the acceptance and usage of the MojDDV app. Specifically, this model helps identify the influence of constructs such as Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions on the intention to use the app. A structured questionnaire was developed based on the UTAUT constructs. The constructs utilized are the following:

- **Performance Expectancy:** Measures how users perceive the effectiveness of the gamification initiative in reducing tax evasion and whether they believe participating in it will lead to a tangible benefit
- **Effort Expectancy:** Assess how easy and convenient users find the process of scanning receipts and participating in the program.
- **Social Influence:** Measure the extent to which social factors, such as seeing others participate or societal pressure to combat tax evasion, influence individuals to engage
- **Facilitating Conditions:** Evaluate the infrastructure and support in place for the initiative, such as the availability and reliability of the receipt scanning technology, and any assistance provided to users.

Each construct was measured using multiple variables on a 5-point Likert scale, ranging from "Strongly Disagree" to "Strongly Agree." The questionnaire also included demographic questions to capture age, gender, employment status, and education level. Moderators were not included in the analysis because only young people were asked to participate, and gender is not considered to be important in the usage of apps in our country.

The target population for this study was Generation Z individuals residing in North Macedonia, defined as those born between the late 1990s and early 2010s. A purposive sampling method was employed to select participants who met the inclusion criteria: being active users of the MojDDV app. This focus on Gen Z is pertinent as younger users are generally more receptive to digital innovations and gamified interfaces in public sector initiatives. The sample size of 180 participants is justified due to the study's focus on a specific population subset, Generation Z students, who are early adopters of technology and highly relevant for evaluating app-based engagement in this demographic.

Data was collected using an online survey platform and participants were informed about the purpose of the study and assured of the confidentiality and anonymity of their responses. In the period between 16.02.2024 through 31.03.2024 more than 180 responses were received via online questionnaire. Data analysis was conducted using SPSS software to perform multiple regression analysis on the UTAUT constructs. By applying SPSS, the study effectively evaluated the relationships between the UTAUT constructs and the intention to use the MojDDV app, providing insights into the critical factors influencing app adoption within Generation Z.

4. RESULTS

4.1. Descriptive statistics

Participants answered a qualifying question “Have you used the app MojDDV?”, where 65.4% of respondents answered affirmatively. This indicates a significant portion of the surveyed population is engaged with the app, demonstrating its reach and potential impact. Most respondents fall within the age group 18-24, accounting for 97.5% of the sample. This is consistent with the focus on Generation Z in this study and underscores the relevance of the findings to this demographic. Among those who reported using the MojDDV app, 71.4% were female. On the question of whether they are scanning most of the receipts, more than 87% of respondents said that they are actually scanning all or almost all of them.

4.2. Cronbach’s Alpha

To ensure the internal consistency of the questionnaire items within each UTAUT construct, Cronbach's Alpha was calculated. Cronbach's Alpha is a measure of internal consistency, indicating how closely related a set of items are as a group. A Cronbach's Alpha value above 0.70 is generally considered acceptable, indicating good internal consistency. The results are presented in the table below:

Table 1: Cronbach’s Alpha for constructs

Construct	Cronbach's Alpha
Performance Expectancy	0.799
Effort Expectancy	0.858
Social Influence	0.815
Facilitating Conditions	0.828

(Source: Authors’ research)

These Cronbach's Alpha values indicate that the items within each construct have good internal consistency, supporting the reliability of the measures used in this study. These results confirm that the questionnaire items for each UTAUT construct reliably measure the intended variables, providing a solid foundation for further analysis.

4.3. Descriptive statistics

The descriptive statistics for the UTAUT constructs provide an overview of the respondents' perceptions and experiences with the MojDDV app.

Table 2: Descriptive statistics

Construct	Mean	Standard deviation	CV
Performance Expectancy	4.15	0.82	0.20
Effort Expectancy	3.83	0.91	0.24
Social Influence	3.99	1.05	0.26
Facilitating Conditions	3.46	0.91	0.26

(Source: Authors’ research)

As shown in Table 2, for the Performance Expectancy construct, respondents generally agreed that the MojDDV app helps reduce tax evasion and ensures retailers issue receipts, with a mean score of 4.15 (SD = 0.82). The Effort Expectancy construct, which measures the ease of use and convenience of the MojDDV app, received a moderately high mean score of 3.83 (SD = 0.91). Social factors, as captured by the Social Influence construct, played a significant role

with a mean score of 3.99 (SD = 1.05). Finally, the Facilitating Conditions construct, which assesses the availability of resources and support for using the MojDDV app, had a mean score of 3.46 (SD = 0.91). These statistics highlight that while there is a positive perception of the app's usefulness and ease of use, there are varying levels of social influence and perceived facilitating conditions among the respondents.

4.4. Multiple regression analysis

Multiple regression analysis was conducted to examine the relationship between the UTAUT constructs (Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions) and the Intention to use the MojDDV app. The results of the analysis are summarized below.

Table 3: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.684 ^a	.468	.449	.59459

(Source: Authors' research)

The regression model explained 46.8% of the variance in intention to use ($R^2 = 0.468$), indicating that the UTAUT constructs collectively have a significant impact on the intention to use the MojDDV app. The adjusted R^2 value of 0.449 suggests a good fit of the model to the data, with a standard error of the estimate of 0.59459.

Table 4: ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	35.461	4	8.865	25.076	<.001 ^b
	Residual	40.303	114	.354		
	Total	75.764	118			

(Source: Authors' research)

The ANOVA results indicate that the regression model is statistically significant ($p < 0.001$). This confirms that the independent variables (UTAUT constructs) reliably predict the dependent variable (Intention to use).

Table 5: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.849	.344		2.471	.015		
	PE_Composite	.100	.073	.109	1.358	.177	.719	1.392
	EE_Composite	.148	.086	.146	1.728	.087	.651	1.535
	SI_Composite	.197	.094	.190	2.094	.039	.568	1.761
	FC_Composite	.441	.086	.417	5.116	.001	.702	1.425

a. Dependent Variable: IU_Composite

(Source: Authors' research)

The regression results indicate that:

- **Performance Expectancy** (PE_Composite) has a positive but not statistically significant effect on intention to use ($b = 0.100$, $p = 0.177$).
- **Effort Expectancy** (EE_Composite) shows a positive effect that approaches significance ($b = 0.148$, $p = 0.087$).
- **Social Influence** (SI_Composite) has a positive and statistically significant effect on intention to use ($b = 0.197$, $p = 0.039$).
- **Facilitating Conditions** (FC_Composite) has the strongest positive and statistically significant effect on intention to use ($b = 0.441$, $p < 0.001$).

5. DISCUSSION

The regression analysis offers significant insights into the factors influencing the adoption and intention to use the MojDDV app among Generation Z in North Macedonia. The results reveal varying levels of influence across the four UTAUT constructs: Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions.

The results of the multiple regression analysis, indicate that the UTAUT constructs collectively explain a significant portion of the variance in the intention to use the MojDDV app. Facilitating Conditions and Social Influence are significant predictors of intention to use, suggesting that the availability of resources and support, as well as social factors, play crucial roles in influencing the use of the app. Although Performance Expectancy and Effort Expectancy are positively related to intention to use, their effects were not statistically significant.

H1: There is a positive relationship between Performance Expectancy and the intention to use MojDDV among Generation Z in North Macedonia. Performance Expectancy, which refers to users' belief in the app's ability to assist in reducing tax evasion and providing value through financial returns, was shown to have a positive, though not statistically significant, effect on intention to use ($b = 0.100$, $p = 0.177$). This suggests that while users may perceive the MojDDV app as beneficial, this alone does not strongly drive their intention to use it. Thus, H1—predicting a positive relationship between Performance Expectancy and intention to use—is not supported by the data. This finding aligns with research that suggests perceived utility alone may be insufficient to motivate consistent engagement if not accompanied by other factors, such as ease of use or social reinforcement.

H2: There is a positive relationship between Effort Expectancy and intention to use MojDDV among Generation Z in North Macedonia. Effort Expectancy, which gauges the ease and convenience of using the MojDDV app, was positively associated with intention to use but was not statistically significant ($b = 0.148$, $p = 0.087$). Although H2 hypothesized a positive influence, this result implies that perceived ease of use may play a supportive rather than a pivotal role in adoption. Users' engagement appears less reliant on the app's simplicity or user-friendly design than on other factors. This finding suggests that while simplifying the user interface could marginally improve engagement, it might not independently drive adoption rates.

H3: There is a positive relationship between Social Influence and intention to use MojDDV among Generation Z in North Macedonia. Social Influence, which captures the effect of friends, family, and social networks on app adoption, emerged as a significant predictor of intention to use ($b = 0.197$, $p = 0.039$). H3 is therefore supported, reinforcing the critical role of peer encouragement and societal perceptions in fostering usage intention. This result aligns with social proof theory, which posits that individuals are more likely to engage in behaviours when they observe others in their social circle doing the same. The significance of Social Influence in this study highlights the importance of community-driven initiatives and the potential impact of peer networks in promoting engagement with public sector digital

solutions. This finding suggests that policies aimed at increasing app adoption should consider strategies that leverage social networks, such as referral programs, community-based campaigns, and influencer partnerships. The influence of peers and family members on MojDDV adoption highlights a potential strategy for future government initiatives to enhance compliance and engagement through socially driven channels.

H4: There is a positive relationship between the presence of Facilitating Conditions and the intention to use MojDDV among Generation Z in North Macedonia. Facilitating Conditions, which encompass the availability of resources, infrastructure, and support, were identified as the strongest predictor of intention to use ($b = 0.441$, $p < 0.001$), thus supporting H4. This indicates that access to reliable resources and technological support significantly impacts users' decisions to engage with the MojDDV app. The importance of Facilitating Conditions aligns with previous literature on digital adoption, suggesting that providing a stable and accessible infrastructure is essential for sustainable user engagement. In this study, Facilitating Conditions were assessed through respondents' agreement with several key statements, including access to information on using MojDDV, the app's functionality and uptime reliability, the availability of customer support, and compatibility with users' devices. Notably, respondents were ambivalent about the support received, both from the app and the government, though they felt confident in their technological capabilities. This highlights the need for continuous technical support and educational initiatives to enhance users' experience and trust in government-provided digital solutions.

6. CONCLUSIONS

The objective of this study was to assess the effects of the MojDDV app, a gamification project created to improve fiscal transparency and decrease the share of the shadow economy in North Macedonia. The research aimed to comprehend the aspects that influence Generation Z's inclination to use the app, using the well-known Unified Theory of Acceptance and Use of Technology (UTAUT) model. The results of the multiple regression analysis indicate that Facilitating Conditions and Social Influence are strong predictors of intention to use. Having in mind that young people experience strong social influence on their behaviour the result is not a surprise. Furthermore, the notable influence of the social environment underscores the significance of social networks and peer recommendations in promoting the adoption of apps. The significant impact of Facilitating Conditions implies that users require dependable technological access and ongoing assistance to properly interact with the application. These findings suggest that the presence of resources and assistance, together with social encouragement from peers, are essential factors in the acceptance and utilization of the MojDDV app. While Performance Expectancy and Effort Expectancy did not show statistical significance as predictors, their positive associations with intention to use indicate that these components still play a role in the adoption process. The app's effectiveness in promoting tax compliance and its user-friendliness, although not the main factors, are crucial for improving user engagement.

The findings have important consequences for policymakers, as well as gamification initiatives in this sector. It is crucial to provide users with the required infrastructure and assistance to ensure the successful implementation of the MojDDV app. Moreover, utilizing social influence using focused ads and referral incentives can amplify user engagement. Continued emphasis should be placed on effectively communicating the advantages of the app and enhancing its user-friendliness. These suggestions should be considered in the period to come to utilize the app by more citizens.

Future research could analyse additional variables that might impact the adoption of the MojDDV application. An in-depth analysis of the relationship between trust in government and

perceived risk could offer valuable insights into the process of adoption. In addition, conducting longitudinal studies that monitor user behaviour over an extended period could provide useful insights into the long-term efficacy of gamification campaigns in encouraging tax compliance. Furthermore, these studies could also enhance the research by incorporating usage behaviour analysis based on the UTAUT model.

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CORPORATE GOVERNANCE AND FINANCIAL PERFORMANCE: THE IMPACT OF THE COVID-19 PANDEMIC

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ABSTRACT

The main objective of the paper is to examine the impact of the COVID-19 pandemic on the relationship between corporate governance and the financial performance of Serbian companies. The research was conducted on 22 non-financial companies listed on the Belgrade Stock Exchange between 2018 and 2022. The data are retrieved from the official websites of the Serbian Business Registers Agency and Belgrade Stock Exchange. The results suggest that the impact of ownership concentration on profitability is negative, while the impact on the market value is positive. On the other hand, the size of the board of directors negatively impacts profitability, while the share of non-executive directors in the board of directors negatively impacts market value. Results also indicate that the COVID-19 pandemic affected the relationship between corporate governance and financial performance and that the impact of corporate governance on financial performance was more significant before the COVID-19 pandemic.

Keywords: COVID-19 pandemic, Ownership structure, Corporate governance, Financial performance, Non-financial companies.

JEL classification: G34, H12, L25.

1. INTRODUCTION

The COVID-19 pandemic considerably affected most countries' everyday life and economic flows (Breuer *et al.*, 2023; Donthu and Gustafsson, 2020). Due to the uncertainty over the crisis's duration and scope, companies' decision-making became more challenging as they had to assess and balance more factors. This holds at least for the companies that could adapt and react to the changed social and economic environment.

The crisis caused by the COVID-19 pandemic turned attention to various problems and negative trends in companies (Golubeva, 2021; Jesus *et al.*, 2020). Management support, the company's ability to cover expenses, and the motivation and innovativeness of the employees became particularly important during the COVID-19 pandemic (Al-Habaibeh *et al.*, 2021; Santoso *et al.*, 2022).

Companies are expected to consider each possible scenario and adapt to it. The economic and business environment includes an increasingly complex string of pressures and requests from

various interest groups, increased expectations regarding corporate social responsibility, and radical uncertainty over future economic conditions (Anas *et al.*, 2023). These factors result in more complex decision-making for managers, questioning the widely accepted management model focused on creating shareholder value.

Well-structured corporate governance adds value to the company as it minimizes the information gap between owners and management and helps align the interests of these stakeholders towards the common objective (Schoenmaker and Schramade, 2023; Stančić, *et al.*, 2012b). It is, therefore, important to differentiate between internal and external mechanisms of corporate governance and their relative importance for shareholders, but also for investors in each stage of the value creation (Affes and Jarboui, 2023). The importance of corporate governance for the financial performance of companies is not studied enough, particularly in developing and/or transition countries, so many authors (Affes and Jarboui, 2023; Bui and Krajcsák, 2024) point to the need for more research on this issue.

The objective of the paper is to examine the impact of the COVID-19 pandemic on the relationship between corporate governance and the financial performance of Serbian companies. Assuming that the whole business world was under a big pressure from the pandemic, and some of the pressure is still evident, the objective was determined to study the relationship between the changed social and economic environment and changes in corporate governance and financial performance. The research covers only non-financial companies operating in Serbia. This research may help to better understand the impact that the COVID-19 pandemic had on Serbian non-financial companies. In addition, as corporate governance assumes a wide variety of elements, the research may emphasize the elements that were changed the most during the COVID-19 pandemic.

This paper may help identify key challenges that companies had to cope with during the COVID-19 pandemic to find the best solutions to overcome these challenges and recover from the negative effects of the COVID-19 pandemic. The paper also emphasizes the strategies that companies may employ to avoid or minimize the consequences of similar crises. Current problems and the available solutions to react to them are therefore analyzed, while we also look for the solutions that may be employed during other similar crises. Specific problems that the pandemic brought require a detailed analysis of corporate governance as an important factor in company survival and development.

Besides the introduction and conclusion, the paper consists of three sections. The theoretical background and results of the prior research are presented in the first section to develop research hypotheses. The second section presents the research methodology, including samples, variables, and research methods. Finally, the research results are presented in the third section.

2. THEORETICAL BACKGROUND AND LITERATURE REVIEW

The separation between company ownership and control led to many theoretical discussions and empirical research on the efficient adjustment of the interests of owners and management. As noted by Pande (2011), Adam Smith started this issue in 1776 arguing that separation between company ownership and control leads to the weak incentives for management to efficiently manage a company. In line with agency theory, agency costs are inevitable to adjust the relationship between owners and management. Companies are the hubs to regulate relationships between different interest groups, which bear the agency costs and have the economic incentive to minimize them (Pande, 2011).

2.1. Ownership and financial performance

Owners control the company in proportion to their share in the equity. The ownership structure may be dispersed or concentrated. The ownership is dispersed when a company has a large number of owners, where each owner does not have control and cannot directly monitor and control management. The main problems of dispersed ownership are the opportunistic behavior of management and well-known agency problems (Nikolić and Babić, 2016). Concentrated ownership assumes that ownership and control are more aligned, thus mitigating agency problems. However, it may lead to many problems such as profit shifting to related-party entities and exploitation of minor shareholders, particularly in weak legal systems (Heracleous and Lan, 2022).

The impact of ownership concentration on financial performance was studied widely in prior research (Guštin Habuš and Prašnikar, 2021; Horobet *et al.*, 2019; Machek and Kubíček, 2018; Stančić *et al.*, 2014; Waheed and Malik, 2019). Abdullah *et al.* (2019) argue that prior research found conflicting interests of stakeholders when the ownership structure is concentrated. On the other hand, owners have less power to control management when the ownership structure is dispersed, which may lead to weak financial performance (Tore, 2017). Pasko *et al.* (2019) also point out the problems that concentrated ownership may bring to investors.

Prior research often studied whether ownership concentration reduces agency costs, i.e. costs of monitoring management (Alkurdi *et al.*, 2021). Concentrated ownership may reduce the conflict of interests between owners and management, thus increasing the financial performance of the company (Guluma, 2021; Mandacı and Gumus, 2010; San *et al.*, 2023). On the other hand, it may deepen agency problems which may reduce company performance (Laporšek *et al.*, 2021). Considering the results of the prior research, we have formulated the first research hypothesis as follows:

H₁: Ownership concentration negatively impacts the financial performance of companies.

2.2. Board of directors and financial performance

The board of directors is often expected to identify chances for company growth and development, but also to minimize or optimize risks that a company faces. Many research studies have found a negative impact of the size of the board of directors on financial performance (Cheng, 2008; Kao *et al.*, 2019; Orozco *et al.*, 2018; Stančić *et al.*, 2012a; Stančić *et al.*, 2014; Yan *et al.*, 2021). It is often emphasized that increasing the number of members on the board to seven or eight reduces the possibility of efficient management control (Tulung and Ramdani, 2018). This is in line with the argument that smaller boards of directors are more efficient in decision-making (Ali, 2018). On the other hand, Orozco *et al.* (2018) find that larger boards of directors may increase the financial performance of companies engaged in different industries.

Topan and Dogan (2014) argue that a larger board of directors' results in increased return on assets and decreased risk of financial distress. They explained such results with the increased efficiency of the decision-making and the fact that directors on larger boards may prioritize the company over personal interests. However, they also find that the size of the board of directors does not significantly impact return on equity and market value. Given the results of prior research, we have formulated the second research hypothesis as follows:

H₂: The size of the board of directors negatively impacts the financial performance of companies.

Non-executive directors are responsible for monitoring the work of executive directors. They are expected to be objective as they are not directly responsible for management functions

(Radović, 2008). They should also express their independent opinion on the business strategies, performance, resources, and behavior standards of a company. They are the core of good corporate governance as they contribute to the development of the relations between owners, other stakeholders, and the whole company, the relations between a company and the market as well as the relations between a company and employees (Alam, 2011). It is, therefore, no surprise that the share of non-executive directors on the board of directors is often found to be positively related to company performance (Khan *et al.*, 2021; Mura, 2007; Muravyev *et al.*, 2016). Given these findings, we have formulated the third research hypothesis as follows:

H₃: Non-executive directors positively impact the financial performance of companies.

2.3. Corporate governance and financial performance during COVID-19 pandemic

The COVID-19 pandemic spread around the world in a very short time, thus considerably impacting the operations and financial performance of most companies, particularly those whose shares are publicly listed. During such a crisis, the board of directors is expected to put higher efforts towards monitoring the management, while remaining highly independent. If managers are endangered or do not work (e.g. if they are infected), the board of directors should be included both in monitoring the management and regular operations of the company (Al Amosh and Khatib, 2023; Nayak *et al.*, 2021).

In the context of pandemics, corporate governance is studied primarily theoretically and mostly in developed countries. Koutoupis *et al.* (2021) emphasize that future research should employ various methodologies and data sources to fully understand the impact of COVID-19 on corporate governance. Prior research also points out that the pandemic questioned the main assumptions of the management model based on the agency theory, thus having important implications for the board of directors (Paine, 2020). It should be also noted that the pandemic crisis offers a unique opportunity to study how different mechanisms of corporate governance influence financial performance (Zattoni and Pugliese, 2021). Considering prior theoretical arguments and the results of some empirical research, we have formulated the fourth research hypothesis as follows:

H₄: The COVID-19 pandemic led to significant changes in the impact of corporate governance on the financial performance of companies.

3. METHODOLOGY

In line with the defined research objective, we hand-collected data for 22 non-financial companies headquartered in Serbia. We retrieved data from the official websites of the Serbian Business Registers Agency and the Belgrade Stock Exchange. Our research covers the period between 2018 and 2022 (a total of 110 observations), thus covering pre-pandemic between 2018 and 2019 (a total of 44 observations) and post-pandemic period between 2020 and 2022 (a total of 66 observations). Such a sample period enables us to identify possible differences in the impact of corporate governance on financial performance under the COVID-19 pandemic.

We employ regression analysis to examine the impact of the COVID-19 pandemic on the relationship between corporate governance and the financial performance of non-financial Serbian companies. Variables employed in the research are presented in Table 1. We measure financial performance with return on total assets (ROA), return on equity (ROE) and Tobin's Q. ROA and ROE are employed as profitability measures, while Tobin's Q is employed as a market value measure. Employed variables enable us to examine whether possible changes in the financial performance of companies may be related to the COVID-19 pandemic.

Table 1: Definitions of variables

Variable	Definition
ROA	Pre-tax income / Total assets
ROE	Pre-tax income / Equity
Q	Market value of equity / Book value of equity
OWN	Share of the largest shareholder in the ownership structure
SIZE	Natural logarithm of the number of directors on the board of directors; for companies with a two-tier board structure, this number includes directors in the supervisory board and executive board
NEX	Share of non-executives on the board of directors
LnTA	Natural logarithm of total assets
Year	Dummy variable for years

Corporate governance variables are ownership concentration or the share of the largest shareholder in the equity (OWN), the natural logarithm of the number of directors in the board of directors (SIZE), and the share of non-executive directors in the board of directors (NEX). Control variables are the natural logarithm of total assets (LnTA) and dummy variables for years (YEAR). This group of variables is employed to study whether specific features of a company and changes in the business environment may explain the impact of the COVID-19 pandemic on the company's success. Therefore, it is possible to examine whether companies with different specific features had different financial performances during the pandemic.

4. RESEARCH RESULTS

4.1. Descriptive statistics

Table 2 presents descriptive statistics for sampled companies, with mean, standard deviation, median, minimum, and maximum values for each dependent, independent, and control variable. Sampled companies considerably differ regarding the size of total assets with a standard deviation of 89.72 billion Serbian dinars. It indicates that the sample is highly heterogeneous in terms of company size. Differences in equity of the sampled companies are considerably smaller. In addition, the mean value of the total assets of the sampled companies is 27.64 billion, while the mean value of the equity is 12.28 billion of Serbian dinars.

Table 2: Descriptive statistics for the period between 2018 and 2022

	Mean	Median	Standard deviation	Minimum	Maximum
ROA (in %)	3.15	3.01	8.76	-34.47	56.56
ROE (in %)	5.39	5.02	23.14	-133.80	146.25
Q	1.14	0.76	1.90	0.08	10.21
OWN (in %)	60.95	64.51	24.37	16.64	100.00
Size of the board of directors	7.23	7.00	2.52	3.00	12.00
SIZE	1.91	1.95	0.38	1.10	2.48
NEX (in %)	55.04	60.00	15.46	25.00	90.91
LnTA	15.34	15.37	1.82	11.02	20.08

*Note: The number of observations is 110
(Source: Authors calculations)*

It is also important to analyze the sample in terms of ownership structure. The minimum share of the largest shareholder is 16.64%, while the maximum share is 100%. The mean value of this variable is 60.95%. In addition, the average size of the board of directors is 7.23,

though the number of directors varies from three to twelve. The mean value for the share of non-executive directors on the board is around 55%, the minimum value is 25%, and while maximum value is around 91%.

Regarding profitability measures, highly dispersed data may be found for ROE as the difference between mean value and standard deviation is large. On the other hand, considerably lower variability appears for the ROA. A slightly higher ROE than ROA indicates that sampled companies adequately used borrowed sources of financing. Tobin's Q indicates that sampled companies, on average, had slightly higher market value than the replacement cost of assets.

Table 3: Mean values of variables before and after COVID-19 pandemic

Period	2018-2019	2020-2022
ROA (in %)	3.04	3.23
ROE (in %)	5.08	5.59
Q	1.16	1.13
OWN (in %)	58.40	62.65
Size of the board of directors	7.45	7.08
SIZE	1.94	1.89
NEX (in %)	55.04	55.04
LnTA	15.32	15.36

(Source: Authors calculations)

Table 3 presents mean values for independent, dependent, and control variables in the period before (2018-2019) and after (2020-2022) COVID-19 pandemic. Number of observations is 44 for the first and 66 for the second period. A slight increase in the total assets may be identified in the post-pandemic period, which may be due to the increased business activity, but also to inflation. On the other hand, average equity is reduced, indicating lower business certainty and lower guarantee for the creditor's claims.

Both ROA and ROE slightly increased in the post-pandemic period, which may be a result of the increased efficiency and resource allocation towards cost optimization. In general, this may be explained as a part of the adaptation to the challenges brought by the COVID-19 pandemic. For instance, online sales and remote working from the house may be some examples of measures that companies implemented to keep or improve their financial performance. On the other hand, we found a slight decrease in Tobin's Q.

The average share of the largest shareholder in the equity considerably increased in the post-pandemic period. On the other hand, the average size of the board of directors slightly decreased, while the share of non-executive directors in the board remained unchanged. In crisis periods, owners with the largest share in the equity may be motivated to increase their share in a company to increase the control of the company in periods of low share prices. This may be supported not only by the major shareholders but also by the company as a type of adaptation and reaction to the new crisis circumstances. A decrease in the size of the board of directors may be viewed as a tendency towards more efficient decision-making and adjusting the interests of stakeholders in light of challenges brought by modified economic circumstances.

4.2. Regression estimates

The results of the regression analysis are presented in Table 4. It appears that the increase in the ownership concentration significantly reduces company profitability in the whole sampling period. Since such influence is statistically significant only in the pre-pandemic, but not in the post-pandemic period, it may be concluded that the COVID-19 pandemic brought

important differences regarding the impact of ownership concentration on profitability. In other words, an increase in the share of the largest shareholder during the COVID-19 pandemic did not have a significant negative impact on profitability. Such results may be explained by the increased importance of the largest shareholder for more efficient decision-making and overcoming crises. Additionally, the ownership concentration significantly and positively impacts Tobin's Q during the whole sampling period and also during both sub-periods, implying that the market positively values companies listed on the Belgrade Stock Exchange whose ownership is highly concentrated.

Regarding the size of the board of directors, regression results suggest that it negatively impacts the profitability measured by ROA in the whole sampling period and the pre-pandemic period. However, the size of the board of directors does not have a significant impact on ROA in the post-pandemic period. This implies that the size of the board of directors lost significance due to the COVID-19 pandemic. Additionally, the size of the board of directors does not have a significant impact on ROE and Tobin's Q neither in the whole sampling period, pre-pandemic or post-pandemic period.

Table 4: Regression estimates

	2018 - 2022			2018 – 2019			2020 - 2022		
	ROA	ROE	Q	ROA	ROE	Q	ROA	ROE	Q
Const.	-0.055 (-0.764)	-0.397** (-2.096)	0.154 (0.109)	-0.025 (-0.355)	-0.151 (-0.997)	0.570 (3.099)	-0.079 (-0.694)	-0.570* (-1.876)	-0.257 (-0.134)
OWN	-0.237** (-2.232)	-0.193* (-1.827)	0.480*** (4.994)	-0.337** (-2.215)	-0.279* (-1.773)	0.456*** (3.099)	-0.194 (-1.308)	-0.176 (-1.218)	0.517*** (3.889)
SIZE	-0.252** (-2.016)	-0.021 (-0.166)	-0.063 (-0.559)	-0.452** (-2.391)	-0.210 (-1.027)	-0.130 (-0.712)	-0.178 (-1.059)	0.038 (0.233)	-0.016 (-0.106)
NEX	-0.083 (-0.704)	0.043 (0.364)	-0.408*** (-3.815)	0.041 (0.230)	0.140 (0.757)	-0.381** (-2.194)	-0.134 (-0.848)	0.025 (0.165)	-0.439*** (-3.100)
LnTA	0.371*** (2.700)	0.282** (2.064)	0.129 (1.034)	0.462** (2.150)	0.343 (1.544)	0.143 (0.688)	0.348* (1.938)	0.281 (1.606)	0.123 (0.763)
YEAR	Yes	Yes	Yes	No	No	No	No	No	No
Adj. R ²	0.058	0.071	0.228	0.138	0.080	0.193	0.017	0.063	0.211
F-value	2.671**	3.090**	9.045***	2.715**	1.932	3.579**	1.289	2.094*	5.335*
Obs.	110	110	110	44	44	44	66	66	66

*Note: statistically significant at 5% (**) and 1% (***)*

(Source: Authors calculations)

The impact of the share of non-executive directors in the board on the profitability is not significant in any observed period. On the other hand, this independent variable has a significant negative impact on Tobin's Q in each observed period. This implies that an increase in the share of non-executive directors does not contribute to the company's profitability, while negatively impacting its market value. Such findings may be explained by the weak non-executive directors who are not able to influence the behaviour of management. In addition, when the ownership concentration is high, the real power of non-executive directors may be relatively small, particularly if the largest shareholders directly influence the decision-making in a company.

5. DISCUSSION AND CONCLUSION

The objective of the paper was to examine the impact of the COVID-19 pandemic on the relationship between corporate governance and the financial performance of companies. The research was conducted on 22 non-financial companies headquartered in Serbia and listed on

the Belgrade Stock Exchange between 2018 and 2022. The data were retrieved from the official websites of the Serbian Business Registers Agency and the Belgrade Stock Exchange. Research results suggest that the ownership concentration is negatively related to profitability and positively to market value. On the other hand, they show the negative impact of the size of the board of directors on the profitability and the negative impact of the share of non-executive directors in the board on the market value of companies. The results also suggest that the COVID-19 pandemic impacted the relationship between corporate governance and financial performance, so the impact of corporate governance on financial performance was more significant in the pre-pandemic period.

This paper suggests that corporate governance has a certain role in shaping the financial performance of Serbian companies. Lo and Shekhar (2018) identified the positive impact of corporate governance on the financial performance of German companies in the pre-pandemic period, while O'Sullivan and Carroll (2021) found a positive impact of corporate governance on the financial performance of companies in the United Kingdom. In this regard, the results of the present research add to the prior research results, confirming the importance of corporate governance for achieving satisfying financial performance, both before and after the COVID-19 pandemic.

The paper contributes to the relatively scarce literature on the impact of the COVID-19 pandemic on business activity. It explains how the crisis affected business operations and decision-making. It is clear that more research is needed, particularly longitudinal ones. Regarding the practical implications, the results may be of interest to companies striving to implement solutions that are useful to overcome crises and increase profitability and market value. Managers may better understand to which elements of corporate governance they should pay more attention. In addition, they may better understand the changes that the COVID-19 pandemic brought to their companies. Public policymakers may benefit from the research results to create policies that are adjusted to the current social and economic environment.

Although the research explains the impact of the COVID-19 pandemic on the relationship between corporate governance and financial performance, it should be considered in light of certain limitations. The research finds that the relationship between corporate governance and financial performance exists but does not clearly identify the causality. In fact, financial performance may also significantly affect key features of corporate governance. Additionally, the research was conducted in a specific context and only on publicly listed companies. It is possible that the research in a different context and with other types of companies would yield different results. The research also could not cover each effect brought by the pandemic. It is, therefore, necessary to track the changes in corporate governance and financial performance in future years, to understand whether changes brought about by the COVID-19 pandemic are present only in the short run.

Future research should avoid the mentioned limitations to yield more reliable results and check the results of this research. The sample in our research is representative, though relatively small, while the sampling period is relatively short. Future research should employ a larger sample, consisting of companies from other transition neighbouring countries and covering a longer period. Using financial data from well-known databases and employing more variables may contribute to the reliability of the empirical results. Future research may also consider using other statistical methodologies.

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RESEARCH TRENDS AND DEVELOPMENTS IN MANAGEMENT ACCOUNTING: A BIBLIOMETRIC ANALYSIS

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EXTENDED ABSTRACT

Purpose Management accounting, as a critical area within the broader domain of accounting, has undergone significant transformations over the years, driven by changes in business practices, technological advancements, and regulatory environments (Merigó and Yang, 2016; Cortés-Sánchez, 2019; Balstad and Berg, 2020). This study aims to identify key themes, influential authors/publications, and emerging research areas that have shaped the field through bibliometric analysis. By examining the evolution of research in management accounting, this study seeks to provide insights into the current state of the field and its future directions.

Design/methodology/approach This bibliometric analysis utilized data from the Scopus database, with the search focusing on the keywords "Management" OR "Managerial" AND "Accounting". The initial search identified 66,822 manuscripts. To ensure the relevance and quality of the dataset, the PRISMA protocol was applied through its four stages: identification, screening, eligibility, and inclusion (Moher *et al.*, 2009). Filtering criteria included the subject area of Business Management and Accounting, English language, and document type restricted to articles, which narrowed the dataset to 13,078 papers. After removing duplicates, a manual relevance check based on abstract analysis further reduced the dataset, resulting in a final set of 5,059 papers for the bibliometric analysis. The VOSviewer software was used to analyze co-authorship patterns among authors, organizations, and countries, as well as to perform keyword analysis on abstracts for the entire period and specifically for the last five years (2019-2023).

Findings The dataset spans research papers from 1957 to 2023, with a noticeable increase in publications over time, particularly in recent decades. The trend culminated in 2023 with a peak of 354 papers. The most cited individual authors are Kaplan R.S., Norton D.P., Orlitzky M., Schmidt F.L., and Rynes S.L. Some of the leading journals for management accounting publications are "Accounting, Organizations and Society", "Management Accounting Research", "Accounting, Auditing, and Accountability Journal", "Journal of Cleaner Production", and "European Accounting Review". The United States and the United Kingdom rank as the top countries in the total number of published articles and citations. The analysis reveals that the most prominent research themes, based on keyword occurrences, are performance measurement, cost management, financial management, management control systems, and sustainability. These results align with Balstad and Berg's (2020) and Porporato and Werbin's (2024) findings and insights.

Originality/value This study employs bibliometric analysis to offer an overview of the evolving field of management accounting. It provides valuable insights into research trends, influential authors, and key publications that have shaped the discipline over the past several decades. The findings deepen the understanding of the intellectual foundation of management accounting, guiding future research and aiding academics and practitioners in navigating the complexities of this field.

Keywords: *Management accounting, Bibliometric analysis, Research trends.*

JEL classification: *M40, G30.*

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PREPARING FOR THE FUTURE: INTERDISCIPLINARY APPROACHES IN INTERNAL AUDITING EDUCATION

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EXTENDED ABSTRACT

Purpose: In an era marked by rapid corporate changes and evolving business paradigms, internal auditing (IA) is crucial for ensuring organizational integrity, transparency, and effective risk management. Pizzi *et al.* (2021) emphasize the need for integrating digital transformation into IA education through tools like data analytics and continuous auditing, enhancing decision-making and fraud detection. Similarly, Coetzee and du Plessis (2020) highlight the importance of soft skills, while studies such as those by Popescu-Grădișteanu and Mocuta (2023) and Fonseca *et al.*

(2020) connect IA education to improved risk assessment, transparency, and governance. Hay (2017) and Crockett (1993) further advocate for interdisciplinary and ethical approaches to better prepare graduates for growing professional demands. This research addresses the pressing need to sustain and advance IA by engaging students from various academic backgrounds beyond traditional Accounting and Auditing programs. Integrating insights from fields like E-business, Finance, and Management, the study aims to close educational gaps and enhance the preparedness of future internal auditors. This paper underscores the importance of recruiting, educating, and empowering a multifaceted workforce to ensure IA's continued relevance and effectiveness in addressing today's complex business challenges.

Design/methodology/approach: To examine the potential of an interdisciplinary approach in sustaining IA as a profession, this study employs a multi-phase research design, encompassing a comprehensive literature review and data collection through student workshops, focus groups, and interactive activities. Relevant insights from professional bodies, including IIA Global, ACFE, IFAC, ISACA, AICPA, ICAEW, CIPFA, INTOSAI, and major auditing firms, informed the study framework. Four thematic workshops featured experienced practitioners and professors who presented and discussed core IA issues with students. In a focus group of 36 students from the Faculty of Economics-Skopje, UKIM—30% in Accounting and Auditing, and 70% from other majors (30% E-business, 17% Finance, and 23% Management and Entrepreneurship)—data were gathered in four complementary phases. Methods included two questionnaires, a psychological-educational game, and team-based research projects. The research centered on students' perceptions of several key topics:

The strategic importance, role, and responsibilities of IA within an organization (research questionnaire);

IA's influence on internal controls and corporate governance structures (research questionnaire); Identification of potential challenges in recruiting qualified IA professionals and proposed solutions for closing this gap (psychological-educational game);

Reflections on necessary changes in IA education, including curriculum updates, skill requirements, and alignment across higher education institutions (team research projects).

Findings: Results from the first thematic research revealed that students view IA as an essential function that extends beyond traditional financial audits, contributing directly to organizational success by improving processes, values, and goal alignment. Key IA focus areas identified include enterprise risk management (ERM), fraud prevention, regulatory compliance, and financial oversight.

The second thematic survey showed diverse perspectives across academic majors: E-business students most strongly emphasized IA's role in strengthening internal controls and corporate governance, followed by students in Accounting and Auditing, Management, and Finance.

In the third thematic research, an interactive psychological-educational game prompted students to collaboratively create a "Future Memory Statement" envisioning IA's evolution over the next decade. Their consensus: "As internal auditors, we observed that disruptive technologies have reshaped corporate operations, presenting new risks and opportunities. By 2034, this challenge was addressed by recruiting students with diverse educational backgrounds and expanded skill sets, maintaining IA's relevance and adaptability." This future-oriented vision aligns with the IA Foundation's "Internal Audit: Vision 2035" initiative.

The fourth phase involved a content analysis of student research projects by major, where students overwhelmingly agreed that IA should be integrated into diverse educational programs, including Finance, Management, E-business, and Economics. Essential skills identified included analytical

and critical thinking (75%), communication (68%), risk management (61%), and accounting knowledge (50%). While the IA curriculum at the Faculty of Economics-Skopje aligns with those of prominent higher education institutions, students highlighted the need for more practical case studies and collaborative projects with industry partners to enhance real-world application.

Originality/value: This study offers a fresh perspective on advancing IA education through an interdisciplinary lens, emphasizing the necessity of broadening IA curricula beyond traditional domains. By actively engaging students from various academic backgrounds, such as E-business, Finance, and Management, this research stresses the need to expand IA's educational scope to prepare a workforce ready to tackle diverse corporate challenges. The incorporation of a psychological-educational game to explore real-world problem-solving provides an innovative pedagogical approach, enriching students' practical understanding. Furthermore, the findings highlight the critical need for ongoing curriculum alignment with global standards and the inclusion of practical experiences to ensure IA education's relevance. This study offers significant implications for educational institutions, professional associations, and industry stakeholders committed to fostering a skilled and adaptable IA workforce.

Keywords: *Internal Auditing, Interdisciplinary Education, Corporate Governance, Higher Education, Curriculum Development.*

JEL classification: *M42, I23.*

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ENVIRONMENTAL STRINGENCY AND INTERNATIONAL TRADE: A LOOK ACROSS THE GLOBE

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ABSTRACT

The main goal of this paper is to analyze the impact of carbon pricing, as a means to reducing carbon dioxide (CO₂) emissions, on international trade in goods using a pane dataset of OECD and other developing countries with data over the period 2007 to 2018. We use Poisson pseudo-maximum likelihood regressions (PPML) with multi-dimensional fixed effects to estimate a gravity model of trade with panel data. To conduct our empirical analysis, we combine data on emissions from fuel combustion, which account for approximately 80 percent of global human-induced CO₂ emissions and have been the main target of carbon pricing, with detailed international trade data using the HS 6-digit codes and information on the market-based policies applied by the countries over the sample period. Our findings confirm that, regardless of the environmental stringency variable used, pollution constraints have a significant impact on trade flows, with this effect being particularly pronounced in the most polluting industries.

Keywords: Environment and trade, Environmental policy, Pollution haven hypothesis, Gravity models, OECD.

JEL: F18, H23, Q52, Q56, Q58.

1. INTRODUCTION

The relationship between trade and the environment is on the front line of today's policy debate. With trade liberalization, tremendous economic development in some regions, and the fast-growing population, there has been an increasing use of natural resources and pressure on the environment. In 2022, the concentration of carbon dioxide in the global atmosphere reached the highest level in 3 million years, and air pollution poses a great threat to human health and even life

(NOAA Earth System Research Laboratory). Global environmental pollution and climate change have the potential to limit the sustainable development of the economy and human beings. Thus, effective control of environmental pollution and curbing climate change is essential to sustainable development and is likely the most urgent issue(s) faced by countries nowadays.

In response, over the past decades governments around the world have actively implemented environmental regulations (Khalid *et al.*, 2021). Going forward, with the concept of green development put forward, environmental regulations are likely to be continuously improved and play an increasing role in solving the externalities of environmental pollution and correcting market failures. Thus, an increasing number of countries have incorporated environmental factors into an important part of national and international trade regulation (Baghdadi *et al.*, 2013; Usman *et al.*, 2021a).

At the same time, international trade has become an increasingly critical driver of economic development, and both developed and developing countries consider trade and investment as a central part of their development strategies. In today's world of augmenting economic activity induced by international trade, it is argued that environmental degradation will be accelerated unless it is protected by taking the necessary measures both at domestic and international borders. Thus, nowadays there is a considerable debate over the magnitude and effects of the nexus between trade and the environment. The links between trade and the environment are multiple, complex, and important and consequently, the extent to which environmental problems might affect many facets of trade, or vice versa, deserves a careful investigation. At the most fundamental level, trade and environment are related because economic activities particularly production are based on the environment, as such: the environment provides the basis for all essential inputs and the energy needed to process them as well as the capacity to absorb the produced waste. In this sense, country-specific interventions regarding trade liberalization would be better informed if they were based on an in-depth analysis of the nexus between international trade and climate change.

Ever since the first major environmental regulations were enacted in the 1970s, there has been much debate concerning the effects of changing environmental policies on international trade patterns and investment flows. Businesses and policymakers fear that in a world that is characterized by the integration of trade and capital flows, large asymmetries in the stringency of environmental policies could shift pollution-intensive production capacity toward countries or regions with less stringent regulation, altering the spatial distribution of industrial production and the subsequent international trade flows. This has caused concern, particularly among countries that are leading the action against climate change, because their efforts to achieve deep emission reductions could put their pollution-intensive producers at a competitive disadvantage in the global economy.

This is so because environmental regulations require polluting facilities to undertake abatement activities and may impose costs on companies. The first tool in the government's toolkit for reducing greenhouse gas emissions is a price to be charged per unit of emissions. Carbon pricing is typically considered to be a less invasive policy intervention than direct regulations given that it leaves decisions on how abatement activities will be undertaken to the market (Mankiw, 2009). A carbon price provides a signal to equate marginal abatement costs across polluters and can incentivize abatement across diverse sources at the lowest possible overall cost (Schmalensee and Stavins, 2017). Abatement opportunities that are cheaper than the carbon price are incentivized, while abatement opportunities that are more expensive than the carbon price are not.

As a consequence, regulatory differences across countries, companies, sectors, or jurisdictions can cause changes in the relative production costs of companies. Such changes could arise from

differences in direct costs or could be experienced indirectly by various economic actors. For example, the European Union Emissions Trading System (EU ETS), which regulates carbon emissions of approximately 12,000 installations across Europe, is estimated to have increased average material costs (including fuel) for regulated companies in the power, cement, and iron and steel sectors by 5 percent to 8 percent (Chan *et al.*, 2013). Increases in relative costs could also result from higher indirect costs caused by policy-induced changes to input costs. For example, even if they are not directly regulated by the EU ETS, European consumers of electricity face higher electricity costs due to the price of carbon emissions paid by electricity producers. Differences in environmental regulations can thus alter the competition between companies by changing their relative production costs.

Thus, from the point of view of the transmission path of production costs, under the influence of strict environmental regulations in a country, the internalization of environmental costs will lead to an increase in production expenditures (Guo *et al.*, 2018). From the perspective of the technology innovation transmission path, in the short term, companies need to raise environmental internalization costs, pay pollution control costs, and cover technology research and development (R&D) costs to adapt to environmental regulation standards (Hojnik and Ruzzier, 2016), which leads to higher production and operation costs and weakens the price comparative advantage of companies, which can ultimately lead to changes in international trade patterns.

Nevertheless, on the other hand, environmental regulations may lead to increased competitiveness as they may stimulate technological innovation and have positive effects on the economy and environment. For example, a company may be unaware of production strategies to lower costs, and environmental regulations may push the company to adopt such strategies and reduce the costs increasing its competitiveness (Margolis, 2002). Thus, if the world is moving toward more environment-friendly products in the future, then the countries innovating technologies of this sort will be in an advantageous position among other countries.

Thus, the question of whether more stringent environmental regulations harm or foster trade is relevant to the current debate on advancing environmental regulation standards, in particular, related to multilateral agreements. To the best of our knowledge, this issue has been hardly studied in the literature, in particular using disaggregated sectoral trade data to look across sectors and types of goods, dirty and clean, mobile and immobile, and also using trade costs and development status among trading partners. The latter has barely been studied using disaggregated trade data.

Against this background and with the purpose of contributing to the growing body of literature on climate change and environmental discourse, this paper pursues a two-fold aim. First, to examine whether the strictness of a nation's environmental regulations leads to the creation of pollution havens or conversely, consequently affecting trade patterns and potentially creating competitive advantages to countries with less stringent regulations, leading to firms relocating parts of their production chains to these countries. Secondly, it seeks to investigate whether the relationship between carbon pricing and imports varies across industries based on pollution levels (polluting vs. clean) and also in terms of levels of mobility of industries (footloose vs. immobile), agglomeration and the development status of trading partners (*note: last three are work in progress*).

In order to shed light on these questions, we will conduct econometric analyses estimating a gravity model using Poisson pseudo-maximum likelihood (PPML) with high dimensional fixed effects, (Correia *et al.*, 2020). Our results confirm that irrespective of the environmental stringency variable used, pollution control measures increase imports from countries with more relaxed environmental regulations (thus having a detrimental effect on the export performance of firms),

with this impact being particularly pronounced in industries characterized as dirty or contaminating.

The remainder of the paper is structured as follows. Section 2 provides an overview of the related literature and theoretical background. In section 3 we provide early stylized facts examining the relation between environmental stringency and trade. In section 4 we present the model and provide explanations on the different variables. Section 5 presents the main results and section 6 concludes, providing policy options along the way.

2. LITERATURE REVIEW

The literature on the relationship between trade liberalization and the environment started in the 1970s when the first environmental standards were introduced but have really picked up in the last decade or two with the growing number and importance of environmental standards. This has been reflected in the growing attention that multilateral organizations have been placing on environmental issues and the multiple and consecutive international agreements signed, starting from the Stockholm Declaration and continuing with the Montréal Protocol, Kyoto Protocol, Paris Agreement, and the latest Dubai agreement. Moreover, this has gained particular attention as international trade has become an increasingly critical driver of economic development, and a growing number of developing countries consider trade and investment as a central part of their development strategies.

In this context, the links between trade and the environment are multiple, complex, and important. The extent to which environmental problems might affect many aspects of trade, or vice versa, has been the subject of considerable debate over the years. This observation has led scholars to typically decompose the environmental impact of trade liberalization into the scale, technique, and composition effects (Antweiler *et al.*, 2001; Cole and Elliott 2003; Grossman and Krueger, 1991; Lopez and Islam, 2008; Stoessel, 2001). Moreover, it has been noted that these three elements are simultaneously present under a liberalized trade regime.

First, the scale effect indicates that under the assumption of constant composition and production techniques, an increase in the global scale of economic activity, a significant part of which will be driven by international trade, global pollution will increase. This would imply a negative effect of trade liberalization on the environment. Nevertheless, as the links between trade and the environment are mixed and complex the nexus will not be that straight forward. An increase in trade will lead to increased growth and thus national income, which in turn will lead to a rising demand for higher environmental quality and standards, in line with the environmental Kuznets curve that explains the phenomenon that environmental degradation occurs with increasing economic growth until the country attains higher income status, after which the environmental impacts start to decline. This will incentivize companies to increase investments in research and development of cleaner technology and the production of greener goods (Copeland and Taylor, 2004; Grossman and Krueger, 1991). Thus, one cannot directly conclude that the effects of trade and growth on the environment are undesirable. This would imply that the net impact of the scale effect is unclear.

The technique effect makes references to the technology embedded in the production process. It implies that as trade is liberalized, changes in the methods and techniques in the production process will have a positive impact on the levels of pollution and the environment. This stems from the belief that the environment will benefit as companies introduce new technologies that reduce pollution per unit of output. In addition, if we assume that the scale of economic activity and the

composition of goods produced are held constant, the effect of an improvement in production technology is even more obvious.

Finally, the composition effect stems from the comparative advantage theory. It assumes that under trade liberalization, countries will specialize in the production of products in which they have a comparative advantage. Nevertheless, as was the case with the scale effects, the impact on the economy under the composition effect is also not that straightforward. In this case, the final net effect on the environment will be linked to whether the source of a country's comparative advantage lies in a country's endowment of capital or labour or the stringency of environmental regulation. In this regard, four hypotheses have been developed which link the effects of trade liberalization and environmental outcomes, including the pollution haven hypothesis, the porter hypothesis, the race to the bottom hypothesis, and the factor endowment hypothesis, with the first two being the most prominent ones.

First, the pollution haven hypothesis goes back more than thirty years (e.g., McGuire, 1982) and in line with Ricardian's comparative advantage theory states that differences in environmental regulations are the main motivation for trade. It predicts that if competing companies differ only in terms of the environmental policy stringency they face, then those facing relatively stricter regulation will lose competitiveness. Higher regulatory costs could, for example, reduce the output and scale of R&D investment, crowd out productive investment in green technology innovation or efficiency improvements, and slow down productivity growth (Gray and Shadbegian, 2003; Greenstone *et al.* 2012; Wei *et al.* 2019). If increased regulatory costs are passed through to product prices in fiercely competitive product markets, distortions in trade could occur, as product prices will increase more in countries with relatively strict regulations. Thus, under trade liberalization of goods, there will be a relocation of pollution-intensive trade and production from countries with high income and tight environmental regulations to countries with low income and lax environmental regulations. Companies in countries with higher costs will then lose market share to competitors in countries producing pollution-intensive exports more cheaply. If environmental regulatory differences are expected to last, companies' decisions regarding the location of new production facilities or foreign direct investment may also be affected, with pollution-intensive sectors, and thus manufacturing employment, possibly gravitating toward countries with relatively lax policies and creating pollution havens. Finally, in this scenario, the developed countries will improve their environmental quality, and developing countries will gradually become pollution havens (Baumol and Oates, 1998; Ulph, 1998).

Pollution haven effects have been analysed in the context of environmental regulations, international trade, and foreign direct investment. Early empirical papers revert to a Heckscher-Ohlin (HO) type of model, where revealed comparative advantages are explained by factor endowments, suggesting that the stringency of environmental regulations had little or no impact on trade patterns (Grossman & Krueger, 1991; Tobey, 1990; Xu, 2000). The argument was that, in general, pollution costs are relatively small concerning total costs and multinational firms that operate in developed and developing countries do not want to be seen as transferring dirty operations to the latter countries.

More recently there has been a renewed interest in the area and a number of studies have investigated the PHH largely from a regional or country-specific perspective and using different methodologies to investigate its validity. Approaches range from cross-sections to panels, depending on data availability and questions of interest. The cross-sections allow only very limited control of other potentially relevant developments – such as in endowments or policies - whereas the potential of panels in this respect is not always fully exploited. For example, Kellenberg (2009)

investigated underlying reasons for outsourcing the US production processes to emerging economies and suggested that significantly lower environmental stringency is the primary reason for manufacturing companies to move from the USA to emerging economies. Yang (2001) provided strong support to the PHH by examining the environmental impact of WTO membership on Taiwan's economy. He found that CO₂ emission in Taiwan has increased after the trade liberalization and the production structure of the economy also has changed towards most polluting industries. Iwami (2001) also found that trade and industrialization in Southeast countries had aggravated the problem of environmental degradation. Similar findings were reported by Takeda and Matsuura (2006). Atici (2012) also found that the export of dirty goods was the main determinant of CO₂ emission in the ASEAN countries for the period of 1970-2000.

López *et al.* (2013) again confirmed strong evidence for the support of the PHH from the analysis of bilateral trade between Spain and China. They found that China has become a pollution haven for energy-intensive industries of Spain. Similarly, Gani (2013) also found that trade and industrial activities have a strong impact on pollution in Arab states. Similarly, from the US-India trade between the period of 1991–2010. Sawhney and Rastogi (2015) concluded that a decade of trade liberalization had made India a pollution haven for some polluting industries of the USA like chemical, steel, and iron. Levinson and Taylor (2008) measured the impact of pollution abatement cost on US net imports of manufacturing sectors from Mexico and Canada over the period from 1977 to 1989. As Mexico is a developing country, therefore, the analysis of US-Mexico trade provided a valid testing ground for PHH. They found that the pollution abatement cost in the USA was a significant determining factor of US trade with Mexico and Canada.

Chakraborty and Mukherjee (2013) are one of the few studies investigating the PHH from a broader perspective. They supported the PHH from the analysis of trade and environment nexus in 114 countries for the period of 2000–2011. They used the environmental performance index as a measure of pollution. They also found that the export of primary and manufactured goods to developing countries has caused environmental degradation in these countries.

A number of studies have investigated the effect of FDI on the environment of a country. According to Winslow (2005), trade and FDI have aggravated the environmental conditions in China. Similar findings were obtained by He (2006) for 29 Chinese provinces. Kellenberg (2009) investigated underlying reasons for outsourcing the US production processes to emerging economies and suggested that significantly lower environmental stringency is the primary reason for manufacturing companies to move from the USA to emerging economies. Seker *et al.* (2015) examined the impact of FDI on CO₂ emission in Turkey for the period of 1974–2010. They used autoregressive distributed lag to test the long-run relation between the variables showing a positive effect of FDI on CO₂ emission thus supporting the PHH. Tang (2015) explored foreign capital inflows both export-oriented and local market-oriented to claim that environmental standards influence investment decisions, with export-oriented FDI significantly more sensitive to environmental regulations. Sapkota and Bastola (2017) examine the impact of foreign direct investment on pollution in Latin American countries within the scope of the Pollution Haven Hypothesis and the Environmental Kuznets Curve hypothesis. As a result of the panel fixed and random effects models it is seen that the Pollution Haven Hypothesis is valid for Latin American countries

On the other hand, there are also a number of studies that contradicted these empirical findings, concluding that PHH does not hold true. For example, Kearsley and Riddel (2010) suggested that no significant correlation exists between per capita GHG emissions and trade openness. Honglei *et al.* (2011) also, generated arguments against the PHH effects. They examined the effect of a set

of variables like FDI economic growth, and foreign trade on environmental pollution in 30 regions of China. They found that FDI was not destructive to the local environment. Rasit and Aralas (2017) examine ASEAN countries in the period 2000–2010 with pooled OLS estimates and show that the Pollution Haven Hypothesis is not valid for the countries in question. Kathuria (2018) examines the case of India with pooled OLS estimates and finds no evidence for the PHH. Balsalobre-Lorente *et al.*, 2019 also came to the same conclusion for MINT countries (Mexico, Nigeria, Indonesia, and Turkey). Shao *et al.* (2019) examine BRICS as well as MINT with panel cointegration tests and obtain similar findings.

Ederington *et al.* (2005) state that there might be three reasons why some studies do not find support for the PHH, including (i) the lion's share of world trade takes place between developed countries, (ii) the likelihood of geographical mobility of industries and (iii) the fraction of total production cost that environmental regulation costs represent in different industries. They argue that in cases where aggregate trade data is used, it may hide the effect of the PHH in the econometric analysis. For this reason, in our study, we test both an aggregate model and a disaggregated sectoral model to account for these possible shortcomings. Moreover, we also account for both clean and dirty industries in our analysis, considering that one would expect to find differences in the pollution regulation effect between the two and also because some authors stated that selecting only dirty industries means selecting the least footloose industries and also (Brunnermeier and Levinson, 2004). Additionally, in our analysis, we also test for the effects of trade costs and the development status of the bilateral trade partners.

The Porter hypothesis takes the more dynamic perspective that more stringent policies have the potential to reduce costs and induce efficient use of resources while encouraging innovation that helps to improve competitiveness (Porter & van der Linde, 1995; Stoessel, 2001). When a country's environmental regulation intensity is high the threshold of export trade is raised, and the market competitiveness of enterprises is weakened, placing pressure on enterprises and incentivizing them to take the initiative and carry out technological innovation. If these technologies induce input (for example, energy) savings that would not have occurred without the policy, they may offset part of the compliance costs.

Porter and van der Linde (1995b) go even further, arguing that environmental regulations can actually "trigger innovation that may more than fully offset the costs of complying with them," i.e., lowering overall production costs and boosting the competitiveness of firms. This Porter hypothesis outcome may occur if cleaner technologies lead to higher productivity, input savings, and innovations, which over time offset regulatory costs (dynamic feedback to the first-order effect) and improve export performance and market share. For example, the existence of learning externalities might prevent the replacement of an old polluting technology by a new, cleaner and more productive technology because firms have a second-mover advantage if they wait for someone else to adopt it first. In this situation, the introduction of an environmental regulation would induce firms to switch to the new, cleaner technology, which improves environmental quality and eventually increases productivity (Mohr 2002). An argument that is related to the Porter hypothesis postulates that a country can generate a first-mover advantage to domestic companies by regulating pollution sooner than other countries, which leads domestic firms toward international.

The empirical tests of the Porter hypothesis are mainly based on specific industries with certain characteristics that profit the most from stringent regulations. Most of the existing studies support the Porter hypothesis and believe that environmental regulation has a positive significance for green technological innovation (Lanjouw and Mody, 1996; Alpay *et al.*, 2002; Horbach, 2008;

Zhang *et al.*, 2011; Yang *et al.*, 2012; Ghisetti and Pontoni, 2015; Li and Lin, 2016; Manello, 2017; Zhang *et al.*, 2018).

Moreover, in recent years, strong and weak versions of the Porter hypothesis have been developed respectively. On one side the “weak” version of the hypothesis states that stricter regulation can actually have a net positive effect on the competitiveness of regulated companies because such policies promote cost-cutting efficiency improvements. stimulate enterprises to further improve the level of pollution control technology by stimulating the innovation process. On the other hand, the “strong” version goes a step further and states that stricter regulation actually enhances business performance and these cost-cutting technologies in turn reduce or completely offset regulatory costs and foster innovation in new technologies that may help firms achieve international technological leadership and expand market share. On the empirical side, the evidence for the weak version of the Porter hypothesis is fairly well established, while the empirical evidence for the strong version is mixed, with only recent studies supporting it (Paul *et al.*, 2011; Nesta *et al.*, 2014; Rubashkina *et al.*, 2015; Xie *et al.*, 2017; Guo *et al.*, 2017). Some studies have found that technological innovation effects of environmental regulation are significantly heterogeneous in different regions, cities, environmental regulation instruments and corporate types (Zhao and Sun, 2016; Li and Wu, 2017; Li *et al.*, 2018; Qiu *et al.*, 2018). Also, the non-linear relationships between environmental regulation and technological innovation have been found, including U-shaped relationship by Zhang *et al.* (2016) and an inverted U-shaped relationship (He *et al.*, 2016; Wang and Shen, 2016; Zhao *et al.*, 2018).

The factor endowment hypothesis, claims that it is not the differences in environmental policy, but the differences in endowments or technology that determine trade patterns. It predicts that the capital-abundant country exports capital-intensive (dirty) goods, which stimulates its production since most polluting industries are also highly capital-intensive (see, e.g., Antweiler *et al.*, 2001; Mani and Wheeler, 1997). Thus, pollution in the capital-abundant country will increase over time. Conversely, pollution falls in the capital-scarce country as a result of the contraction of the production of pollution-intensive goods, since there is no comparative advantage of producing polluting goods in the developing world. Since higher-income countries are more capital-abundant than lower-income countries, in the presence of trade liberalization, developed countries will specialize in capital-intensive, dirty industries, and developing countries will specialize in labour-intensive, relatively cleaner industries. This is the opposite of what the PHH predicts, and thus, the actual impact of liberalized trade on the environment depends on the determinants of comparative advantages across countries.

The race to the bottom hypothesis states that in a liberalized international trade system as countries are faced with economic competition, they will have incentives to relax their environmental standards in an effort to attract new (or retain existing) industries in fear of losing this economic investment or competitiveness to countries with lower standards (Dua and Esty, 1997; Kim and Wilson, 1997, Aşıcı and Acar, 2016; Amran *et al.*, 2018). Some studies suggest that the race to the bottom hypothesis may exist only in developing countries because countries that have implemented high standards (usually developed countries) will not lower their environmental standards for international industrial competition (Porter, 1999; Eichner and Pethig, 2018).

In summary, from the above analysis, it is found that environmental regulations have both inhibitory and promoting effects on export trade. The inhibiting effect on exports is coming from the rearrangement of international trade patterns which will stem from the reallocation of the pollution-intensive industries from countries with stringent environmental standards to countries with lax standards. This will lead to a decline in exports in the former country, but also to an

increase in pollution in the latter country. On the other hand, the positive effect stems from the incentives that companies face when confronted with higher environmental standards. This can lead to technological innovation, improve production efficiency, or replace formerly polluting products with new environmentally safe, high-quality products, services, and technology, which builds up long-term competitive advantages and export scale expansion.

3. DATA, VARIABLES AND STYLIZED FACTS

In this section, we present the main data and variables (sub-section 3.1) used and a number of stylized facts of the proxies used for environmental policy stringency (subsection 3.2).

3.1. Data and variables

Trade values are from the Balance International Merchandise Trade Statistics from the OECD. Bilateral exports and imports are measured in current USD. The environmental policy stringency index (EPI) and its different dimensions, as well as environmentally related tax revenues, are also from the OECD. The EPI is a country-specific and internationally-comparable index of the stringency of environmental policy. Stringency is defined as the degree to which environmental policies put an explicit or implicit price on polluting or environmentally harmful behaviour. The carbon price variable and ETS dummy are from the World Bank Carbon Pricing Dashboard. Emissions intensities are obtained from the inter-country input-output database and the Trade in embodied CO2 database, both maintained by the OECD.

Additional variables used as controls or to compute interactions, such as Gross Domestic Product, value added by activities, and maritime transport costs are also obtained from the OECD.

Table 1 presents the summary statistics of the variables that will be used in the gravity model of trade, with the corresponding mean values, standard deviations, and minimum and maximum values.

Table 1: Summary statistics

VARIABLES	Obs	Mean	Std. dev.	Min	Max
Bilateral imports	418,842	2.11E+08	1.25E+09	0.485646	1.09E+11
Bilateral exports	402,169	2.22E+08	1.31E+09	0	1.07E+11
Carbon Price CO2 Reporter	418,842	0.1459249	2.229063	0	220
Carbon Price CO2_Partner	418,842	0.1141235	1.7544	0	220
Environ. Tax_CO2 Reporter	417,599	0.4310855	10.00676	-1.538529	1020.8
Environ. Tax_CO2_Partner	396,646	0.3977713	8.117552	-1.538529	1020.8
Tax Energy_CO2 Reporter	417,599	0.3257646	8.15302	-1.769811	833.8
Tax Energy_CO2 Partner	396,646	0.3000543	6.621353	-1.769811	833.8
EPI_CO2 Reporter	375,920	0.5140354	6.824891	0	647.7778
EPI_CO2_Partner	303,510	0.5069987	6.02622	0	647.7778

Note: EPI denotes environmental policy stringency index

3.2. Stylized facts

In this subsection we start by reporting some figures on the main proxies used for environmental policies. Figure 1 shows an increasing trend of carbon pricing policies adopted globally. Ever since the first carbon tax was introduced in Finland in 1990, the number of other countries that have implemented a carbon price policy(s) has been growing rapidly. By 2022, 67 countries had a carbon price at either the national or subnational level, covering around 26 percent of global greenhouse gas emissions (World Bank 2023). In addition, 38 countries have or are participating in an emissions trading system (ETS) under international, national, or subnational initiatives. Recent adopters include Indonesia, Vietnam, Mexico, Uruguay, China, and Montenegro, which introduced carbon taxes over the period from 2021 to 2023. However, the geographical coverage of carbon pricing remains far from universal, with the policy instrument facing technical and political barriers that hinder implementation in some countries (Rabe, 2018).

Figure 1: Countries with implemented carbon pricing policies

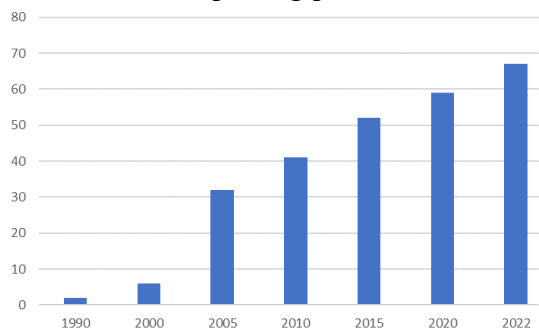
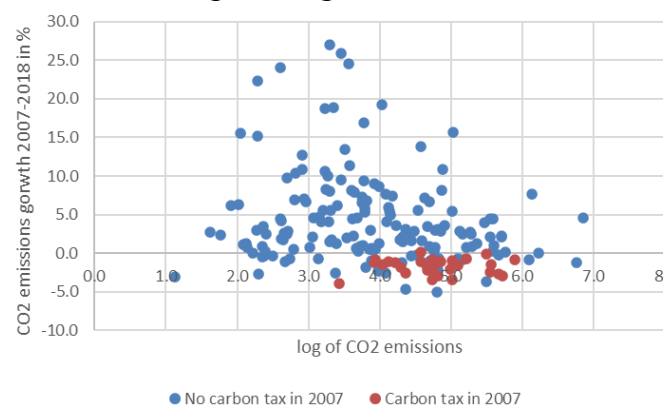


Figure 2: CO2 emissions growth, annual average, %, 2007–2018 against log CO2 emissions in 2007



(Source: Authors elaboration using data from the World Bank)

Figure 2 plots the average annual growth in CO2 emissions over 2007–2017 against the previous decade's average annual growth rate in this variable. We can observe that for countries without a carbon tax/price in 2007, there is a negative relationship between the initial level of log CO2 emissions and the subsequent growth rate of these emissions. For these countries, the CO2 emissions growth was negative in the period 2007–2018. Their CO2 emissions fell in the period by an average annual rate of 1.7 percent. On the other hand, for the countries that did have a carbon tax/price in 2007, the relationship is positive. For these countries, CO2 emissions increased by an average rate of 4.4 percent per annum (with some exceptions, as it is evident from the chart).

Figures 3 and 4 approximate the stringency of the environmental regulations, using as a proxy the evolution over time of environmental taxes, for the period 2007–2018, distinguish between OECD and Non-OECD countries. Figure 3 shows the evolution of taxes on energy, while Figure 4 shows the evolution of taxes on pollution. On the one hand, some convergence toward lower average values can be observed for the period under study for the OECD countries, indicating perhaps a shift to cleaner production processes that are taxed less. On the other hand, we can see an increase in environmental taxes for the non-OECD countries (the decline in 2020 is due to the COVID-19 effect), likely indicating an increase in the tax base intensity, as new environmental taxes are being introduced in these countries.

Figure 3: Taxes on Energy (including fuel for transport), as % of GDP

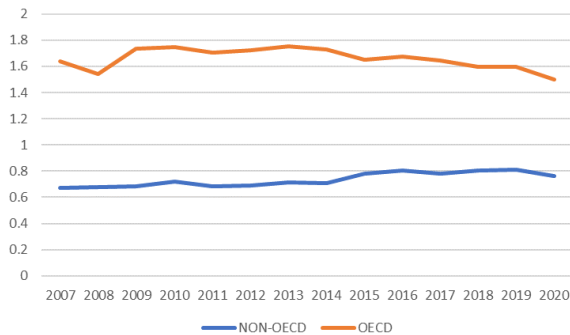
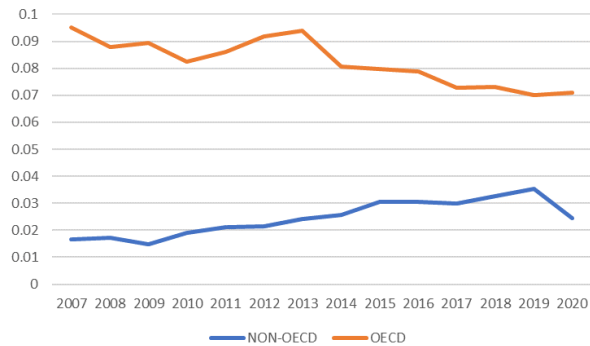


Figure 4: Taxes on Pollution, as % of GDP



(Source: Authors elaboration using data from OECD Environmentally Related Tax Revenue)

Apart from looking at the environmental side of the story we need to take a glimpse at the trade side of the same coin. In Figure 5 we show the evolution of trade, distinguishing between intra- and extra-OECD trade. On average, OECD countries have increased their trade by around 10.7 percent in nominal terms per annum in the period 2007-2018. Nevertheless, trade had increased more with non-OECD countries compared to intra-OECD trade. The former one increased by over 12 percent per annum, while the latter one increased by 10 percent annually. Still, extra-OECD trade increased at a much lower rate. Moreover, as can be seen in Figure 6 the share of intra-OECD trade is much higher compared to extra-OECD trade. In 2018, the former was just over 70 percent of the overall trade of OECD countries, declining slightly from 76 percent in 2007. On the other hand, the share of trade with extra-OECD countries stood at just under 30 percent in 2018, increasing from 24 percent in 2007.

Figure 5: Trade growth in OECD and Non-OECD countries, 2007-2018, in p.p.

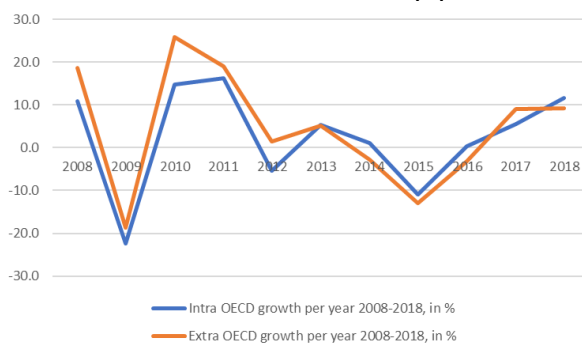
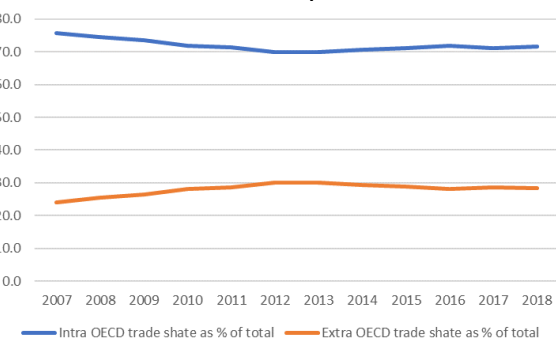


Figure 6: Share of intra and extra OECD trade, 2007-2018, as % of total

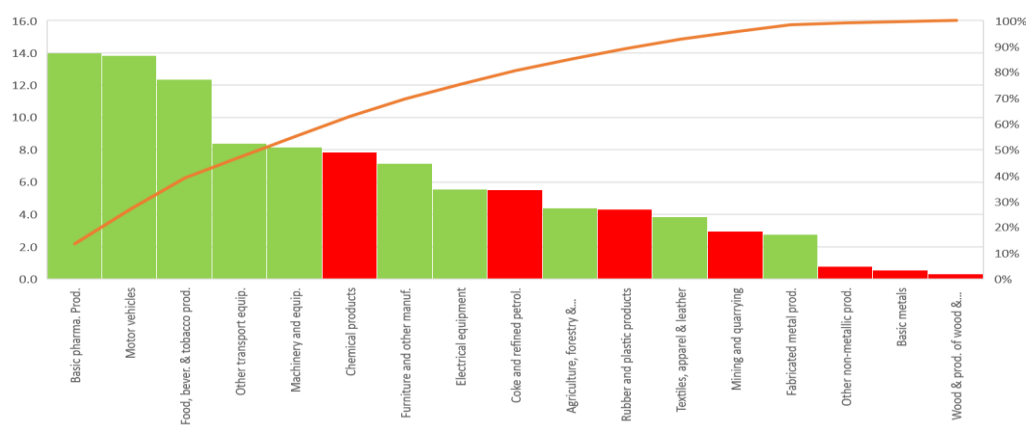


(Source: Authors elaboration using data from OECD Environmentally Related Tax Revenue)

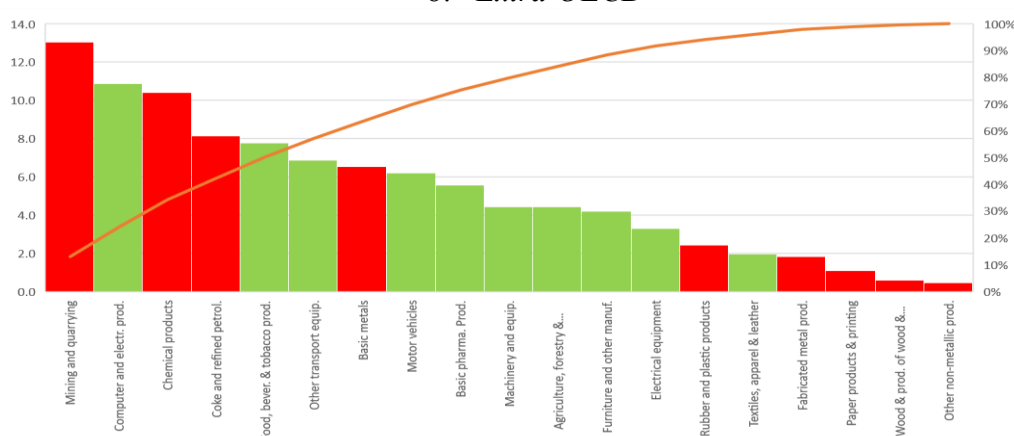
Figure 7 shows the contribution to trade growth of OECD countries by industry. We have divided the industries between clean and dirty for comparison. As can be seen, intra-OECD trade growth was largely driven by clean industries with pharmaceuticals, motor vehicles, food and beverages and transport equipment and machinery equipment leading the way and accounting for almost 2/3 of growth. This indicates that trade (and thus comparative advantage) among these countries, with relatively similar environmental standards, is likely driven by factors that are not environment-related. The contribution of dirty industries was small accounting for 20 percent. Differently, extra-

OECD trade in dirty industries accounted for 1/3 of overall trade, but most of the trade growth over the sample period 2007-2018 is attributed to them, representing almost ½ of trade growth, with mining, chemicals, coke and petroleum and basic metals making over 38 percentage points.

Figure 7: Contribution to growth per clean and dirty industry, 2007-2018 in p.p.
a. Intra-OECD



b. Extra-OECD



(Source: Authors elaboration using data from OECD International Merchandise Trade. Note: Clean industries are in green colour and dirty ones in red. See Appendix A.X for the classification)

In summary, from the presented stylized facts we can infer that environmental regulations are becoming increasingly more important in a growing number of countries, not just developed ones, but developing ones as well. Moreover, as a result of the rising number of developing countries that are implementing environmental regulations, we can observe a tentative move towards convergence of environmental taxes among developed and developing countries. A first graphical analysis indicates that in general countries that have had some sort of environmental regulations in the past tend to have lower CO2 emissions. Finally, looking across industries in OECD countries, in terms of dirty and clean ones, we can see that almost all intra-trade growth in OECD countries was mainly driven by clean industries, while the opposite is the case for extra-OECD trade, where trade was primarily driven by dirty industries. This last point provides a first

indication, which has to be empirically tested, of the possible existence of a pollution haven hypothesis that will be reflected in trade flows of OECD and non-OECD countries. However, we cannot ignore that other factors that may be also influencing this relationship, or the potential measurement errors are not being taken into account. To deal with these issues, in the following section, we carry out a complete regression analysis, considering other covariates, and potential endogeneity problems.

4. THEORETICAL BACKGROUND AND MODEL SPECIFICATION

The gravity model of trade is nowadays the most accepted framework to model bilateral trade flows (Anderson, 1979; Bergstrand, 1985; Anderson and Van Wincoop, 2003). Independent from the theoretical framework of reference, most of the mainstream foundations of the gravity model are variants of the Anderson (1979) demand-driven model, which assumes a constant elasticity of substitution and product differentiation by origin. According to the underlying theory, trade between two countries is explained by nominal incomes, by the distance between the economic centers of the exporter and importer, and by trade costs usually proxied with a number of trade impeding and trade facilitating variables, such as trade agreements, common language, or a common border.

According to the underlying theory that has been reformulated and extended by Anderson and van Wincoop (2003), the model assumes a constant elasticity of substitution and product differentiation by place of origin. In addition, prices differ among locations due to symmetric bilateral trade costs. The reduced form of the model is given by

$$X_{ijkt} = \frac{Y_{it}Y_{jt}}{Y_t^W} \left(\frac{t_{ijt}}{P_{it}P_{jt}} \right)^{1-\sigma} \quad (1)$$

where X_{ijkt} are bilateral exports of product k from country i to country j in year t , and Y_{it} , Y_{jt} , and Y_t^W are the GDPs in the exporting country, the importing country, and the world in year t , respectively. t_{ijt} denotes trade cost between the exporter and the importer in year t and P_{it} , P_{jt} are the so-called multilateral resistance terms. σ is the elasticity of substitution between goods.

The empirical specification of the model in equation (1) in log-linear form is given by

$$\ln X_{ijkt} = \ln Y_{it} + \ln Y_{jt} - \ln Y_t^W + (1 - \sigma) \ln t_{ijt} + (1 - \sigma) \ln P_{it} + (1 - \sigma) \ln P_{jt} \quad (2)$$

The estimation of equation (2) is not straightforward, since some assumptions are required, concerning the trade costs and multilateral resistance terms. The trade cost function is assumed to be a linear function of trade barriers, namely the time-invariant determinants of trade flows such as distance, common border, common language, and whether a country is landlocked.

Substituting the trade cost function into equation (2) suggests estimating the following model:

$$\ln(X_{ijkt}) = \alpha_0 + \alpha_1 \ln Y_{it} + \alpha_2 \ln Y_{jt} + \alpha_3 \ln D_{ij} + \alpha_4 \text{Land}l_i + \alpha_5 \text{Land}l_j + \alpha_6 \text{Border}_{ij} + \alpha_7 \text{EU}_{ijt} + u_{ijkt} \quad (3)$$

where D_{ij} denotes the geographical distance from country i to country j , and take the value of one when countries i or/and j are respectively landlocked, zero otherwise, $\text{Land}l_i$ takes the value of one when the trading countries share a border, zero otherwise, and EU_{ijt} takes the value of one when the trading

countries are members of the EU, zero otherwise. Based on the recent gravity literature the multilateral resistance terms are modeled as country-pair specific dummies. That prevents us from obtaining the coefficient estimates for time-invariant variables, and their effects are subsumed into the country-pair dummies.

The gravity model has been widely used to investigate the role played by specific policy or geographical variables in explaining bilateral trade flows. Consistent with this approach, and in order to investigate the effect of environmental regulations on trade, we augment the model with the different environmental regulations in the reporter (OECD) and partner countries (OECD or non-OECD) and use bilateral imports of OECD countries as the main dependent variable. Additionally, we also estimate the results of exports and net imports as a robustness check. Introducing several sets of fixed effects, the specification of the gravity model is as follows:

$$\ln(X_{ijkt}) = \alpha_0 + \alpha_1 (EI * EnvPol)_{ikt} + \alpha_2 EI * (EnvPol)_{jkt} + \theta_{it} + \lambda_{jt} + \delta_{ij} + \gamma_{kt} + \epsilon_{ijkt} \quad (4)$$

where, X_{ijkt} is exports (imports) of industry k from country i to country j at time t ; and $EnvPol$ is proxied by the interaction of carbon emissions intensity (EI_{kt}) with 4 different environmental policy variables: Pis is a dummy variable with a value of one for countries that had implemented carbon pricing in year t and zero otherwise; Ln represents taxes on different environmental aspects, including pollution and energy; $EnvPol$ is a country-specific and internationally-comparable measure of the stringency of environmental policy, where stringency is defined as the degree to which environmental policies put an explicit or implicit price on polluting or environmentally harmful behaviour. We use in our estimations several sets of fixed effects: reporter-time, it ; partner-time, jt ; sector-time, kt ; and reporter-partner, ij .

Despite the widespread use of linear models, for estimating the gravity equations we employed an efficient estimator designed for panel data models featuring multi-way fixed effects, a Poisson pseudo-likelihood estimator with high-dimensional fixed effects (PPML-HDFE). This approach combines the strengths of PPML regression, which has clear advantages over OLS as outlined by Santos Silva and Tenreiro (2006), with the flexibility of a high-dimensional fixed effects estimator developed by Correia (2019)¹.

The PPML specification is given by:

$$X_{ijkt} = \exp(\alpha_1 [EI * EnvPol]_{ikt} + \alpha_2 [EI * EnvPol]_{jkt} + \theta_{it} + \lambda_{jt} + \delta_{ij} + \gamma_{kt}) * \epsilon_{ijkt} \quad (5)$$

where the variables have been defined below equation (4).

4. MAIN RESULTS

The main model has been estimated for imports and exports, separately. Results from estimating specification (5) are presented below for imports and exports of OECD countries. Four different proxies for environmental policy stringency of the importer and exporters are introduced sequentially in the specification, each of them interacting with the CO2 emissions intensity by sector and time. For instance, carbon prices in column (1), environmental and energy taxes in

¹ This estimator accommodates multiple fixed effects and interactions. Building upon this, Correia, Guimarães, and Zylkin (2020) propose a novel and more robust approach for verifying the existence of (pseudo) maximum likelihood estimates, referred to as fast Poisson estimation with high-dimensional fixed effects.

columns (2) and (3), and the EPI in column (4). The estimated coefficients show positive and significant effects on imports of the introduction of a carbon price, an increase in taxes, and increases in the EPI of the importing country (i), whereas decreases in imports are observed when the stringency of environmental policy increases in the exporting country. This result is in accordance with the theories indicating that more stringent environmental policies increase imports of dirty goods.

Table 2: Main Results Imports: PPML estimations, 2007-2018

Dependent variable: Imports	(1)	(2)	(3)	(4)
	Carbon Price	Envir. Taxes	Tax Energy	EPI
Explanatory variables:				
Env stringency importer*EI	0.027***	-0.046**	0.003	0.240***
	(0.003)	(0.019)	(0.004)	(0.027)
Env stringency exporter*EI	-0.114***	-0.055***	-0.011**	-0.325***
	(0.034)	(0.016)	(0.005)	(0.033)
Observations	496851	293312	307283	288278
Reporter-partner FE	YES	YES	YES	YES
Reporter-time FE	YES	YES	YES	YES
Partner-time FE	YES	YES	YES	YES
Sector-time	YES	YES	YES	YES
Robust z-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by pair-sector.				

Table 3: Main Results Exports: PPML estimations, 2007-2018

Dependent variable: Exports	(1)	(2)	(3)	(4)
	Carbon Price	Envir. Taxes	Tax Energy	EPI
Explanatory variables:				
Env stringency exporter*EI	-1.041***	-0.440***	-0.347***	-0.623***
	(0.091)	(0.087)	(0.080)	(0.065)
Env stringency importer*EI	0.157**	0.057**	0.021	-0.013
	(0.067)	(0.028)	(0.042)	(0.051)
Observations	1031769	304808	435557	291021
Reporter-partner FE	YES	YES	YES	YES

Reporter-time FE	YES	YES	YES	YES
Partner-time FE	YES	YES	YES	YES
Sector-time	YES	YES	YES	YES
Robust z-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by pair-sector.				

Table 4: Heterogenous effects for groups of countries, 2007-2018

Dependent variable: OECD and non-OECD importers	(1)	(2)	(3)	(4)
	CarbonP	EnvTax	EnerTax	EPI
Explanatory variables:	b/se	b/se	b/se	b/se
Env String#Non-OECD_P#c.EI	0.026***	-0.021	-0.181***	0.153***
	-0.003	-0.036	-0.035	-0.043
Env String#OECD_P#c.EI	0.031***	-0.113***	0.005	0.140***
	-0.004	-0.029	-0.003	-0.035
Env String_P#Non-OECD_P#c.EI	-0.016***	-0.04	-0.105***	-0.875***
	-0.005	-0.041	-0.018	-0.053
Env String_P#OECD_P#c.EI	-0.134***	-0.111***	-0.012*	-0.156***
	-0.038	-0.023	-0.007	-0.045
Observations	496851	293312	307283	288278
Robust z-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by pair-sector.				

Table 5: Main Results: PPML estimations, 2007-2018

Dependent variable: Polluting Imports	(1)	(2)	(3)	(4)
	Carbon Price	Envir. Taxes	Tax Energy	EPI
Explanatory variables:				
Env stringency importer*EI	0.081***	-0.048**	-0.001	0.250***
	(0.020)	(0.022)	(0.010)	(0.020)
Env stringency exporter*EI	-0.199***	-0.056***	-0.021	-0.308***
	(0.040)	(0.018)	(0.017)	(0.028)
Observations	224477	132461	137998	132687

Reporter-partner FE	YES	YES	YES	YES
Reporter-time FE	YES	YES	YES	YES
Partner-time FE	YES	YES	YES	YES
Sector-time	YES	YES	YES	YES
Robust z-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by pair-sector.				

Table 6: Main Results: PPML estimations, 2007-2018

Dependent variable: Imports neutral products	(1)	(2)	(3)	(4)
	Carbon Price	Envir. Taxes	Tax Energy	EPI
Explanatory variables:				
Env stringency importer*EI	1.118***	2.218***	2.216***	3.701***
	(0.237)	(0.237)	(0.289)	(0.245)
Env stringency exporter*EI	-2.086***	0.319***	-0.344*	-3.038***
	(0.230)	(0.051)	(0.203)	(0.189)
Observations	272350	160844	169284	155591
Reporter-partner FE	YES	YES	YES	YES
Reporter-time FE	YES	YES	YES	YES
Partner-time FE	YES	YES	YES	YES
Sector-time	YES	YES	YES	YES
Robust z-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by pair-sector.				

NOTE: Comments and explanations of the tables are not included because of time constraints in submitting the paper. Nevertheless, if the paper is accepted full comments and explanations will be provided by the time of the Conference.

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VARIABLE	SOURCE	DESCRIPTION	UNIT OF MEASURE	AVAILABILITY PERIOD
Reported Export Value	OECD - Balanced International Merchandise Trade Statistics (by CPA) https://stats.oecd.org/Index.aspx?DataSetCode=BIMTS_CPA#	The reported export value: The value of exports from the Reporter to the Partner, as reported by the Reporter (Values are expressed in US dollars).	US dollars	2007-2018
Reported Mirror Import Value	OECD - Balanced International Merchandise Trade Statistics (by CPA) https://stats.oecd.org/Index.aspx?DataSetCode=BIMTS_CPA#	The reported import value: The value of imports by the Reporter (OECD country) from the partner, as reported by the Reporter (Values are expressed in US dollars).	US dollars	2007-2018
OVERALL Environmental Stringency Index	OECD - Environmental Policy Stringency Index https://stats.oecd.org/Index.aspx?DataSetCode=EPS	The ESI is a country-specific and internationally-comparable measure of the stringency of environmental policy. Stringency is defined as the degree to which environmental policies put an explicit or implicit price on polluting or environmentally harmful behaviour.	The index ranges from 0 (not stringent) to 6 (highest degree of stringency) and	covers 40 countries for the period 1990-2020
Carbon price and ETS (dummy)	World Bank - carbon Pricing Dashboard https://carbonpricingdashboard.worldbank.org/map_data	The dummy variable taking the value of 1 if the country has a carbon tax or an ETS (or both) in place and 0 if otherwise.	Dummy variable with values 1 or 0	1990-2023
Environmental Taxes as % of GDP	OECD - Environmentally related tax revenue https://stats.oecd.org/Index.aspx?DataSetCode=ERTR#	An environmental tax is a charge levied on a physical unit of an item that has a proven negative impact on the environment. A gallon of petrol, a passenger flight or a ton of waste bound for landfill are examples of such physical units. It contains detailed qualitative and quantitative information on environmentally related taxes, fees and charges, tradable permits, deposit-refund systems, environmentally motivated subsidies and voluntary	Overall environmental tax revenues as % of GDP. The data need to be interpreted with caution as environmentally related tax revenue can increase or decrease for several independent or interlinked factors. For	1994-2021

		approaches used for environmental policy	example, declines can be caused by base erosion beneficial from an environmental perspective) or lowered tax rates (usually harmful from an environmental perspective).	
Taxes on Energy, (including fuel for transport)	OECD - Environmentally related tax revenue https://stats.oecd.org/Index.aspx?DataSetCode=ERTR#	Includes all CO ₂ -related taxes on energy products (e.g. fossil fuels and electricity) including those used in transportation (e.g. petrol and diesel).	Tax revenues from energy products as % of GDP	1994-2021
CO ₂ emissions intensities	OECD - OECD Inter-Country Input-Output Database and Trade in embodied CO ₂ (TeCO ₂) Database	CO ₂ emission intensities are calculated by dividing the CO ₂ emissions from fuel consumption by output from the OECD Inter-Country Input-Output (ICIO) Tables and multiplying the result by 1 million for scaling purposes	Metric Tons of CO ₂ Emissions per \$ 1 million USD of output	1995-2018
OTHER VARIABLE S THAT WE DID NOT USE AT THE END				
Market-based ESI	OECD - Environmental Policy Stringency Index https://stats.oecd.org/Index.aspx?DataSetCode=EPS	The ESI is a country-specific and internationally-comparable measure of the stringency of environmental policy. Stringency is defined as the degree to which environmental policies put an explicit or implicit price on polluting or environmentally harmful behaviour.	The index ranges from 0 (not stringent) to 6 (highest degree of stringency) and	covers 40 countries for the period 1990-2020
Non-market based ESI	OECD - Environmental Policy Stringency Index https://stats.oecd.org/Index.aspx?DataSetCode=EPS	The ESI is a country-specific and internationally-comparable measure of the stringency of environmental policy. Stringency is defined as the degree to which environmental policies put an explicit or implicit price on polluting or environmentally harmful behaviour.	The index ranges from 0 (not stringent) to 6 (highest degree of stringency) and	covers 40 countries for the period 1990-2020

Teck supp policies ESI	OECD - Environmental Policy Stringency Index https://stats.oecd.org/Index.aspx?DataSetCode=EPS	The ESI is a country-specific and internationally-comparable measure of the stringency of environmental policy. Stringency is defined as the degree to which environmental policies put an explicit or implicit price on polluting or environmentally harmful behaviour.	The index ranges from 0 (not stringent) to 6 (highest degree of stringency) and	covers 40 countries for the period 1990-2020
National Greenhouse gas emissions	United Nations Framework Convention on Climate Change (UNFCCC). 2022. Greenhouse Gas Inventory Data - Detailed data by Party Annex I. https://di.unfccc.int/detailed_data_by_party	The data contains annual Net Emissions/Removals of all Greenhouse Gas Emissions	Million metric tons of CO2 equivalent	1970-2021
Domestic CO2 emissions embodied in gross exports	OECD - Carbon dioxide emissions embodied in international trade (2021 ed.) https://stats.oecd.org/Index.aspx?DataSetCode=IO_GHG_2021#	Domestic CO2 emissions embodied in gross exports, by industry i in country/region c to partner country/region p, represents the embodied CO2 emissions in exports that have been generated anywhere in the domestic economy (i.e. not just by the exporting industry).	Million of Tonnes	1995-2018
CO2 emissions	OECD - Carbon dioxide emissions embodied in international trade (2021 ed.) https://stats.oecd.org/Index.aspx?DataSetCode=IO_GHG_2021#	CO2 emissions from a production perspective, are equal to CO2 emitted and consumed domestically + CO2 emitted domestically and embodied in exports. It shows for country c and industry i the total emissions in production and it is here defined only for partner World.	Million tonnes of CO2 Estimated from the IEA's CO2 emissions from fuel combustion (http://www.iea.org/statistics/topics/co2emissions).	1995-2018
CO2 emissions intensities	OECD - OECD Inter-Country Input-Output Database and Trade in embodied CO2 (TeCO2) Database	CO2 emission intensities are calculated by dividing the CO2 emissions from fuel consumption by output from the OECD Inter-Country Input-Output (ICIO) Tables and multiplying the result by 1 million for scaling purposes	Metric Tons of CO2 Emissions per \$ 1 million USD of output	1995-2018
CO2 emissions multipliers	OECD - OECD Inter-Country Input-Output Database and Trade in embodied CO2	CO2 emission multipliers are calculated by multiplying the Leontief inverse (also known as output multipliers matrix) from the OECD Inter-Country Input-Output (ICIO) Tables by the CO2 emission intensities.	Metric Tons of CO2 Emissions per \$1million USD of output	1995-2018

	(TeCO2) Database			
Gross Value Added per industry (source OECD)	OECD - Value added and its components by activity, ISIC rev4 https://stats.oecd.org/Index.aspx?DataSetCode=SNA_TABLE6A#	Gross value added per industry in a given country	in mill US\$	1950-2021
GDPpc, constant prices, constant PPPs (source OECD)	OECD - Gross domestic product (GDP) https://stats.oecd.org/index.aspx?queryid=60706#	Gross domestic product, expressed in constant prices and using Purchasing Power Parity	in constant US\$ PPP	1950-2021
GDPpc, Per head, current prices, current exchange rates (source OECD)	OECD - Gross domestic product (GDP) https://stats.oecd.org/index.aspx?queryid=60706#	Gross domestic product in current prices and expressed per capita	in mill US\$ per capita	1950-2021
Transport costs - exporter OECD country (source OECD)	OECD - Maritime Transport Costs https://stats.oecd.org/Index.aspx?DataSetCode=MTC#	Maritime transport costs are calculated at 6 6-digit product level and aggregated per industry using conversion tables.	in USD	1991-2007
Transport costs Ad Valorem-exporter OECD country (source OECD)	OECD - Maritime Transport Costs https://stats.oecd.org/Index.aspx?DataSetCode=MTC#	Maritime transport costs are calculated at 6-digit product level and aggregated per industry using conversion tables. Maritime transport cost is divided by the import value, i.e. the share of transport cost represents the total import value of the product.	in % as the share of transport cost represents the total import value of the product.	1991-2007
International Transport and Insurance Costs of Merchandise Trade (ITIC)	https://stats.oecd.org/Index.aspx?DataSetCode=CIF_FOB_ITIC#	The OECD ITIC dataset combines the largest and most detailed cross-country sample of official national statistics on explicit CIF-FOB margins with estimates from an econometric gravity model	Ratio (The Cif-Fob ratio corresponds to: (Cif value-Fob value)/(Cif value)	1995-2020

TRADE INTENSITY IN DIGITALLY DELIVERED SERVICES AND ECONOMIC COMPLEXITY

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EXTENDED ABSTRACT

Purpose Digitally delivered services have become a pivotal component of global trade, accounting for over 50% of total services exports worldwide as of 2020 (Mourougane, 2021). But how is this digital trade related to the structure of an economy? Despite the growing significance of digital trade, the relationship between trade intensity in digitally delivered services and the structure of an economy remains underexplored (Mourougane, 2021; Dong and Xu, 2022; Zhou *et al.*, 2023; Chiappini and Gaglio, 2024). In this paper, we fill this research gap by examining how exports per capita of digitally delivered services relate to multidimensional economic complexity, encompassing measures for the trade and research structure of an economy (Stojkoski *et al.*, 2023). Understanding this relationship is crucial for policymakers and stakeholders aiming to enhance competitiveness in the digital economy (Hidalgo and Hausmann, 2009; Hausmann *et al.*, 2014; Hartmann *et al.*, 2017; Hidalgo, 2021; Romero and Gramkow, 2021).

Design/methodology/approach We employ a panel regression analysis with time-fixed effects to control unobserved heterogeneity and temporal dynamics across countries and over time. We follow the Handbook on Measuring Digital Trade (Mourougane, 2021) and define digitally delivered services as all international trade transactions that are delivered remotely over computer networks. These range from providing online educational services to cloud computing subscriptions (Stojkoski *et al.*, 2024). Using this definition, we collect data from the BATIS WTO dataset on services (Fortanier *et al.*, 2017) and Eurostat mappings (European Commission. Statistical Office of the European Union., 2021) to calculate per capita exports of digitally delivered services for over 120 countries from 2005 to 2020. We also use data on the Economic Complexity Index (ECI) for the research and trade dimensions from the Observatory of Economic Complexity (Simoes and Hidalgo, 2011). These indexes compare the economic structure of a country to an ensemble of other countries, with higher values

implying that the country is more sophisticated compared to the ensemble. We then employ panel regression analysis on average data segmented into four four-year periods: 2005-2008, 2009-2012, 2013-2016, and 2017-2022 in which the dependent variable is the log of the digitally delivered services exports per capita. This methodological approach allows us to investigate the correlation between exports per capita and the economic complexity indices derived from trade and research data, and to study their interaction in explaining digital trade. **Findings** The analysis reveals a robust positive relationship between economic complexity and digitally delivered services exports per capita (see Table 1 for the regression results). Specifically, according to our final model (including all covariates, Table 1, column 7), a one-unit increase in trade ECI is associated with a 0.733 increase in the log of digitally delivered services exports per capita ($p<0.05$), while a one-unit increase in research ECI corresponds to a 0.172 increase ($p<0.05$). The significant positive interaction between trade and research ECIs (coefficient 0.361, $p<0.05$) suggests that countries with both advanced trade sectors and strong research outputs experience a synergistic boost in digital services exports.

Table 1: Regression results for the relationship between trade intensity in digitally delivered services and economic complexity

<i>Dependent variable: log of Digitally delivered services exports per capita (2005-2008, 2009-2012, 2013-2016, 2017-2020)</i>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ECI (trade)		1.939*** (0.074)	0.841*** (0.099)			0.805*** (0.098)	0.733*** (0.103)
ECI (research)				1.259*** (0.085)	0.422*** (0.077)	0.243*** (0.074)	0.172** (0.075)
ECI (trade) x ECI (research)						0.252*** (0.059)	0.361*** (0.068)
log of GDP per capita	-0.474*** (0.095)	-1.024*** (0.100)	-0.724*** (0.094)	-0.665*** (0.097)	-0.550*** (0.087)	-0.747*** (0.092)	-0.659*** (0.094)
log of Natural resources exports per capita	1.077*** (0.093)	1.023*** (0.093)	0.623*** (0.089)	0.896*** (0.102)	0.463*** (0.087)	0.620*** (0.091)	0.523*** (0.093)
log of Fixed broadband connections per capita			0.765*** (0.100)		1.004*** (0.092)	0.945*** (0.093)	0.601*** (0.109)
log of Internet access per capita			0.516*** (0.127)		0.633*** (0.138)		0.679*** (0.154)
Observations	531	477	467	455	448	436	433
R ²	0.303	0.710	0.799	0.511	0.785	0.806	0.819
Adjusted R ²	0.296	0.706	0.796	0.505	0.781	0.802	0.815
F Statistic	51.612*** (df=5; 525)	179.252*** (df=6; 470)	185.944*** (df=8; 458)	98.969*** (df=6; 448)	166.156*** (df=8; 439)	198.360*** (df=9; 426)	172.985*** (df=10; 422)

Note: Robust standard errors in parentheses. * $p<0.1$; ** $p<0.05$; *** $p<0.01$.

Originality/value This study contributes to the literature by integrating the structure of an economy through multidimensional economic complexity into the analysis of digitally delivered services trade—a nexus that has been largely overlooked. By developing a novel dataset and combining trade and research ECIs, we provide a comprehensive understanding of their joint impact on digital trade. The findings suggest that enhancing both trade and research sectors can significantly boost a country's digital services exports. Limitations to our work include potential unobserved variables and data constraints for certain regions. Future research

could explore causal relationships and the impact of specific policy interventions on economic complexity and digital trade performance.

Keywords: Digital trade, Economic complexity, ICT, Panel data analysis.

JEL classification: F10, F13, F14, C23, F63.

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HOW TO IMPROVE BILATERAL TRADE BETWEEN WESTERN BALKAN COUNTRIES BY APPLYING DIGITAL AND SUSTAINABLE TRADE FACILITATION MEASURES

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EXTENDED ABSTRACT

Purpose The purpose of this paper is to give a detailed insight into the digital and sustainable trade component of trade facilitation measures that the Western Balkan Countries can apply to enhance their mutual trade. The analysis in this paper is based on previous research conducted on a set of measures derived by the UN Global Survey on Digital and Sustainable Trade in 2023 (UN ESCAP, 2023). The UN Global Survey makes available five sets of around sixty trade facilitation measures grouped into transparency, formalities, institutional arrangements and cooperation, paperless trade, and cross-border paperless trade (UN, 2023). A gravity model in trade was applied and the results have shown that for improving trade among the Western Balkans countries the biggest importance and significance have the trade facilitation measures connected to transparency and formalities. The measures from the set: institutional arrangements and cooperation are also significant but with a negative sign. Also, significant but with a lower level (on a 10% significance) are the measures from cross-border paperless trade. The measures grouped in paperless trade have resulted in being insignificant in improving bilateral trade among the Western Balkans countries (Toshevska-Trpchevska *et al.*, 2024). Our goal in this analysis would be to make an in-depth analysis of the reasons for the importance and significance of the specified trade facilitation measures.

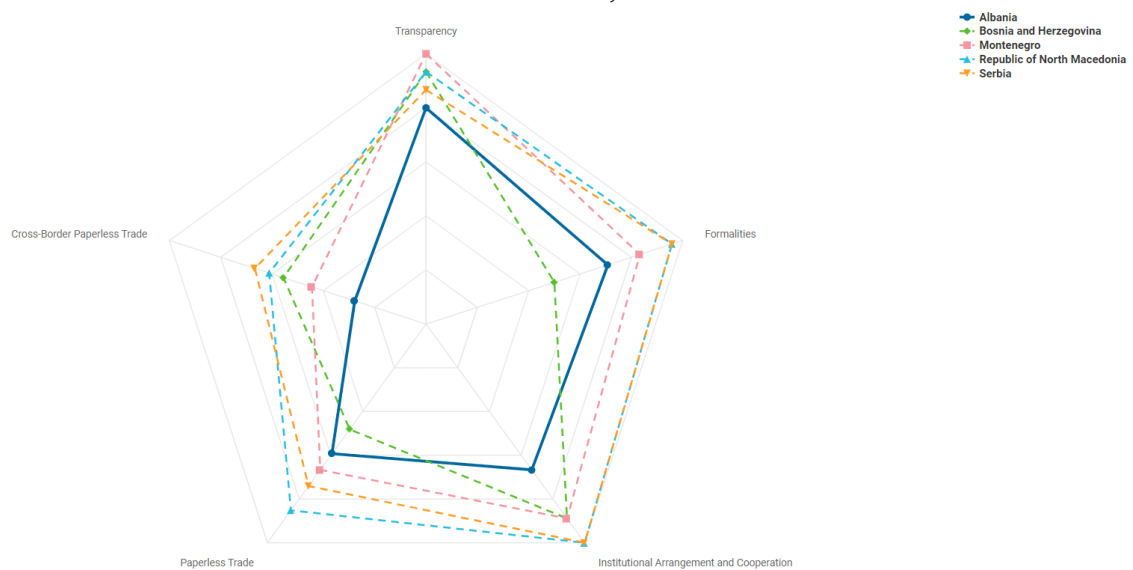
Additionally, we plan to make a sectoral analysis of the importance of digital and sustainable trade facilitation measures for improving bilateral trade among the Western Balkan countries. The results from the gravity model analysis have shown that digital and sustainable trade facilitation measures, especially measures on transparency and formalities are important for improving trade of the following groups of products: animal products, vegetable products, animal and vegetable bi-products, and foodstuffs; animal hides, wood products, paper goods, textiles, and footwear and headwear; machines, transportation, instruments, and weapons; and chemical products and plastics, and rubber. This sectoral analysis of the importance of trade facilitation measures confirms the sectoral structure of trade among these countries. We plan to make an in-depth analysis of the constraints and barriers that this sectoral group of products faces in bilateral trade.

Western Balkans economies are all members of regional trade integration created by the revised central European Free Trade Agreement from 2006 (CEFTA 2006), including the Republic of

Moldova. Since some of them are not members of the World Trade Organization (WTO) and have not ratified the Trade Facilitation Agreement, CEFTA 2006 concluded its own Trade Facilitation Act – Additional Protocol 5. This Protocol goes even beyond TFA with the trade facilitation measures applied. The three countries from the region are members of subregional trade integration - Open Balkan, Albania, Macedonia, and Serbia and apply some specific trade facilitation measures, that will be addressed in the paper.

Design/methodology/approach In this analysis we plan to base the research on interpreting results done with a gravity model and present the results from the sectoral analysis. We will also graphically present the comparative results of the digital and sustainable trade facilitation scores of the separate Western Balkan countries that are analysed.

Figure 1: Comparison of trade facilitation and paperless trade implementation of Western Balkan economies, 2023



(Source: <https://www.untfsurvey.org/compare-economies?id=ALB&year=2023&op=2&countries=BIH%2CMNE%2CMKD%2CSRB&measures=default>)

For example, Figure 1 provides a graphical comparison of the Digital and Sustainable trade facilitation measures implemented by the separate Western Balkan countries in 2023. Additionally, in Table 1 the separate scores of the five sets of digital and trade facilitation measures are presented between the Western Balkans countries. This data provides us with insights into the level of implementation of different sets of digital and sustainable trade facilitation measures between the countries. For example, it is visible that Albania has the lowest score on the implementation of cross-border paperless trade and further research could be done on the reasons for this.

Table 1: Western Balkans TFScores 2023

Country	ALB	BIH	MNE	MKD	SRB
TFScore	60.22%	61.29%	74.19%	86.02%	82.80%
Transparency	80%	93.33%	100.00%	93.33%	86.67%
Formalities	70.83%	50.00%	83.33%	95.83%	95.83%
Inst.arrangements&coop.	66.67%	88.89%	88.89%	100.00%	100.00%
Paperless trade	59.26%	48.15%	66.67%	85.19%	74.07%
Cross-border paperless	27.78%	55.56%	44.44%	61.11%	66.67%

(Source: Authors calculation from data available on <https://www.untfsurvey.org/>)

Findings The main findings of our analysis are connected to the in-depth analysis of the reasons for the significance of the measures of transparency and formalities and identifying the possible improvements in this sphere that could be done by the trade policy creators of Western Balkans countries. With our analysis, we plan to identify the bottlenecks that exist for improving the transparency of the trading procedures and harmonizing and facilitating the formalities in the trade among these countries. We also plan to identify the reasons for the significance but with negative signs of the measures connected to institutional arrangements and cooperation. Additionally, we plan to investigate the level of implementation of paperless trade measures in these countries as they appear to be insignificant for improving bilateral trade, but at the same time, these are the measures that can be directly identified as digital trade facilitation measures and present the important digital component for enabling sustainable trade nowadays (WTO,2023).

Originality/value This analysis is a result of a collaboration that came out from a research grant funded by the Western Balkan FUND project titled “Digital and Sustainable Trade Facilitation in Western Balkans Countries” under protocol number PN: MO-4-024. For this analysis, five Western Balkan countries have been included: Albania, Bosnia & Herzegovina, Macedonia, Montenegro, and Serbia. Kosovo was not included due to a lack of data in the UN Global Survey on Digital and Sustainable Trade Facilitation. The originality of this paper comes from the fact the digital and sustainable concept in international trade is a relatively new concept that derived and has been promoted by international organizations, like the United Nations Conference on Climate Change and the World Trade Organization in the last 2 years, after the Covid-19 Pandemic (UN, 2023; UN ESCAP, 2023). We believe that it is of utmost importance to investigate the possibility of applying digital and sustainable trade in the region of Western Balkans countries. That’s why we think that this analysis is valuable. We will try to precisely identify the specific measures that could be undertaken in the field to harmonize the trading formalities and to improve the transparency in the trading procedures among these countries. We suppose that the findings from our research could be suitable as future solutions that can be applied by the trade policy creators.

Taking into consideration that to our knowledge only the previously cited published paper deals with modeling the digital and sustainable component of bilateral trade between the Western Balkan countries, this analysis will provide original detailed findings on this issue. We believe that it is important to investigate the trade facilitation measures of Western Balkans countries because these countries have long been striving to become members of the European Union and continuously apply different trade tools, measures, and agreements to integrate and strengthen their position on the international trade scene (Mojsovska and Bjelic, 2022; Markovic *et al.*, 2021).

Keywords: *Bilateral Trade, Digital and Sustainable Trade Facilitation Measures, UN Global Survey on Digital and Sustainable Trade, Western Balkans Countries.*

JEL classification: *F10; F14; C23.*

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GLOBAL VALUE CHAIN PARTICIPATION AND THE TECHNOLOGY STRUCTURE OF EXPORTS: EXPERIENCE FROM THE CENTRAL AND SOUTHEAST EUROPEAN COUNTRIES

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ABSTRACT

Producing and incorporating technologically complex goods in the production process is a fundamental pillar to achieving long-term economic development. In this sense, integration into the global production and trade networks is viewed by many countries as a way to achieve this technological improvement. This paper examines the relationship between global value chain (GVC) integration and technology absorption through trade in high-tech products of Central and Southeast European countries over the period 1996-2019. We construct a GVC participation measure applying the latest Broad Economic Categories (BEC) classification that distinguishes between generic and specific intermediate goods. We also analyse the technology structure of exports at a country level and the sectoral level. Using panel data estimation techniques, we find that higher participation in GVCs enhances the export of high-tech products at both country and sectoral levels. This result is robust to different regression models including the use of lagged control variables and instrumental variables.

Keywords: *Global Value Chains, Technology Structure of Exports, Central and Southeastern European countries.*

JEL classification: *F14, F60, C23, C26.*

1. INTRODUCTION

Over the past decades, the world economy has experienced unprecedented globalization through the rise of global value chains (GVCs). This was a period of “hyperglobalisation” caused by factors like trade liberalisation, ICT development, fall of communist systems (Antràs, 2020b). It is often argued that GVCs have offered a new path towards industrial development since firms from high-technology nations are combining their specific managerial, technical, and marketing know-how with the low wages in developing nations (Baldwin, 2016). Nevertheless, the nexus of increased GVC participation in supporting the international transfer of technology to firms in developing countries has been given somewhat less attention in the literature.

It has long been argued that innovation and international trade are two driving forces of economic growth and development (Romer, 1999). Increased innovation provides opportunities for product differentiation and reduction of production costs, which facilitates a firm's expansion to international markets (Krugman, 1980; Guan and Ma, 2003; Tavassoli, 2018). On the other hand, trade with foreign countries results in technological spillovers (Coe and Helpman, 1995; Castellani and Fassio, 2019), which are beneficial for productivity growth in developing countries.

These two driving forces of innovation and international trade are best combined in the GVC-related trade. The rise of the GVC production model has altered the traditional way of industrialization where one country needed to develop the whole set of components that formed part of a final product. With the GVC production model, instead of having to build-up an entire domestic industry in order to export, countries can specialize in one or more stages of production and produce only some particular components that form part of the final product(s) of a GVC. This has allowed countries to leap-frog and shorten the industrialization process and penetrate international markets faster than was the case with more traditional industrialization processes.

Looking from a development standpoint, it is crucial for a country to engage dynamically in the process of GVC participation. This implies a strive to move up the value chain and accumulate more human and physical capital with time. Typically, developing countries enter GVC in low value-added tasks producing less technologically sophisticated products and performing labour-intensive tasks like product assembly. Nevertheless, within the GVC a foreign firm and a local supplier are part of the same supply chain, and they need to interact and coordinate to secure the proper functioning of the supply chain. With time, this facilitates the transfer of tacit knowledge, potentially increasing domestic innovative capabilities. Thus, opportunities to engage in the production of more sophisticated high-tech products or tasks emerge, allowing companies and the economy to move up the value chain ladder. The production of high-tech products is beneficial for the economy as a whole as it allows for positive spillovers in terms of technology transfer, skills upgrading, and productivity gains (depending on the absorptive capacity of the country). Thus, this new GVC-related model of development focuses on first joining and then crucially moving up the value chain towards higher technology and value-added processes.

In addition, the process of fragmentation of manufacturing within GVCs, has reduced the production complexity of high-tech products and opened-up opportunities for developing countries. Detaching production into smaller sub-components which are designed and produced separately and then assembled into final product(s) has facilitated this process of technology transfer. Inter-firm linkages in GVCs are important in the transfer of knowledge and in the promotion of innovation, influenced by internal or intra-firm sources of learning, fostering a capability accumulation process (Morrison *et al.*, 2008; Reddy *et al.*, 2021). This has allowed newcomers to the industries to be able to shorten the gap or catch-up with lead companies from advanced economies. Firms from small developing countries can also take advantage of the fragmentation of production and leverage their regional markets for scale and move up the technological and value chain spectrum. The Central and Southeast European countries (CSEE), which are of interest in this study, are following suit in this process.

In this paper we aim to look at the link between a higher participation in GVCs and a country's involvement in high-technology products trade. We focus on the Central and Southeast European countries¹. These are economies that underwent a sizable socio-economic transformation over the past decade. They had relatively similar starting points in their

¹ The countries in this study are comprised of Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia, Serbia, North Macedonia, Bosnia and Herzegovina and Albania.

development after the fall of communism/socialism, but the pace of their development and technological upgrading has been different; with the CSEE countries leading the way, and the WB countries following a similar pathway, but with a lag. In our analysis we try to answer the following question: has greater integration into global value chains enhanced the technology upgrading of exports in these countries through certain sectors prone to higher technology adoption?

In our analysis, we rely on an empirical method based on panel data techniques to address this question. The potential endogeneity of the participation in global value chains and technology transfer is considered in our regressions through the inclusion of lagged explanatory variables and the use of instrumental variables. In the aggregate model, we also control for human capital as an additional regressor. In all cases, our findings confirm the impact of GVC integration on the technology structure of exports at both the country and sectoral levels.

We contribute to the existing literature on GVC and trade integration in the following ways: First, we develop a method of calculating GVC participation by applying, in a novel way, the new Broad Economic Categories (BEC) classification Rev. 5. That distinguishes between generic and specific intermediate goods which are consistent for the countries in question². Moreover, as an additional contribution to the literature, we build a model to analyse the high-technology exports in the CSEE countries, something that has been scarcely investigated for these regions. Finally, we estimate this relationship using panel data through a country-level analysis, but we also drill deeper and look at the sectoral level to see the influence of different segments of the economy.

The rest of the paper is organized as follows. Section 2 provides an overview of the literature that relates the participation in GVCs with technology upgrading. The next section outlines the methodology applied in calculating the GVC participation and the benefits of using the BEC classification. Section 4 contains some relevant stylized facts about GVC participation and trade in high-technology goods for the CSEE countries. The econometric methodology and estimation results are presented in Section 5. The final section concludes.

2. RELATED LITERATURE

International trade is considered to be a channel of technology transfer. On the one hand, the level of connection to international markets brings advantages for trading firms in the form of better-quality inputs and higher revenues, which can influence productivity gains as argued by Amiti and Konings (2007), Topalova and Khandelwal (2011) and Halpern *et al.* (2015). On the other hand, this process is self-reinforcing as firms will be stimulated to invest more in upgrading their technology (Bustos, 2011; Lileeva and Trefler, 2010). Moreover, this process of technology adoption is more pronounced if GVC trade is involved and if local absorption capacity is adequate.

The empirical literature has shown the benefits for countries from GVC participation that go beyond those associated with trade in final goods (Lall, 2000; Humphrey and Schmitz, 2002; Cheng *et al.*, 2015; Baldwin and Yan, 2014; Shimbov *et al.*, 2016). As mentioned by the seminal papers of Collier and Venables (2007) and Athukorala and Yamashita (2006), the international fragmentation of production has allowed many countries to improve their competitiveness derived from the possibility to be specializing in a segment of the production process, even when they are not the most efficient producers of the final good.

From a development perspective, as shown by Hausmann *et al.* (2007), the process of the composition and sophistication of a country's export basket will be influenced by capacity building, learning, and technology adoption, which will ultimately play a vital role in

² Data limitations and consistencies issues limited our options of using some of the existing sources of GVC participation measures.

stimulating economic growth. This was further developed in more recent literature, arguing that a greater participation in GVCs also provides benefits for firms through access to more sophisticated intermediate inputs presenting opportunities for acquiring better technologies, stimulating technological spill-overs, and forming trade networks faster than with conventional arm's length trade (Gereffi, 2019; Shimbov *et al.*, 2016; Stöllinger, 2017; Pahl and Timmer, 2020).

Firms integrated into GVCs usually have relatively high import and export levels due to intra-chain trade. Thus, they can benefit from both learning by importing and exporting. On the one hand, access to world markets for intermediate goods gives firms the ability to use high-quality inputs that may not be available domestically. Developing countries can strive for a technology upgrading by incorporating high-quality intermediates, which will enable the production of new and more sophisticated products and crucially to obtain knowledge and learn about the technology embodied in the imported inputs, which may eventually enhance production efficiencies in domestic firms (Andersson *et al.*, 2008; Elliott *et al.*, 2016). On the other hand, exporting within GVCs allows firms to learn from markets that are more competitive and have more sophisticated consumers. Thus, they can move further up the technological and value-added ladder. The outcome of both processes has positive implications for the level of technological quality of exports.

The empirical literature has shown that when entering GVCs, developing countries often integrate in low-value-added activities. While this may be a natural starting point for a developing country it may not be the desired one as developed countries are positioned either at the upstream or downstream end of the value chains, where the maximum value addition takes place. Export of high-tech goods in developing countries often can be bound to certain multinational affiliates with a few given products, while the economy remains specialized in low-tech and low-skill fragments of the global value chains (Éltető, 2018). Thus, from a development perspective, a country can have more benefits through GVC participation when it moves towards the parts of the chain where the most value is created. One of the key components for this to happen is technology adoption and innovation, which will influence the change in the trade structure of a country. This process helps firms and countries to start moving up the value chain and operate closer to the technological and value-creation frontier (Ito *et al.*, 2019; Brancati *et al.*, 2017).

The movement towards a more sophisticated and higher technology exports is defined by the technological capabilities and the ability of a country to absorb new technologies and adapt or reproduce them elsewhere, as argued by Morrison *et al.* (2008). As a result, local technological capabilities are crucial for shaping the production and technology structure of a country, thus influencing the technological content of its exports. Taglioni and Winkler (2016) argue that policies which strengthen, and foster innovation and capacity building are essential for expanding and strengthening the level technological content in exports and the level of GVC participation. For example, the increasing participation in GVCs has allowed countries like China to specialize in tasks with higher value-added within this international division of labour, which has led to export and import of goods with higher technological content (Ndubusi and Owusu, 2020).

A similar process was followed by the CSEE countries. According to Stehrer-Stöllinger (2015) and Shimbov *et al.* (2013), Germany became the main trade hub, forming a Central-European manufacturing core, with the southeast European countries gaining ground in more recent years, as argued by Ilahi *et al.* (2019). Similarly, Grodzicki and Geodecki (2016) and Kersan-Skabic (2017) discuss the core-periphery model in Europe based on the country groups in the value chains. Both works find that in GVC participation central European countries are in a better position than the southern European. According to Mandras and Salotti (2020) the southeast European countries also increased their GVC participation significantly between

2000 and 2018, even though not at the level of the central European counterparts. Kejžar *et al.* (2020) arrive at a similar conclusion of rising GVC participation for the southeast European countries, with a relatively more pronounced backward participation. This means that they import a significant part of intermediate goods, as they are close to innovation-related activities, in particular Germany as the main global value chain production hub in Europe. This proximity is likely to have an effect on the technology transfer in these countries, which is what we set to investigate in our analysis.

As our summary of the literature highlights, despite its relevance from the point of view of modernization and economic growth in this region, studies investigating the connection between innovation, technology upgrading, and GVC participation are not many, particularly not for the CSEE countries. This paper contributes to this nascent literature by exploring the nexus between technology adoption influencing the technology upgrading of exports and the participation in GVCs for the CSEE countries. In addition, the few related studies provide a productivity or macroeconomic perspective on the subject, as can be seen in Kersan-Skabic (2019) and Amador and Cabral (2016). In contrast, as a novelty, we present here, in addition to the aggregate model, a sectoral picture of the connection between the technology content of exports and GVC participation, for the regions of CSEE countries.

3. MEASURING THE PARTICIPATION IN GVCs

The rise of global value chains has made the analytical distinction between trade in intermediates and trade in final goods more important³. The dynamics of contemporary trends in international trade and economic globalization have been widely analyzed by distinguishing intermediate and final goods trade. A more recent expansion in the analysis of economic interconnectedness has been made possible by the development of global input-output tables and indicators of trade in value added (TiVA, WIOD, Eora). Nevertheless, we do not use these databases in our analysis, as we do not consider the narrower term of value added in trade, but rather the participation of countries in a GVC type of trade and its effects on the structure of exports. In addition, another shortcoming that we face with these data sources is the lack of information for some of the countries in our sample. Thus, for a more accurate and complete empirical analysis, in this paper, we use the BEC classification as an alternative source.

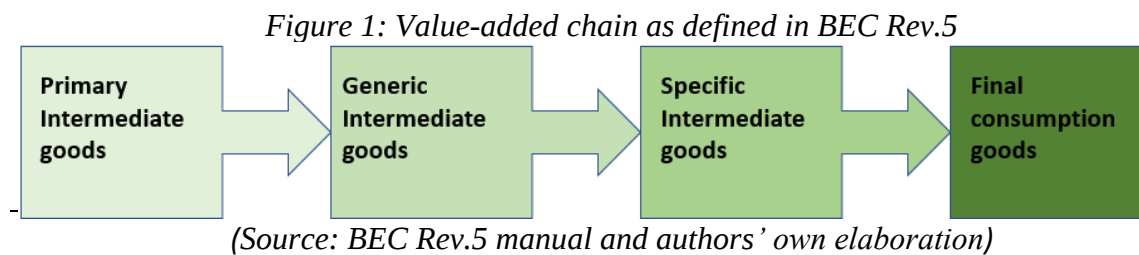
The BEC is a high-level aggregation of existing product classifications. It provides an overview of international trade based on the detailed commodity classifications in the Standard International Trade Classification (SITC), the Harmonized Commodity and Coding System (HS), and the Central Product Classification (CPC). Its comparative advantage has traditionally been the classification of goods by end-use category. This made a range of analytical applications possible in the past, and in the latest revision, it also facilitates observing the relative integration of economies in global value chains. We use the latest, fifth revision from 2016 that adds a new component defined as “specification dimension” to differentiate generic intermediates, i.e., consumed across a wide range of industries, from those that are specified, i.e., typically consumed only in certain industries. The aim of using this new dimension is to help researchers analyse countries’ participation in global value chains and its diverse implications, which is precisely what we take advantage of.

Furthermore, the BEC Rev. 5 has an additional improvement as it defines broad economic categories entirely based on product specificities and does not mix intermediates with end-use categories as was the case in past revisions. This is a meaningful improvement as it provides greater international comparability. In the new BEC Rev.5 the products included in a given

³ The literature on the analysis of global value chains refers to the broad plethora of research on similar phenomena referred to as production sharing, vertical specialization, the fragmentation or disintegration of production, offshore outsourcing, and most recently trade in value added.

economic category are in concordance with classifications agreed to internationally, such as HS and CPC. We also take advantage of this new feature in the database, which helps us to do the reclassification of products in order to go one layer below the aggregated country-level and be able to do a sectoral analysis as well.

The main purpose of the novel specification dimension in the BEC Rev. 5 is to isolate trade in primary commodities and generic intermediates from trade in highly specified intermediates. This new variable is particularly useful because global value chains most prominently involve international transactions with some level of explicit coordination, rather than the arm's-length transactions underpinning more "traditional" trade (Figure 1). While researchers have developed ad-hoc lists of differentiated and highly specified products in the past, the specification dimension of BEC Rev.5 defines an official, internationally accepted list.



Specified processed intermediates, as defined in the BEC Rev.5, are highly dependent on the industry for which the goods are made. Moreover, as specified in the BEC manual, in some cases parts and components are produced according to the specific requirements of one or a few buyers, with a single or small number of downstream uses. For instance, almost all components in the aircraft, automotive, and electronics industries can be considered as part of the GVC trade. In addition, even products that are not produced in reduced or limited lots, like pharmaceuticals, or are produced in large quantities like chemicals, can still be considered as specific, as they are almost always protected by patents required by their value chain, thus limiting the access to these products. This dimension of products as defined in BEC Rev.5 is also related to the "Products Complexity index" as defined by Harvard's Center for International Development, which uses the diversity of countries that make specific products and the average ubiquity of the other products that these countries make⁴. On the other hand, the generic intermediate goods can normally be found further upstream in the value chain (see Figure 1). These products are more linked to an arm's length type of trade, rather than related to global value chains because their generic use would normally have a broader application across industries. Thus, the generic intermediates can be associated with homogeneous and referenced priced goods, while specified intermediates with differentiated goods.

The abovementioned characteristics of the BEC Rev.5 classification are the starting point of our analysis. Namely, as mentioned we take advantage of the specification dimension to come up with the specified goods related to GVC trade and also to the interconnectedness of the BEC Rev.5 with other classifications to do the sectoral analysis. In our analysis, we use UN Comtrade data, and we look at the period 1996-2019 period (we exclude 2020 and 2021 due to the COVID-19 shock of global trade). We apply UN Comtrade gross trade data classified according to the Harmonized System (HS) and converted to International Standard Industrial Classification (ISIC) for sectoral analysis. Thus, we use the same industries as in the OECD-WTO TiVA database, for the sectoral analysis. Using this data, we construct total exports, final goods exports, intermediate exports, intermediate imports, and high-tech goods exports. We use a similar procedure as in Duval *et al.* (2014), but we use the new BEC classification. In

⁴ For more detail see atlas.cid.harvard.edu/about/glossary/

addition, we do not interpolate results into the TiVA database as in Duval *et al.* (2014), but we work with absolute data for each year, country and sector⁵.

Thus, before being able to use the data from UN Comtrade, we had conducted substantial rearrangements, reclassifications and calculations. A step-by-step description of the processes carried out is presented in Annex 1 at the end. Based on the conversions and reclassifications, the calculations for the high-tech goods and GVC participation are conducted. Specifically, based on concordances provided by the UN, for HS, SITC, CPC, ISIT and BEC, we first match sectoral trade statistics (at six-digit HS classification level) with the specification dimension in BEC Rev.5 (specified vs. generic and primary goods) classifications. Then, we adjust the original data to match sectoral series so that they are consistent with the ISIC Rev. 4 industries (using the CPC classification as an intermediary). Series for each industry are then estimated separately. Based on the above-mentioned reclassification we obtain the values for the dependent variable of high-tech exports per sector. Then for the sectors in which there is trade in high-tech goods we construct the share of high-tech exports, as a share of exports per sector. For the main explanatory variable of GVC participation, for each observation year, country and sector at the exporter-sector level, we calculate the share of specified intermediate imports (as defined above using the BEC Rev.5 classification) in a given sector as a share in overall exports of the same sector to create the backward participation. The same procedure is repeated for each observation year, country, and sector at the exporter-sector level to obtain the forward participation as the share of specified intermediate exports in a given sector in both total exports and in overall exports of the same sector, respectively.

4. STYLIZED FACTS: HIGH-TECH EXPORTS AND THE PARTICIPATION IN GVCS

The share of high-technology products in total exports is an indicator that is often included in international innovation and business indices. The concept is that the higher this ratio is, the more technologically advanced the export structure of a country is and thus the higher the development potential can be. As mentioned before, this can be partially true for certain countries and certain industries as not all countries and industries follow the same pattern. Table 1 provides a first glance at the share of high-tech products in exports for the CSEE countries for four years of our sample: 1996/7, 2000, 2010, and 2019.

Table 1: Share of high-tech products in total exports

	1996/97	2000	2010	2019
Albania	0.4	0.9	0.9	0.04
Bosnia and Herzegovina		1.4	1.6	4.2
Bulgaria	2.4	1.8	4.6	6.1
Croatia	6.7	6.4	7.0	8.3
Czechia	5.8	7.8	15.5	19.5
Estonia	5.3	21.0	9.7	11.1
Hungary	3.6	22.8	21.3	15.5
Latvia	3.5	2.4	5.0	10.5

⁵ A similar method is used in a recent European Central Bank publication by Cigna et al. (2022).

Lithuania	0.7	1.5	0.8	2.1
Macedonia	0.6	0.8	2.3	3.5
Poland	2.1	2.6	6.0	7.8
Romania	0.7	2.1	3.2	4.9
Serbia		1.2	1.4	1.3
Slovakia	1.7	1.8	1.1	1.5
Slovenia	1.8	2.2	2.9	4.6

(Source: own calculations based on UN Comtrade database)

Note: the countries that did not have 1996 data available the 1997 figures are used.

In general, the countries in our sample managed to increase their high-technology content of the export structure over the period, with the exception of Albania and Montenegro. Still, we can observe different patterns in terms of magnitude and in certain cases high volatility in time. In the period 1996-2019, Romania saw the highest (almost eleven-fold) increase in its high-technology exports (even though from a very low base). Lithuania and Poland increased their share of high-technology exports by over four times, while Bosnia and Herzegovina, Latvia and Slovakia managed more than a three-fold increase. The remaining countries on average doubled their share of high-tech exports.

In some cases, these dynamics are driven by some sectors in particular, which have a significant influence on the export structure. The three most dominant sectors, achieving the highest shares in overall exports are (i) computers, electronic and electrical equipment, (ii) chemicals and non-metallic mineral products, and (iii) machinery and equipment. Moreover, in some countries, this dynamic is driven by a single exporter of significant world market share. For example, Lithuania has Europe's second largest polyethylene terephthalate company⁶ and its export is a very important item. The outstandingly high Hungarian figures for the period 2000-2010 was due to the local Nokia affiliate that exported mobile phones at that time, but closed later (indeed, 58% of high-tech exports were telecom equipment and this dropped to 30% in 2018). Estonia's high figure in 2000 was due to Ericsson's activity. In the Czech high-tech export computer and data processing machines and telecommunication equipment dominate. North Macedonia has a local company that is a leading European manufacturer of electronic printed circuit boards⁷. In Serbia, there have been a number of FDI investing the chemicals and non-metallic mineral products industry over the years. Poland and Slovenia have seen an increase in machinery and transport equipment high-technology products as a result of significant FDI establishing operations in these countries.

The rise of high-technology exports resulted in these products being the predominant export of certain sectors in some countries. The most obvious cases are the computers, electronic and electrical equipment from Latvia, Estonia, Czechia, Lithuania and Slovakia, where the share ranges from 39 to 68% of overall exports in the sector (Table 2). In the chemicals and non-metallic mineral products sector, high-technology products account for 14% of overall exports in the sector in Croatia and Hungary and 12% in Slovenia. In addition, this trend of rising share has been maintained though ought the period, but with different magnitudes per sector. By far the sector that most benefited from the rising exports of high-technology products was

⁶ <https://neogroup.eu/en/company/about-us/>

⁷ <https://www.hitech.com.mk/en/about-us/>

computers, electronic and electrical equipment, but also sectors like chemicals and non-metallic mineral products and machinery and equipment had significant gains (Figure 2).

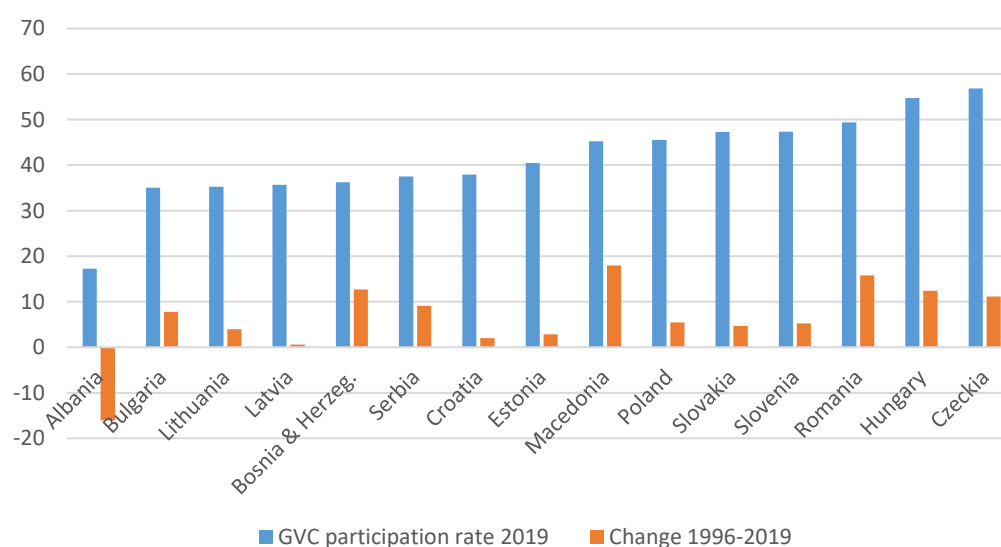
Table 2: Share of high-tech products exports per manufacturing sector, 2019

	Chemicals & chemical prod.	Computer electronic & optical prod.	Electrical equipment	Fabricated metal prod.	Machinery & equipment	Other transport equip.	Pharmac., medicinal chem. & botanical prod.	Other manufacturing n.e.c.
Albania	4.0	93.4	1.0	0.0	0.3	0.0	0.0	0.0
Bosnia and Herzegovina	13.5	77.3	10.4	0.6	9.5	0.2	0.9	0.3
Bulgaria	3.3	66.7	12.7	0.0	5.2	5.2	24.4	0.8
Croatia	6.8	66.1	8.4	4.7	13.3	5.5	49.1	1.4
Czechia	3.1	87.5	10.1	3.7	14.8	37.6	23.2	1.1
Estonia	3.0	86.5	16.3	0.7	7.1	32.8	23.8	0.9
Hungary	10.7	66.0	17.5	0.0	18.0	9.8	38.3	1.8
Latvia	7.3	85.9	12.2	0.0	14.7	30.4	12.2	1.2
Lithuania	19.9	81.6	9.6	0.1	6.5	10.1	33.0	1.7
Macedonia	0.3	65.4	15.9	0.0	2.5	0.3	25.2	0.2
Poland	2.9	59.9	4.1	0.2	9.5	41.4	29.9	0.6
Romania	8.1	61.8	23.4	0.0	10.7	6.3	17.8	0.7
Serbia	2.7	60.5	1.6	0.4	10.8	12.4	16.1	0.5
Slovakia	1.8	54.1	9.0	1.0	6.9	4.6	21.4	1.6
Slovenia	10.2	55.9	4.7	0.0	7.2	42.3	19.8	1.5

(Source: own calculations based on UN Comtrade database)

Note: the countries that did not have 1996 data available the 1997 figures are used.

Figure 2: Change in the share of high-tech products exports per manufacturing sector (difference between 2019 and 1996)



(Source: own calculations based on UN Comtrade database)

Note: the countries that did not have 1996 data available the 1997 figures are used

Throughout the past two decades, the CSEE countries have also considerably increased their participation in GVCs, as part of their development strategy. As mentioned, they became increasingly connected to the main GVC hubs in Europe, in particular Germany and integrated themselves in the manufacturing core. In general, all of the CSEE countries have relatively high GVC participation rates, even though variations among countries exists.

Looking at the sectoral level we observe variations among countries, but also among sectors. The four main sectors with the highest GVC participation are i) computers, electronic and electrical equipment, ii) chemicals and non-metallic mineral products, iii) machinery and equipment, and iv) other manufacturing products. These have been the sectors that observed the fastest growth in GVC participation and also the ones that achieved the highest integration in the European manufacturing hub⁸. Sectors like textile and apparel and wood and paper, show smaller GVC participation in all countries. The higher weight of sectors that contain technologically more advanced products places the CSEE countries on the right track, as they can benefit more from the possible technological spill-overs.

Table 3: GVC participation per sector (period average 1996-2019)

	Albania	Bosnia and Herzegovina	Bulgaria	Croatia	Czechia	Estonia	Hungary	Latvia	Lithuania	Macedonia	Poland	Romania	Serbia	Slovakia	Slovenia
Basic metals	19.7	23.8	12.2	20.0	17.0	46.9	14.2	21.0	27.9	10.0	13.1	23.5	10.6	14.3	16.3
Chemicals & chemical prod.	26.0	38.5	39.4	31.4	39.1	18.5	39.1	34.0	27.4	51.4	36.0	35.7	32.3	41.1	38.9
Coke & refined petroleum	3.9	5.5	1.8	5.5	5.4	79.7	5.0	2.7	1.7	7.1	6.5	4.5	5.1	5.3	4.4
Computer electronic & optical prod.	81.7	82.2	86.0	85.4	89.2	69.3	87.5	78.7	81.2	87.3	77.6	89.5	82.8	74.9	88.5
Electrical equipment	73.9	72.1	78.8	77.4	89.5	56.9	83.7	73.9	73.0	77.3	76.9	88.1	76.0	87.7	72.2
Fabricated metal prod.	73.3	69.9	60.5	67.4	66.9	35.5	64.6	63.3	65.0	66.7	64.4	62.5	61.3	64.0	62.6
Machinery & equipment	1.0	0.0	0.5	0.2	0.3	36.7	1.2	0.6	0.2	0.2	0.3	0.5	0.2	0.6	0.2
Food, beverages & tobacco	0.2	47.5	45.8	51.1	53.7	42.1	62.8	49.0	46.1	33.9	53.2	52.2	46.5	59.0	50.5
Motor vehicles	38.0	58.1	47.4	42.4	57.5	25.3	70.4	49.5	44.9	51.3	66.0	66.7	49.5	49.0	40.8
Other non-metallic mineral prod.	54.2	64.7	67.9	66.4	67.1	72.4	76.3	62.4	67.3	71.3	69.1	62.2	71.3	62.5	71.8
Other transport equip.	63.8	76.9	83.7	95.7	87.5	91.0	67.3	89.8	85.6	51.9	96.4	96.3	91.3	90.0	84.3
Pharmac. & medicinal chem. Prod.	99.2	99.6	99.2	99.3	99.2	98.8	99.2	99.0	99.3	99.6	98.5	98.4	98.8	99.3	99.6
Rubber & plastics	34.0	23.4	28.2	28.1	29.8	29.3	39.5	28.1	36.9	33.5	25.8	30.4	20.0	26.4	22.6
Textiles, wearing & leather	38.6	32.1	34.1	20.5	29.8	27.4	31.6	27.2	32.8	27.5	29.0	35.4	28.6	27.3	24.1
Wood, paper & printing	52.9	30.6	47.1	37.3	43.8	30.3	56.9	22.1	41.2	50.1	53.6	36.6	51.5	46.3	45.4
Other manuf.	47.3	52.2	51.7	47.2	54.7	37.2	61.6	43.4	46.3	60.9	42.4	41.6	54.2	57.0	62.4

(Source: own calculations based on UN Comtrade database)

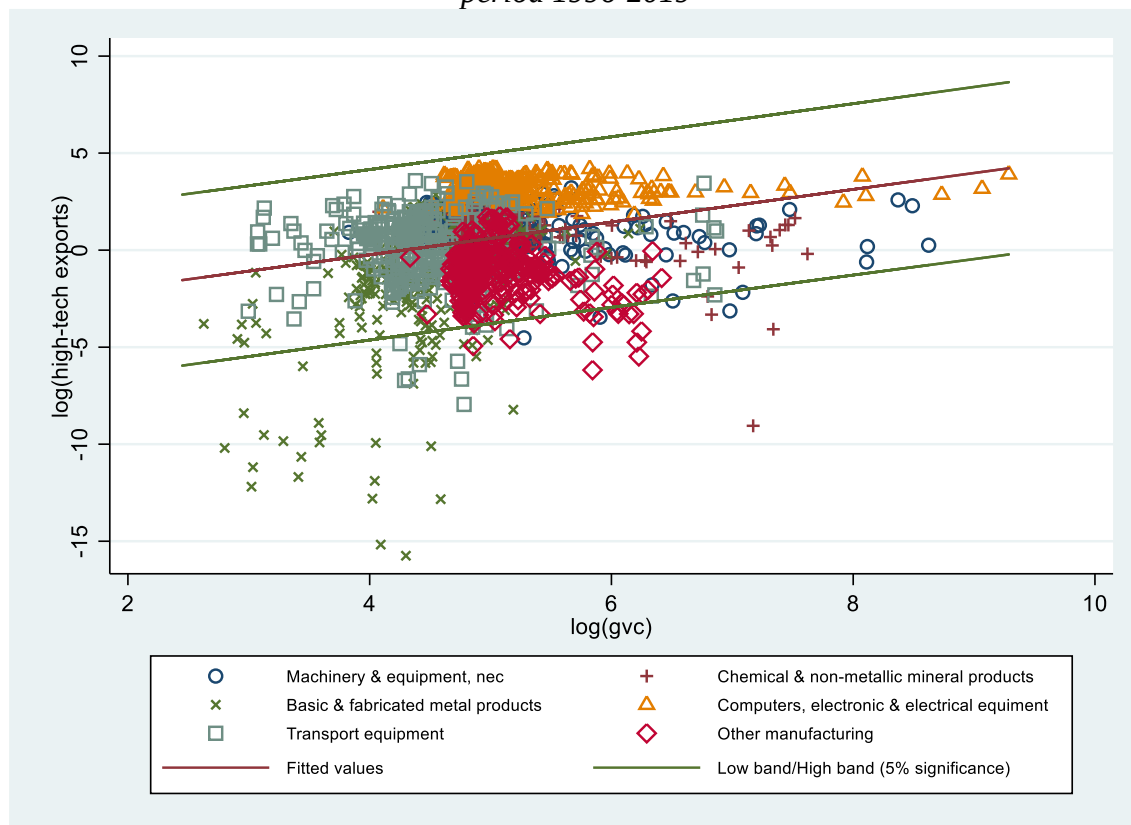
The foregoing stylized facts reveal that, on the one hand, the weight and the structure of exports vary across countries and sectors, although, in general, there is a clear tendency of rising high-technology exports in total exports. On the other hand, figures about GVC participation show different patterns along countries, but with computer, electronics and electrical equipment sector clearly emerging as dominant in most of them. Other sectors that show relatively high participation rates are machinery and equipment, other manufacturing and chemicals and non-metallic mineral products.

As a first approximation to the nexus between GVC participation and the technological composition of exported goods, we next plot the share of high-tech exports across different levels of GVC participation by sectors. As can be seen in Figure 4, most of the sample observations are contained within the significance bands of the regression line, confirming thus the positive link between the participation in global value chains and high-technology exports. Looking at different sectors, we appreciate that this positive relationship is more pronounced

⁸ In general, 2/3 and more of overall gross trade of the CSEE countries is done with the European Union countries, or with other WB countries.

in industries such as machinery & equipment, computers, electronic & electrical equipment, and chemical & non-metallic mineral products. This is in line with the observed dynamics of the two variables, which are more noticeable in these sectors as highlighted in the above tables.

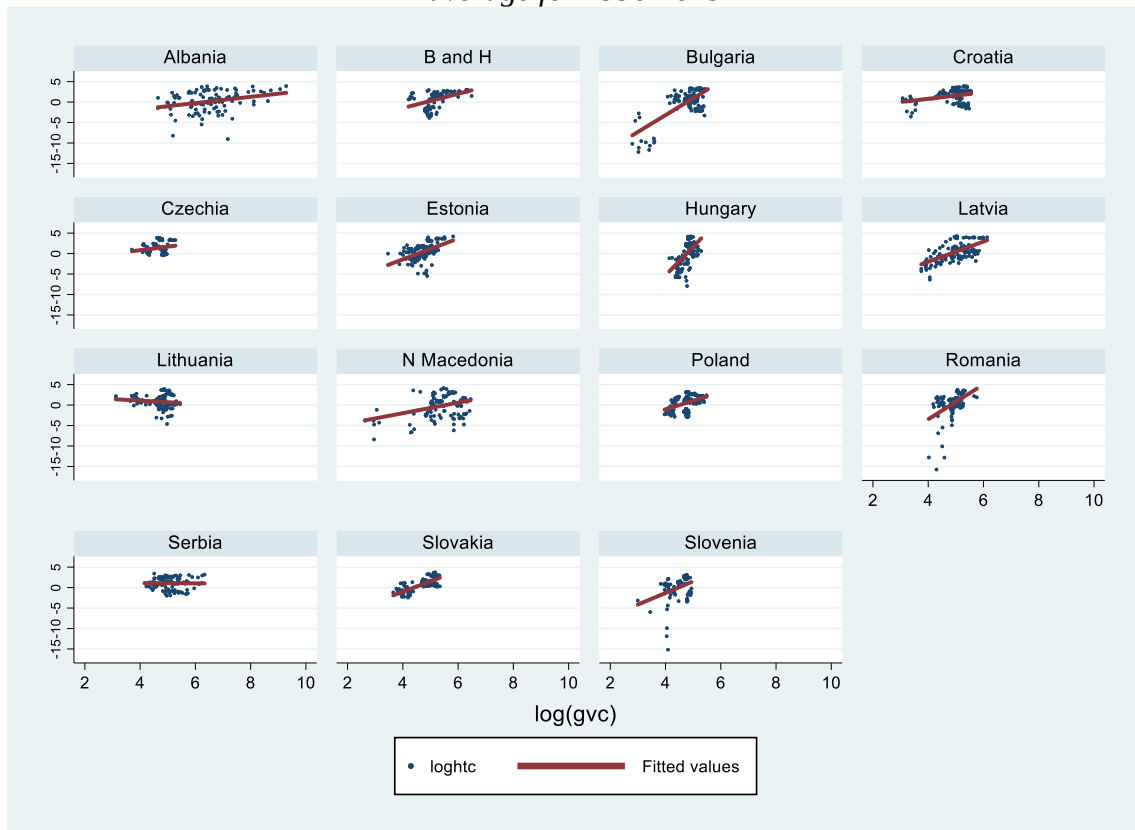
Figure 3: Correlation between high-technology trade and GVC participation, average for the period 1996-2019



(Source: own calculations using UN Comtrade data)

The positive connection between GVC participation and high-tech exports holds, in general, when the correlation between both variables is studied country by country (Figure 4). Except for the case of Lithuania and Serbia, the line representing the fitted values of the log of the high-tech exports concerning GVC participation has an upward slope in the rest of the countries. This can be seen as the first evidence of our hypothesis about the gains in terms of higher technology adoption in exported goods from greater involvement in the international division of production. However, we cannot ignore that in the above plots other factors may influence this relationship, as they might affect both variables simultaneously, or the potential measurement errors are not being taken into account. To deal with these issues, in the following section, we carry out a complete regression analysis, considering other covariates, and possible endogeneity problems or measurement errors.

Figure 4: Correlation between high-technology trade and GVC participation by country, average for 1996-2019



(Source: own calculations using UN Comtrade data)

5. IMPACT OF GVC PARTICIPATION ON THE TECHNOLOGICAL INTENSITY OF EXPORTS

As previously mentioned, a proper causal study of the effects of GVC participation on the technology structure of exports in the CSEE countries requires resorting to regression analysis. However, for the countries under study, this is not an easy task given the lack of data. As previously mentioned, to make up for this deficiency we have built our database using information from UN Comtrade which by substantial reclassification and calculation has allowed us to carry out the study at the country and sectoral level for the period 1996-2019. The econometric analysis here is reported under two subsections: first, we define the empirical model, and the regression methodology employed. Next, we discuss the results obtained for both the aggregate model and the regressions using sectoral data.

5.1. Econometric approach

To examine the influence of a greater participation of countries in GVC on the quality of their exports we consider here the following regression model,

$$\ln HTE_{c,s,t} = \alpha_0 + \alpha_1 \ln GVC_{c,s,t} + x'_{c,t} \beta + \gamma_{c,s} + \delta_t + \varepsilon_{c,s,t}$$

Where the dependent variable is the share of high-technology products in total exports of country c in sector s and time t , in logs ($HTEExports_{c,s,t}$).⁹ The main explanatory variable here is the logarithm of the GVC participation index of country c in sector s and time t ($\ln GVC_{c,s,t}$). As in Harding and Javorcik (2012) and Ndubuisi and Owusu (2020), we consider country-sectors specific effects ($\gamma_{c,s}$) to capture time-invariant characteristics and time effects ($\gamma_{c,t}$). In the aggregate model, we further control for other factors related to human capital ($x'_{c,t}$). In the sectoral model, we could not estimate this extended model due to the unavailability of data on human capital and innovation for these countries at the sectoral level. Finally, u is a regression disturbance term, which is assumed to be strongly independent across countries and sectors. Data sources and descriptions of variables are presented in Appendix II. The decision as to whether to consider unobserved sector-country-specific effects as fixed or random is made based on the Hausman test.

The plausibility of both the potential positive impact of an increase in the degree of participation in GVCs on technology acquisition through exports and the possibility of sectors with a higher technology composition on export level attracting more GVC activities leads us to consider in the regressions of the endogeneity or reverse causality problem. As Ndubuisi and Owusu (2021) pointed out, GVC participation in a sector or region may be correlated with other characteristics of the sector or region that also affect the quality of its exports. This phenomenon would imply that the degree of participation in global value chains could not be considered an exogenous variable, or independent of the technology upgrading process.

To mitigate this potential reverse causality, we proceed first to estimate the model using the lag value of the GVC participation index as our main explanatory variable. Despite this regression strategy indeed controls for a causal link in the opposite direction, it does not totally prevent us from endogeneity biases that stem from the omission of additional explanatory variables or possible measurement errors. (Wooldridge, 2020). The quality of exports depends on many unobserved factors that may be correlated with GVC participation, which could give rise to simultaneous changes in both variables, explanatory and regressor, due to alterations in third external factors rather than to a causal relationship. Therefore, to properly address the endogeneity concern, we next resort to two-stage regression techniques with instrumental variables (IV). This regression strategy has been carried out both in the aggregate model and in the sectoral estimates, as can be seen below.

4.2. Main results

4.2.1. Aggregate GVC participation and technological composition of exports

The estimation results at the country level are depicted in Table 4. The coefficients in this table are shown sequentially for the different estimation methodologies. First, we estimate Eq. (1) through fixed effects (Model 1). As can be seen at the bottom of the table, the Hausman test suggests that the fixed effect (FE) estimation model is preferred to the random effects (RE) model. Next, under the assumption that time will not significantly alter the impact of GVC participation on the technologic composition of exports, at least at short to medium term, and to control for potential reverse causality, we re-estimate the model including the lagged valued of the regressor instead (Model 2). Again, the FE model appears as a better option to the RE estimation. The coefficients on the GVC participation index obtained in both cases (Model 1 and Model 2) are positive and significant, confirming the existence of a technology adoption and technological upgrading of exports from of a greater integration in GVC. They are also of similar magnitude. Specifically, our estimates imply that, on average, an increase in the GVC

⁹ Note that for the estimations with aggregate data, the s subscript disappears, and the fixed effects are country specific.

index of 1% leads to a rise in the share of high-technology products in total exports between 1.15% and 1.26%, *ceteris paribus*.

However, as previously mentioned, the above outcomes should be taken with caution as they may suffer from a problem of endogeneity or measurement errors. Even when FE estimation is capturing the time-invariant characteristics, it might be country shocks across time affecting both the participation in GVC and the technological composition of exports. Moreover, according to Reed (2015) and Bellemare *et al.* (2017), the use of lagged explanatory variables is appropriated to escape from simultaneity biased only under very restrictive assumptions, which entail, among other things, assuming the absence of serial correlation among the unobserved sources of endogeneity. This empirical strategy does not take into account possible measurement errors.

Accordingly, to address potential endogeneity issues and to identify the source of the technological upgrading of exports that arises exclusively due to the influence of greater participation in GVC, we next estimate the model using two-stage regression techniques with an instrumental variable (IV), considering GVC as an endogenous regressor. Following Banh *et al.* (2020), we built our instrumental variable using the average GVC measured at the EU level.¹⁰ Concretely the IV is obtained as the total GVC participation rate in the EU by the GVC index by country lagged one period. The validity of this instrument is confirmed through the weak identification and under-identification test (see Table 4 at the bottom).

The results obtained from the two-stage fixed effect with the mentioned instrumental variable (2SFE_IV) estimation are shown in Model 3 (Table 4). In this regression, the coefficient on GVC index is positive and highly significant ratifying thus the beneficial impact on the technological structure of exports from a greater participation in global value chains found before. Moreover, its value confirms an elasticity greater than one, as in previous regressions. Our estimates are also consistent with previous literature (Ndubuisi and Owusu, 2020) delving into the hypothesis that a higher participation in GVC provides an opportunity to adopt new technologies and to incorporate more sophisticated inputs.

Table 4: Estimation results for high-tech exports (in logs). Period: 1996-2019

VARIABLES	Model 1 FE	Model 2 FE with lags	Model 3 2SFE IV
$\log (GVC\ index)_t$	1.264** [0.587]		1.556** [0.743]
$\log (GVC\ index)_{t-1}$		1.146* [0.599]	
Constant	-4.290* [2.535]	-3.692 [2.594]	-5.126* [0.816]
Country effects	YES	YES	YES
Year effects	YES	YES	YES
Wald χ^2 test year-effects	207.15 (0.000)	816.42 (0.000)	270.42 (0.000)
Hausman test	18.33	18.62	

¹⁰ Specifically, we have obtained the average value of the GVC index for the EU countries before the 2004 enlargements (excluding the UK, Malta and Cyprus). In concrete, these countries are France, Italy, Belgium, Luxembourg, the Netherlands, Germany, Ireland, Denmark, Greece, Spain, Portugal, Austria, Finland, and Sweden. In the case of Luxembourg and Belgium, we have included the value of their GVC indexes only from 1999 on, as no information is available before this period.

	(0.006)	(0.005)	
Weak ident. test – CD F stat.			345.713
Stock-Yogo critical value (5%)			16.85
Stock-Yogo critical value (10%)			10.27
Underident. test – Anderson LM stat.			223.854
			(0.002)
Observations	329	312	279
Number of countries	15	15	15

*Robust standard errors in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The dependent variable and the GVC participation index are expressed in logs. The figures reported for the Wald tests year-effects in parenthesis are the p-values. The instrumental variables used in the IV-FE regressions are the total GVC participation rate in the EU and the GVC index by country lagged three periods, $GVC\ index_{t-1}$, $GVC\ index_{t-2}$ and a $GVC\ index_{t-3}$. The figures reported for the weak identification and the underidentification tests are the p-values.*

Table 5 below presents the regression results including human capital, *HK1*, as an additional covariate influencing the technological composition of exports. *HK1* is defined here in such a way that a high value of this variable shows a greater degree of participation in tertiary education by students of all ages of a country in a specific year (see Appendix II). In line with the related literature, the estimated coefficients on *HK1* are positive (although only significant in the two-stage FE regressions), suggesting that human capital abundant countries are also those with a greater weight of their high-tech exported goods (Ndubuisi and Owusu, 2021) and thus in a better position to absorb the technology spill-overs.

Regarding the influence of the GVC index on the technology upgrading of exports, this main regressor remains significant in the explanation of our dependent variable considering both its current or past value (Model 1 and Model 2, respectively), and when it is treated as an endogenous regressor (Model 3). In concrete, a 1% increase in the GVC participation index result in an increase of 1.17% to 1.45% increase in high-technology exports (from Model 1 to Model 3). In addition, the appropriateness of the IV is confirmed in the first stage regression and in tests of both under-identification and weak identification shown at the bottom of Table 5.

Table 5: Estimation results for high-tech exports (in logs). Period: 1996-2019. Extend

VARIABLES	Model 1 FE	Model 2 FE with lags	Model 3 2SFE IV
$\log(GVC\ index)_t$	1.302** [0.599]		1.450*** [0.198]
$\log(GVC\ index)_{t-1}$		1.173* [0.611]	
$\log(HK)_t$	0.830 [0.530]	0.677 [0.600]	0.556*** [0.161]
<i>Constant</i>	-8.071** [3.607]	-6.757* [3.561]	-7.313*** [1.134]
Country effects	YES	YES	YES
Year effects	YES	YES	YES
Wald χ^2 test year-effects	127.76	351.18	127.79

	(0.000)	(0.000)	(0.000)
Hausman test	29.03	30.41	
	(0.000)	(0.000)	
Weak ident. test – CD F stat.			350.210
Stock-Yogo critical value (5%)			16.85
Stock-Yogo critical value (10%)			10.27
Underident. test – Anderson LM stat.			223.714
			(0.000)
Observations	324	308	278
Number of countries	15	15	15

Robust standard errors in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The dependent variable and the GVC participation index are expressed in logs. The figures reported for the Wald tests year-effects in parenthesis are the p-values. The instrumental variables used in the IV-FE regressions are the total GVC participation rate in the EU and the GVC index by country lagged three periods, $GVC\ index_{t-1}$, $GVC\ index_{t-2}$ and $a\ GVC\ index_{t-3}$. The figures reported for the weak identification and the underidentification tests are the p-values.

In Appendix III, we perform similar regressions including as additional control variable the proportion of skilled people doing scientific or technological tasks (*INNOV*). This covariate can be considered a proxy of the degree of innovation of the different economies. In this case, the human capital variable has been redefined to avoid multicollinearity problems. Concretely, *HK2* depicts the percentage of total working-age population with advanced education. In general, the estimates confirm the positive influence of a higher integration into global trade networks on technology adoption and the technological composition of exports. Although now, the estimated coefficients on the lags of GVC is not significant (Model 2), the current value of GVC participation significantly influences high-tech exports as shown in Model 1 and 3. Regarding the innovation tasks, the estimated coefficients confirm the expected positive impact on the technological upgrading of exported goods. This variable is positive and statistically significant in all models. Similarly, a greater availability of human capital leads to a higher technological upgrading of exports. The statistics of over-identification and weak-identification tests shown at the bottom of Table 5 ratify that the IV used in this case is also appropriate¹¹.

4.2.2. Sectoral GVC participation and technological composition of exports

Having obtained conclusive results on the aggregate level as presented above, in the next section we attempt to drill deeper and shed new light on the sectoral level. We aim to explore to what extent the technological improvement of exports occurs in the same sector in which firms experience a greater participation in global value chain. Despite the limitations imposed on this analysis due to lack of data for the CEE&WB countries, in this section we carry out a similar regression analysis, but at a more disaggregated level. Specifically, and as a novelty in the related literature, we estimate our regression model with sectoral data, including the following sectors: i) textiles, wearing apparel, leather and related products, ii) wood and paper products; printing, iii) chemicals and non-metallic mineral products, iv) basic metals and fabricated metal products, v) computers, electronic and electrical equipment, vi) machinery and equipment, vii) transport equipment, and viii) other manufacturing; repair, and installation of machinery and equipment.

¹¹ The statistics of over-identification and weak-identification tests shown at the bottom of Table 5 ratify that the IV used in this case is also appropriate.

The outcomes obtained from sectoral data are shown in Table 6. In line with previous results, the coefficient on $\log(gvc)$ are positive and highly significant in all cases. Since the study of causality is limited to the same sector, it is not surprising that the impact of this effect is smaller than in the case of the aggregate model. Specifically, according to our estimates, when the GVC participation index increases by ten percentage points, we predict, on average, a rise in the share of high-tech exported goods around 3.6% and 5.3%, *ceteris paribus*. As in the previous regressions, we find that this result is robust to the use of lags or instrumental variables. For the 2SFE regressions and following the same reasoning as in the aggregate model, we employ as instrumental variable the average GVC measure at the EU level at the sector level and the lags of the sectoral $\log(gvc)_t$.

At the bottom of Table 6, we report the Anderson canonical correlation LM statistic of underidentification and the Cragg-Donald statistic (1993) to test the null hypothesis that the model instruments are weak. A rejection of the null of the under-identification test indicates that the matrix is full column rank, i.e., the model is identified. Moreover, the result of the Cragg-Donald F statistic rules out the possibility that the model be weakly identified as we reject the null that our instruments are weak.

Table 6: Estimation results for high-tech exports (in logs). Period: 1996-2019. Sectoral model

	Model 1 FE	Model 2 FE with lags	Model 3 2SFE with IV
$\log(gvc)$	0.417** [0.192]		0.531* [0.286]
$\log(gvc)_{t-1}$		0.359** [0.164]	
Constant	-1.235 [1.104]	-1.623* [1.125]	-2.360* [1.419]
Country-sector effects	YES	YES	YES
Year effects	YES	YES	YES
F-test year-effects /Wald test year-effects	61.87 (0.001)	62.59 (0.000)	61.07 (0.001)
Hausman test	7.29 (0.007)	87.10 (0.000)	
Weak ident. test - CD F stat.			465
Stock-Yogo critical value (5%)			16.85
Stock- Yogo critical value (10%)			10.27
Underident. test – Anderson LM stat.			863.411 (0.000)
Observations	1,925	1,861	1,911
Number of id	90	90	90

Robust standard errors clustered at the country-sector level in squared brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. To test the significance of year effects, we use an F-statistic in Models 1 and 2 and a Wald chi-squared statistic for Model 3. The instrumental variables used are the log of the average GVC measured at the sectoral level of the European Union countries, France, Italy, Belgium, Luxemburg, Netherland, Germany, Ireland, Demark, Greece, Spain, Portugal, Austria, Finland, Sweden; and three lags of $\log(gvc)$ at sectoral

level. The figures reported for the weak identification and the underidentification tests are the p-values.

6. CONCLUDING REMARKS

Literature argues that long-term sustainable growth cannot be achieved without technology development allowing for an upgrade in the technological structure of a country's export basket. This process has further been highlighted by the recent rise of GVCs, which allowed countries to participate in the global production and knowledge-sharing process. In this paper, we analyse the nexus between GVC participation and the technology structure of trade (the share of high-tech exports). We perform our analysis for the regions of CSEE countries for the period 1996-2019.

We construct a GVC participation measure applying the latest BEC Rev.5 classification that distinguishes between generic and specific intermediate goods. In addition, we match this with a list of high-tech products (involving a high intensity of research and development). In the calculations of both variables, we reclassify various product nomenclatures including HS, SITC, CPC, ISIC, and BEC.

Our analysis indicates that in general, there is a clear tendency of rising high-technology exports in total exports. GVC participation also shows a rising trend, although with different patterns along countries, but with a clear dominance in certain sectors. In a first approximation, the analysis of the nexus between these two variables indicates a positive connection between the GVC participation and the technological upgrading of exports in the CSEE countries.

We further examine this result with an econometric model using panel data. The main findings from the different regression models confirm our hypothesis that higher participation in GVC improves the technological structure of exports, possibly by providing an opportunity to adopt new technologies and incorporate more sophisticated inputs. These results hold even when we treat a potential endogeneity issue using a two-stage fixed effect estimation. Furthermore, in line with the related literature, we test the effect of human capital and find that human capital-abundant countries are also those with a greater weight of their high-tech exported goods and thus in a better position to absorb the technology spill-overs.

Finally, as a novelty for the literature on CSEE countries, we drill deeper into the issue and perform a sectoral analysis. This confirms our previous findings of a positive relationship between higher GVC participation and rising technology levels of exports. This is particularly true for the sectors of chemicals and non-metallic mineral products; computers, electronic and electrical equipment; machinery and equipment, and transport equipment, as also indicated by the qualitative analysis.

The lack of sectoral-level data on human capital impeded the use to drill even deeper into the analysis. As further research lines, it would be interesting to use approximations for human capital, as well as to analyse the granular characteristic of exporting firms, and the weight of sectoral champions in the CSEE countries. In addition, another research direction can be the examination of the trade patterns in the post-pandemic era and the possible changing organisation of GVCs and their impact on technology transfer and adoption.

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APPENDIX I: THE PROCESS OF DATA RECLASSIFICATION FOR THE CALCULATION OF GVC PARTICIPATION AND HIGH-TECH GOODS

- We started with the BEC classification Rev.5. Out of this classification, from the specification dimension, we have selected the product codes that are intermediate specific goods (as per the defined specification in BEC no final products are listed in this selection, only intermediate ones). Then as there are some products related to capital formation or consumption, we have further purified the selection, by omitting them.
- Next, we used the UN correspondence tables to obtain the corresponding product codes in the HS 2017 classification. The BEC includes all sub-headings of the HS Classification, so the total trade in terms of HS equals the total trade of the goods side of the BEC.
- As the data downloaded from the UN Comtrade required a further reclassification, to be able to download the full series from 1996 to 2019, we reconciled the HS 2017 classification with the one from 2016.
- Next, in order to be able to conduct a sectoral analysis, which is of main interest in our research, we had to classify the HS product codes into sectors. This was done both for the intermediate goods as well as for final goods, as we need a classification of the overall manufacturing trade per sector. For this, we used the link between the HS classification and the Central Product Classification as a first step and the International Standard Industrial Classification of All Economic Activities (ISIC) as a second step.
- The sectors as defined in the System of National accounts are related to the ISIC, but there are no direct correspondence tables between the HS and ISIC, so we had to use the CPC as an intermediary. Thus, we mapped the HS product codes as per the CPC classification.
- In the next step we mapped these CPC codes with the corresponding ones in the ISIC to obtain the sectors as defined in the System of National Accounts (SNA). This is made possible by the fact that the relationship between ISIC, on the one hand, and the HS and CPC, on the other, is based on the fact that the product classifications in principle combine in one category goods or services that are normally produced in only one industry as defined in ISIC. Thus, we were left with an HS classification per product code that is mapped by sector.
- At the end we were left with 2092 HS classification product codes for intermediate specific goods (as per the BEC Rev.5 definition), out of a total of 5300 product codes. These codes had been classified per sector, which allows us to delve into the sectoral analysis later on.
- A similar procedure was followed for obtaining the high-technology products. We used a Eurostat list based on the OECD definition that contains technical products for which the manufacturing involved a high intensity of research and development. The list uses a product approach that looks at the level of technological intensity of products of manufacturing industries and similarly identifies the trade in high-tech products¹². In order to ensure consistency with the data on intermediate-specific goods, as outlined above, here we also had to conduct similar re-arrangements, reclassifications and calculations before getting the final data. A step-by-step description of the processes carried out is presented in continuation.
- The high-tech product list is provided on the basis of the Standard International Trade Classification Rev.4 and contains 71 product groups defined at the basic heading level

¹² For more detail, please see https://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an5.pdf

(five-digits). As the data was provided in the SITC Rev.4 format, we had to convert it to SITC Rev.3 to be able to use the correlation tables with the HS classification.

- Next, we have mapped the high-tech products obtained in the SITC Rev.3 with the corresponding product codes in the HS classification. As the products in the SITC five-digit level may have multiple corresponding products in the HS classification at six-digits, the conversion requires substantial inputs.
- As the data downloaded from the UN Comtrade required a further reclassification, to be able to download the full series from 1996 to 2019, we had reconciled the HS 2017 classification with the one from 2016.
- Next, in order to be able to conduct a sectoral analysis, we had to classify the HS product codes into sectors. This was done in the same way as described above for the intermediate specific goods. For this we used the link between the HS classification and the Central Product Classification as a first step intermediary classification to the International Standard Industrial Classification of All Economic Activities (ISIC) as a second step to obtain the sectors as defined in the System of National Accounts.
- At the end we were left with 311 high-tech products in the HS classification at six-digit level (out of a total of a total of 5300 product codes). As was the case with the intermediate specific goods, these high-tech product codes had been classified per sector, which allows us to delve into the sectoral analysis latter on.

APPENDIX II: SOURCE AND DEFINITIONS OF DATA

Abbreviation	Definition	Data Source
<i>High tech exports</i>	High-tech products share in total exports	Own elaboration based on UN Comtrade data and using a Eurostat list based on the OECD definition
<i>GVC index</i>	GVC participation index calculated as, $\frac{(\text{intermediate goods imports} / \text{gross exports}) * 100}{+ (\text{intermediate goods exports} / \text{gross exports}) * 100}$	Own elaboration based on UN Comtrade data
<i>HK1</i>	Labor force with advanced education (% of total working-age population with advanced education)	World Bank – World Development Indicators
<i>HK 2</i>	Labor force with advanced education (% of total working-age population with advanced education)	World Bank – World Development Indicators
<i>INN</i>	Persons (25-64 age) with terciary education (ISCED) and employed in science and technology, share of total population of 25-64 age (in logs)	Eurostat

APPENDIX III: ADDITIONAL REGRESSIONS

VARIABLES	Model 1 FE	Model 2 FE with lags	Model 4 2SFE IV
$\log (GVC\ index)_t$	0.609** [0.238]		0.849*** [0.278]
$\log (GVC\ index)_{t-1}$		0.300 [0.224]	
$\log (HK)_t$	0.436* [0.192]	0.444** [0.190]	0.266 [0.015]
$\log (INNOV)_t$	0.567* [0.294]	0.304** [0.200]	1.300*** [0.295]
<i>Constant</i>	-0.009** [0.008]	2.835 [1.836]	3.288 [2.088]
Country effects	YES	YES	YES
Year effects	YES	YES	YES
Wald χ^2 test year-effects	14.74 (0.9037)	12.22 (0.953)	17.88 (0.595)
Hausman test	65.37 (0.000)	14.80 (0.0965)	
Weak ident. Test – CE F stat.			159.53
Stock-Yogo critical value (5%)			16.85
Stock-Yogo critical value (10%)			10.27
Underident. test – Anderson LM stat.			172.645 (0.000)
Observations	265	261	243
Number of id	90	90	90

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in brackets. The dependent variable and the GVC participation index are expressed in logs. The figures reported for the Wald tests year-effects in parenthesis are the p-values. The instrumental variables used in the IV-FE regressions are the total GVC participation rate in the EU and the GVC index by country lagged three periods, $GVC\ index_{t-1}$, $GVC\ index_{t-2}$ and $a\ GVC\ index_{t-3}$. The figures reported for the weak identification and the underidentification tests are the p-values.

DEMAND FOR TOBACCO PRODUCTS IN NORTH MACEDONIA

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ABSTRACT

Tobacco use in North Macedonia represents a critical public health issue, with one of the highest global smoking prevalence rates at 48.4%. A significant portion of smokers (51.3%) begin smoking between 18 and 24 years, and 44.4% consume over 20 cigarettes daily. Smoking contributes substantially to mortality, with 170.17 deaths per 100,000 people attributed to smoking in 2019. North Macedonia's low cigarette prices and minimal illicit tobacco trade create significant potential for effective tobacco tax policy improvements. Smoking, a major risk factor for non-communicable diseases (NCDs) such as cardiovascular diseases and cancers, underscores the need for comprehensive tobacco control measures to reduce premature mortality and enhance mental health. This study examines tobacco demand in North Macedonia, analyzing consumption patterns, trends, and product types. It underscores the importance of understanding the socio-economic, cultural, and policy dimensions driving tobacco use. The methodology involves a multi-resource desk research approach, drawing on academic literature, government reports, and data from international organizations to provide a comprehensive overview of tobacco demand. Key findings reveal a high smoking prevalence with a slight decline over recent years. Economic factors, especially cigarette prices, significantly influence smoking rates. While the average number of cigarettes smoked per day remains high, there is evidence of reduced smoking prevalence among youth, attributed to increased health awareness and preventive measures. Despite legal restrictions, smoking remains socially accepted, complicating public health efforts.

The paper highlights the urgent need for enhanced tobacco control policies, including increased taxes, stricter smoking bans, and targeted interventions to reduce smoking rates, particularly among vulnerable populations. These measures, combined with continuous monitoring and research, are crucial for achieving significant public health improvements and aligning with Sustainable Development Goals.

Keywords: Tobacco use, North Macedonia, Smoking prevalence, Tobacco tax policy, Smoking patterns, Tobacco consumption trends.

JEL Classification: I12, I18, D12, C83.

1. INTRODUCTION

Tobacco use remains a significant public health crisis in North Macedonia, with a smoking prevalence among the highest globally (48,4%) (Mijovic Spasova and Mijovic Hristovska, 2018). Around half of smokers (51.3%) began to smoke very early in life, between 18 and 24 years of age. Smoking intensity is also very high: 44.4% of current smokers consume more than 20 cigarettes a day. In 2019, in North Macedonia, 170.17 deaths per 100,000 people were attributed to smoking, and the risk from tobacco increased by 2.4% between 2009 and 2019. This widespread addiction translates to a devastating burden of disease, healthcare costs, and lost productivity. Understanding the factors driving this high demand for tobacco products is crucial for designing effective strategies to reduce its consumption and improve public health outcomes.

North Macedonia has both a high smoking prevalence and the region's lowest cigarette prices. In addition, North Macedonia has the most affordable cigarettes in the region, with 2.55% of the average GDP per capita required to purchase 2,000 cigarettes. The estimation of the illicit market in manufactured and hand-rolled tobacco in North Macedonia is also very low at 1.9% - the lowest level of all countries in the region. Therefore, there is significant space for tobacco tax policy improvement.

Tobacco consumption is a major risk factor for non-communicable diseases (NCDs), including cardiovascular diseases and cancers. High smoking rates contribute to premature mortality. Implementing effective tobacco control measures can significantly contribute to reducing premature deaths from NCDs. While not directly related to tobacco use, mental health and well-being are influenced by various factors. Smoking, often linked to mental health challenges, can indirectly impact the suicide mortality rate. Comprehensive tobacco control measures can contribute to overall mental health improvement.

By addressing tobacco-related challenges, North Macedonia can play a pivotal role in achieving a healthier population and progress towards the Sustainable Development Goals.

The paper delves into the demand for tobacco products in North Macedonia, exploring consumption patterns, analyzing trends, and types of products consumed.

As a small yet significant player in the global tobacco landscape, North Macedonia occupies a pivotal position, both as a producer and consumer of tobacco products. With a rich history deeply intertwined with tobacco cultivation and manufacturing, the nation grapples with the dual challenges of promoting economic development while safeguarding public health. Against this backdrop, understanding the drivers of tobacco demand assumes paramount importance, serving as a cornerstone for evidence-based policymaking and targeted interventions aimed at curbing tobacco use and its associated harms.

The objectives of this paper extend beyond mere data aggregation and statistical analyses. Rather, the paper aims to engender a nuanced understanding of tobacco demand that encompasses the diverse realities and lived experiences of North Macedonia. Through a synthesis of existing literature, empirical research, and descriptive statistics analysis, this study endeavors to offer actionable insights that can inform policy discourse, catalyze transformative change, and advance the public health agenda in North Macedonia.

The country ratified the World Health Organization Framework Convention on Tobacco Control (WHO FCTC) in 2006, which introduced a general ban on smoking in public places but has become less restrictive on smoking bans in public places, contributing to exposure in bars and restaurants. The WHO FCTC recommends comprehensive bans on smoking in enclosed public spaces to protect non-smokers from exposure to secondhand smoke. This includes places such as bars, restaurants, and nightclubs. The aim is to create a smoke-free environment to reduce the health risks associated with passive smoking. Implementation Challenges in North Macedonia: Less Restrictive Bans: The information suggests that the smoking bans in North Macedonia have become less restrictive over time, particularly in places

like bars and restaurants. This has led to a significant proportion of adults being exposed to tobacco smoke in these venues.

2. LITERATURE REVIEW

The demand for tobacco and tobacco products has been a focal point of research globally, with scholars delving into various facets of this complex phenomenon. Within the Macedonian context, understanding tobacco demand requires a nuanced exploration of socio-economic, cultural, and policy dimensions. This literature review synthesizes key findings from seminal studies and scholarly works that have contributed to our understanding of tobacco demand in North Macedonia.

Chaloupka (1991) conducted a seminal study on the demand for cigarettes and tobacco products, emphasizing the role of price elasticity in shaping consumption patterns. This foundational research underscored the significance of economic factors in influencing tobacco demand and laid the groundwork for subsequent inquiries into the efficacy of taxation policies and price interventions.

Building on Chaloupka's work, Blecher (2008) investigated the impact of tobacco advertising bans on consumption in developing countries, providing valuable insights into the effectiveness of regulatory measures in curbing demand. His findings highlighted the pivotal role of marketing restrictions in deterring tobacco use, particularly among vulnerable populations.

Fong *et al.* (2006) developed a comprehensive framework for evaluating tobacco control policies through the International Tobacco Control (ITC) Policy Evaluation Project. Their research offered a robust methodology for assessing the effectiveness of various policy interventions, ranging from taxation to smoke-free legislation, in reducing tobacco demand and prevalence.

Siahpush (2003) conducted a seminal study on the socio-economic determinants of smoking cessation, identifying income, education, and social factors as critical predictors of tobacco use behaviors. His findings underscored the importance of addressing socio-economic disparities in tobacco control efforts and tailoring interventions to target high-risk populations.

Huang *et al.* (2018) examined the impact of federal and state cigarette taxes on smoking behaviors, providing empirical evidence for the effectiveness of tax policies in reducing tobacco consumption. Their research demonstrated the utility of fiscal measures in curbing demand and highlighted the role of government intervention in promoting public health objectives.

While these studies offer valuable insights into global trends and dynamics in tobacco demand, a noticeable dearth of research specific to North Macedonia persists. Localized studies examining the socio-economic, cultural, and policy determinants of tobacco consumption are scarce, highlighting the need for contextually relevant research in this area. By addressing this gap, this study aims to contribute to the evidence base informing tobacco control strategies and public health initiatives in North Macedonia.

3. METHODOLOGY

A multi-resource desk research method is employed for this report. This methodology involves the systematic collection and analysis of existing data, literature, reports, and other relevant information from secondary sources. Utilizing secondary data sources allows for a comprehensive investigation of the topic without the need for primary data collection.

The research questions guiding this paper are clearly defined, enabling focused inquiry into specific aspects of tobacco demand in North Macedonia. This structured approach ensures that the information gathered is relevant and aligned with the objectives of the report.

To conduct the literature review, a thorough examination of academic journals, conference papers, reports, and books pertaining to tobacco demand was undertaken. Online databases such as Tobacconomics, Tobaccotaxation, University of Illinois Chicago, Studies from Analytica think tank, Tobacco Control journal, PubMed, Google Scholar, and Scopus were accessed to access a diverse range of scientific literature on the subject.

Furthermore, reports and publications from government bodies, including the Ministry of Health, the Ministry of Finance, the Customs Administration, and the State Statistical Office of North Macedonia, were analyzed. These governmental sources provide valuable data on tobacco consumption rates, policies, and initiatives implemented at the national level.

International organizations such as the World Health Organization (WHO) and the World Bank were also consulted for their reports and publications related to global tobacco control efforts, best practices, and data on tobacco use. These sources offer insights into broader trends and initiatives in tobacco control that may inform the Macedonian context.

Reputable websites and online platforms dedicated to tobacco control, public health, and research were scrutinized for relevant research articles, policy briefs, and statistics pertaining to tobacco demand. Data from these sources were analyzed, and themes were identified to synthesize findings effectively. The information is organized in a structured manner to address the research questions and provide a coherent overview of tobacco demand in North Macedonia.

By employing the desk research method using a variety of resources, this report aims to offer a comprehensive overview of existing knowledge and insights regarding tobacco demand in North Macedonia. This approach enables the synthesis of information from multiple sources, facilitating a deeper understanding of the subject matter.

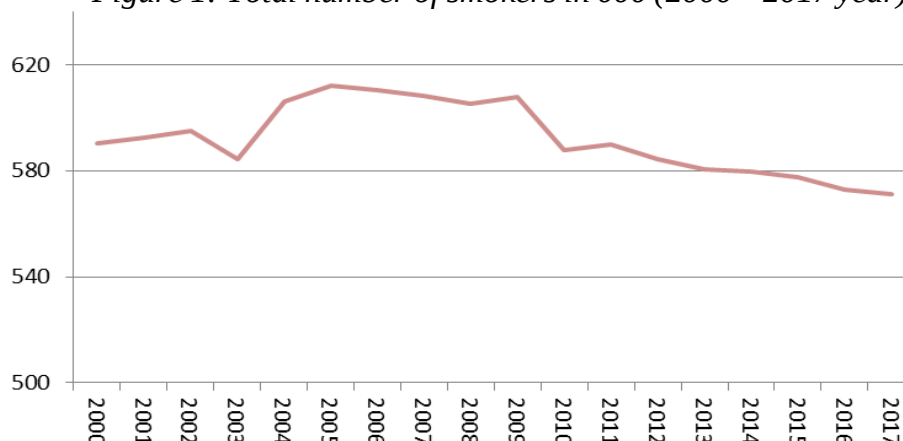
It is important to acknowledge the limitations of this methodology, particularly in terms of the availability, accuracy, and timeliness of the data obtained from secondary sources. Therefore, efforts were made to utilize information from reliable and up-to-date sources to maintain the credibility of the research findings.

4. DEMAND FOR TOBACCO PRODUCTS IN NORTH MACEDONIA

4.1. Prevalence of smoking

The prevalence of smoking in North Macedonia has exhibited a gradual decline over recent years. As of 2017, data indicates that there were approximately 571,000 smokers in the country. Of the total number of smokers in North Macedonia, 304,000 were men and 267,000 were women (refer to Figure 1).

Figure 1: Total number of smokers in 000 (2000 – 2017 year)

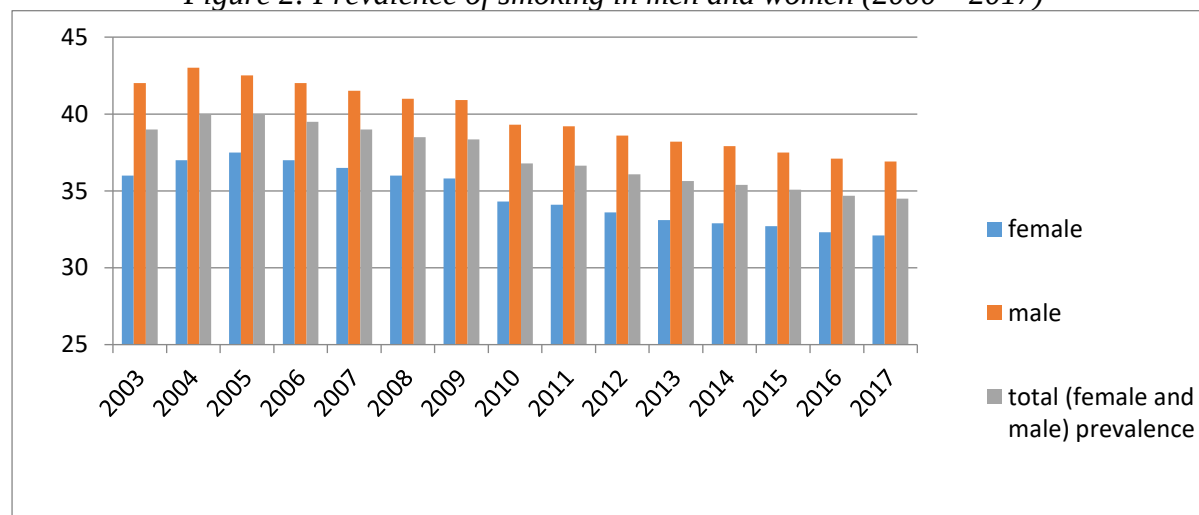


(Source: Calculations on the author upon the basis of data from the Institute for Publicly Health on North Macedonia, estimates on WHO, and estimates on IMEX DATA LLC Skopje)

In 2017 the smoking prevalence rate was estimated at around 35%. Smoking prevalence has seen a moderate decline in both women and men. The reasons behind this trend might be rising cigarette prices (Figure 3), as well as improved education and health awareness about the negative effects of smoking on people's health. Despite this decrease, North Macedonia remains among the countries with the highest prevalence of smoking globally, as well as in terms of the total number of cigarettes smoked per day per smoker. The prevalence of smoking in men was higher and amounted to 37%, and lower in women and was 32%.

Until 2017, we can present the prevalence of tobacco use in North Macedonia due to available data. However, a gap of two years exists without any recorded data on tobacco prevalence. In 2019, a nationally representative survey provided crucial insights, indicating a prevalence rate of 48.4% (Mijovic Hristovska *et al.*, 2020). This marked a notable increase compared to previous years. Subsequently, in 2022, another national representative survey yielded a prevalence rate of 45.4% (WHO, 2023), showcasing a slight decline in tobacco use compared to the 2019 figures. These figures underscore the importance of periodic data collection to track changes in tobacco prevalence over time and inform targeted interventions and policy measures aimed at reducing tobacco consumption in North Macedonia.

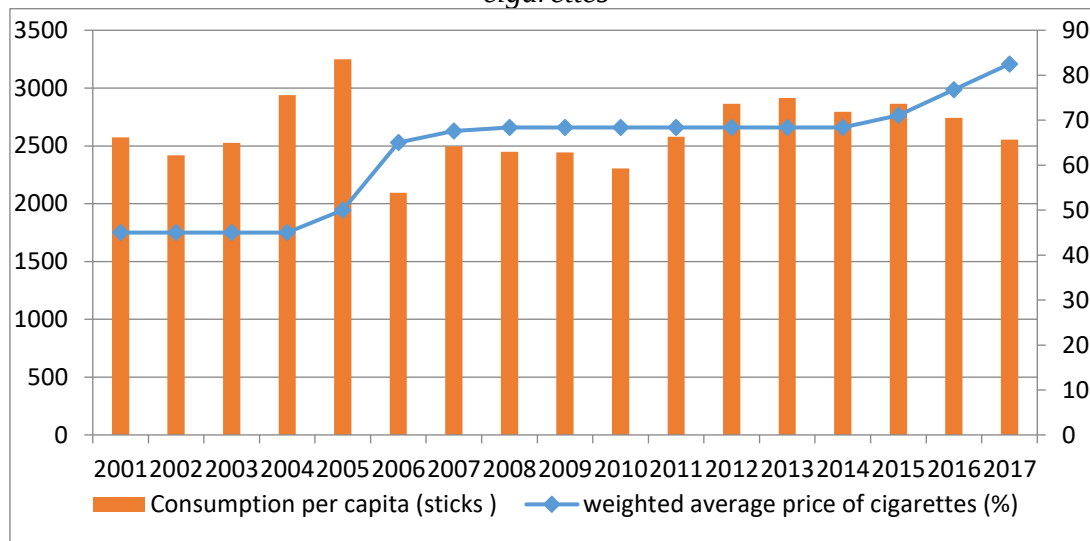
Figure 2: Prevalence of smoking in men and women (2000 – 2017)



(Source: Author's calculations based on data from the Public Health Institute of North Macedonia, WHO estimates and IMEX DATA DOOEL Skopje estimates, Global Journal of Medicine and Public Health; <http://www.gjmedph.com/uploads/O3%20-Vo3No4.pdf>; <http://iph.mk/wp-content/uploads/2016/12/ESPAD-izvestaj-final-final.compressed.pdf>)

Figure 3 explains the inverse relation between the consumption of cigarettes and the price of cigarettes. This relation might lead to one of the possible reasons for the decline in consumption of cigarettes (and by that in smoking prevalence) over the years. Namely, from the figure we can see the overview of cigarette consumption per capita alongside the weighted average price of cigarettes in North Macedonia spanning from 2001 to 2017. The orange bars depict the consumption of cigarettes per capita, while the blue line represents the weighted average price of cigarettes.

Figure 3: Consumption of cigarettes per capita (sticks) and Weighted average price of cigarettes

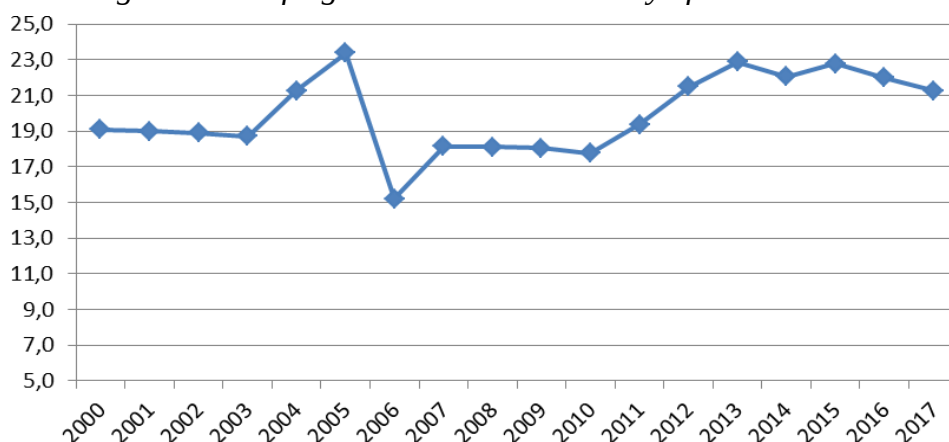


(Source: Author's calculations based on data from the Customs Administration of North Macedonia and State Statistical Office of North Macedonia)

Across the observed period, there is a fluctuating trend in cigarette consumption per capita, with an upward trend in some years and while decreasing trend in other years. The weighted average price of cigarettes demonstrates fluctuations but generally exhibits an upward trajectory.

The connection of these two variables suggests a potential inverse relationship between cigarette prices and consumption. As the price of cigarettes rises, there may be a corresponding decrease in consumption, while decreases in prices could lead to increased consumption. This pattern aligns with economic theory, which posits that higher prices typically deter consumption, especially for goods with discretionary or harmful attributes. This figure underscores the interplay between pricing policies and smoking behavior, highlighting the potential efficacy of price interventions in curbing cigarette consumption. It provides valuable insights for policymakers and public health advocates seeking to implement evidence-based strategies aimed at reducing tobacco use and its associated health risks in North Macedonia.

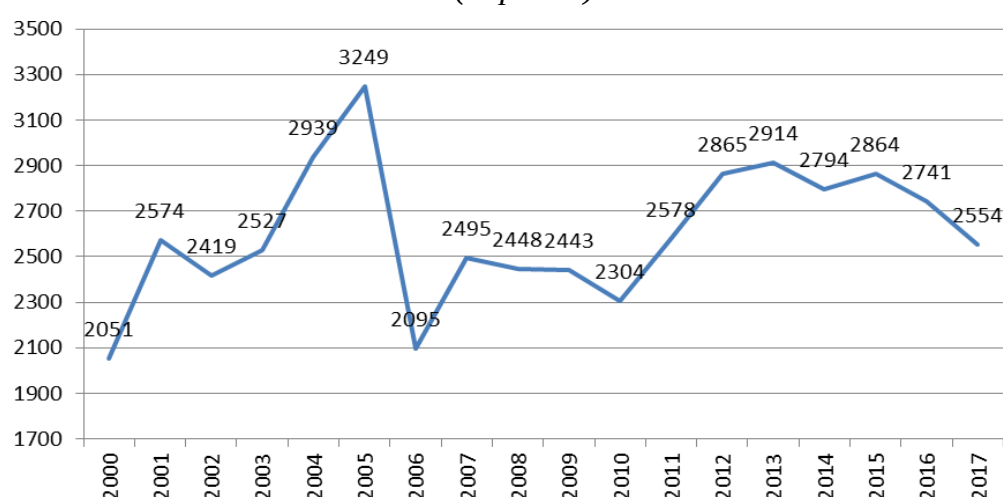
Figure 4: Average number of cigarettes smoked out daily after a smoker 2000 –2017 year



(Source: Calculations on the author upon the basis of data from Institute for Public Health on North Macedonia, WHO estimates and IMEX DATA LLC estimates Skopje, *Global Journal of Medicine and Public Health*; <http://www.gjmedph.com/uploads/O3%20-Vo3No4.pdf>; <http://iph.mk/wp-content/uploads/2016/12/ESPAD-izvestaj-final-final.compressed.pdf>)

While the prevalence of smoking continues to decline, the average number of cigarettes smoked per day per smoker remains fairly stable (Figure 4). In 2017, the average smoker in North Macedonia smoked 21.3 cigarettes per day.¹ The trend in Figure 4 matches the trend in cigarettes sold (Figure 5), showing the same large decline in cigarettes smoked per smoker per day in 2006. This is due to the drastic increase in the price of cigarettes in January 2006; hence the big drop in the number of cigarettes sold at the end of 2006.

Figure 6: Annual consumption of cigarettes after head-on resident 2000 –2017 year (in pieces)



(Source: State Statistical Office (method on estimated consumption))

Figure 5 shows that annual cigarette consumption per capita between 2000 and 2017 oscillated around a moderately increasing trend. In 2006, a significant decrease in the annual consumption of cigarettes per capita was observed, which followed an average increase in the prices of tobacco products of 21.6%, an increase in the cigarette excise tax of 10%, and the introduction of a new fee of 0, 15 denars per piece for each manufactured or imported tobacco cigarette (i.e. 3 denars per box) (National Bank of Republic of Macedonia, 2006). As a consequence of the large increase in the price of cigarettes, at the end of 2006, a large drop in the annual consumption of cigarettes per capita was observed.

The increasing trend between 2010 and 2017 can be explained by increased cross-border purchases of cigarettes by tourists from neighboring countries, especially Greece, Bulgaria, and Kosovo with significantly higher cigarette prices. This coincides with EU regulations - Common Agricultural Policy - CAP (Common Agricultural Policy - CAP). Between 2007 and 2013, there were major changes in the EU's tobacco production policy, which led to a sharp decline in tobacco production in all member states, especially in neighboring Greece and Bulgaria (European Commission, 2023).

4.2. Minimum smoking age

According to Article 5 of the Law on Protection from Smoking, the legal age for smoking in North Macedonia is 18 years. As is the case in other countries, the Government of the Republic of North Macedonia has adopted laws and measures to prevent the sale of tobacco products to minors (below 18 years of age). Taking this into consideration,

¹ Author's calculations based on data from the Public Health Institute of North Macedonia, WHO estimates and IMEX DATA DOOEL Skopje estimates, Global Journal of Medicine and Public Health; <http://www.gjmedph.com/uploads/O3%20-Vo3No4.pdf>; <http://iph.mk/wp-content/uploads/2016/12/ESPAD-izvestaj-final-final.compressed.pdf>

vending machines for tobacco products are strictly prohibited in North Macedonia. Online retail of tobacco products is not prohibited per se but is subject to strict legislation, which regulates and prohibits sales to minors. Article 9 of the Law on Protection from Smoking states that legal entities and people who are found to violate the law will face fines penalties between 2,000 and 4,500 euros. Each parent or guardian of the minor will also be fined from 500 to 1,000 euros. These penalties apply to several violations of the law, including the sale of tobacco products to minors.

4.3. Youth smoking prevalence

The smoking prevalence among young people in North Macedonia is especially worrying (Institute of Public Health, 2016a). The most vulnerable population is between 13 and 17 years. North Macedonia has taken some measures to address this problem in the past, though so far they have had limited success. National sponsored campaigns were conducted to inform the public and prevent youth from initiating smoking, as well as to reduce the youth smoking prevalence. Some of the measures conducted in the past were undertaken by the governmental body, Agency for Youth and Sports, which has encouraged young people to accept healthy lifestyles and participate in sports. Hence, there was a trend of increase in the focus on health and well-being from the side of the younger generations who tend to lead a healthier lifestyle. According to the Agency, health consciousness about the negative effects of smoking among young people in North Macedonia in the past years has increased.

In North Macedonia, there are three series of research conducted among youth: the European School Survey Project on Alcohol and Other Drugs – ESPAD, Health Behavior School Children Study – HBSC, and the Global Youth Tobacco Survey - GYTS. So far, in North Macedonia, the ESPAD research has been carried out four times: 1999, 2008, 2012 (just on the territory of the city of Skopje), and 2015 year (Institute of Public Health, 2016b).

According to ESPAD from 2008 year, smoking among youth in North Macedonia is widespread. About 43% of minors, aged 16 years and less smoked at least once in their life, while about 13% smoked at least one cigarette daily. The 2008 “Global School-Based Student Health Survey” showed that 14% of minors aged 12 to 16 were smoking at least once in the last calendar month. The study also indicated an encouraging trend regarding tobacco exposure among young people, where 67% of young people were exposed to tobacco smoke in public places in 2008, which was significantly lower when compared to 2002. According to the ESPAD study (Institute of Public Health, 2016b). In 2015, the percentage of minors who have smoked at least once in their lifetime dropped to 38.4%, while those who answered that smoked one or two times in their lifetime was 14.7%. According to this study, most young people start smoking at the age of 15. In comparison with previous years, the number of young people using cigarettes is decreasing. The prevalence of smoking declined from 57.6% in 1999 to 38.4% in 2015 year. According to the latest Global Youth Tobacco Survey (GYTS) conducted in 2016, around 12.4 percent of students (14.6 percent of boys and 9.8 percent of girls) use tobacco products.

In this context, increasing tobacco taxes, restricting access to tobacco products, and implementing comprehensive tobacco control policies are crucial strategies for preventing smoking and reducing youth smoking rates. Empirical evidence indicates that higher prices and various non-price tobacco policies can discourage smoking initiation among young people (Merkaj et al., 2022 and Tauras et al., 2001). However, some studies have found inconclusive or weak evidence regarding the impact of prices and taxes on youth smoking initiation (DeCicca et al., 2008, DeCicca et al., 2002, Douglas, 1998 and Douglas & Hariharan, 1994).

Additionally, young people are more likely to start smoking if they are influenced by social factors such as peer pressure and positive attitudes toward smoking. Other factors that can increase the likelihood of youth smoking onset include low socioeconomic status, parental smoking, and exposure to pro-smoking advertising.

4.4. Social acceptance of smoking

In general, the level of social acceptance of smoking in North Macedonia is quite high, having in mind the tradition of tobacco growing country. However, in recent years there has been a trend of changing the lifestyle and increased public consciousness and focus on health and well-being, contributing to a decrease in the consumption of cigarettes per capita (from 3249 in 2005 to 2554 in 2017) (State Statistical Office, 2018.) and decrease in the number of cigarettes sold (from 5225 in 2005 to 4290 in 2017) but a very slight decrease in the smoking prevalence (from 40% in 2005 to 34.5 in 2017).

One of the facts confirming the social acceptance of smoking is the change of the Law on Protection from Smoking in 2018. Namely, the government amended the Law and relaxed the smoking ban, allowing smoking in determined places for smoking and open terraces (Sloboden Pecat, 2018). The move was welcomed by the majority of smokers and the HoReCa sector (hotels, restaurants, cafeterias) (OhridNet, n.d.).

5. SOUTH-EAST EUROPEAN COUNTRIES DEMAND FOR TOBACCO PRODUCTS

The Southeastern Europe (SEE) region is characterized by high tobacco consumption and low cigarette prices (Zubović & Vladislavljević, 2019). According to STC-SEE data (2019), smoking prevalence in the SEE region is very high at 37.6%, which is about nine percentage points higher than the European average of around 29%. Smoking prevalence varies significantly among the countries, ranging from 24.7% in Albania to 48.9% in North Macedonia. Manufactured cigarettes are the most commonly smoked product, with 32.8% of the adult population using them, while roll-your-own tobacco (RYO) is much less prevalent, at 6.3%. Other tobacco products have negligible prevalence (less than 0.5%). On average, MC users smoke 16.5 cigarettes per day, while RYO users smoke 14.6 cigarettes per day.

At the same time, the average cost of a pack of manufactured cigarettes in this region is about €2.1, significantly lower than the European Union (EU) average of €4.91. High tobacco consumption imposes a significant economic burden on households, particularly in light of the poverty rates across these countries. Additionally, the negative health effects of tobacco consumption are long-lasting, with approximately half of smokers dying from tobacco-related diseases. Tobacco taxation is one of the most effective measures to reduce tobacco consumption (World Health Organization, 2018). The effectiveness of these measures relies on consumer responses to price increases. Lower tobacco use prevalence and intensity are associated with more smoking restrictions and support for tobacco price increases. These non-price factors independently and additionally contribute to reducing tobacco use prevalence and intensity.

In contrast to SEE countries, where smoke-filled establishments have largely diapered and smoking prevalence has significantly declined over the past two decades due to comprehensive public health initiatives, the SEE countries have witnessed a less pronounced decrease, influenced by both legal and cultural factors. Experts across the region acknowledge the urgent need for governments and stakeholders to intensify efforts in raising awareness about the hazards of smoking and aligning regional legislation with EU standards. Medical doctors from the Faculty of Medicine in North Macedonia (Zdravevska et al., 2020), emphasize the multifaceted nature of the smoking issue in North Macedonia and the broader SEE region. Factors such as a longstanding tradition of tobacco cultivation and consumption, coupled with

social acceptance of smoking, pose significant challenges. Additionally, limited health education, lack of proactive prevention programs, and insufficient access to supportive treatments further compound the complexity of addressing the smoking epidemic in the region. In addition to traditional tobacco products, during the last few years, new tobacco products have emerged, as heated tobacco and electronic cigarettes, slipping through the gaps of legislation and poorly enforced smoking bans. Available data indicate that smoking (of any tobacco product) remains a significant public health issue. Namely, Serbia, Bulgaria, North Macedonia, Bosnia and Herzegovina, and Montenegro lead not just in Europe but also globally in the number of smokers.

Some of the possible reasons for the high smoking rates in the SEE countries most probably are low prices of tobacco products, lack of smoking bans in closed public spaces in some countries, and lack of efficient implementation of existing laws. In Serbia, attempts to curb indoor smoking in bars and restaurants were undermined by pressure from the hospitality industry, allowing venues smaller than 80 square meters to choose their smoking policy. As a result, most allow smoking. Larger venues must have separate smoking sections, but what qualifies as “separate” is often loosely interpreted. Bosnia and Herzegovina has not enacted any indoor smoking bans. Despite efforts by NGOs and stakeholders, proposed legislation from 2018 has yet to become law (Đorđević, 2020).

The region's tobacco control measures are further weakened by loopholes in advertising restrictions and the aggressive marketing of new tobacco products. Cigarettes are prominently displayed at checkout counters, and tobacco companies frequently redesign packaging to exploit legal gaps. Heated tobacco products, like IQOS and Glo, are often marketed without restriction, with promotional samples freely distributed in bars. Montenegro is one of the countries in the SEE region with the highest level of illicit trade and estimates suggest the market share for illicit tobacco was 51% in 2019. This is contributing to the problem and is countering the efforts to curb consumption. In Montenegro, despite the government's 2018 law banning smoking in bars and restaurants, enforcement issues and the exclusion of heated tobacco products limit its effectiveness. Other regional countries face similar challenges. Bulgaria initially saw success with its 2012 indoor smoking ban but weakened enforcement led to a recovery in smoking rates. In addition, the lack of smoking cessation services and the affordability of tobacco are persistent issues. In North Macedonia, a general ban on smoking in public places, including restaurants and bars, came into effect on January 1, 2010. In early 2018, the Law on Protection was amended, and the smoking ban was weakened by allowing smoking in specially designated areas and open-air terraces. This certainly challenges the tobacco cessation policies.

Ultimately, the SEE region's struggle with smoking is exacerbated by a lack of political will and comprehensive government action. The absence of comprehensive and solid tobacco control measures and robust legal frameworks undermines their effectiveness.

6. CONCLUSION AND POLICY RECOMMENDATIONS

This paper's findings highlight the complexity of tobacco demand in North Macedonia, influenced by various factors such as consumption behavior patterns, economic considerations, social and cultural influences, health implications, and policy interventions. The prevalence of tobacco use remains a significant public health concern, with specific demographic groups and regional differences playing a role in consumption patterns.

Economic factors, especially the price, price elasticity of demand, and implementation of antismoking laws and measures have been identified as important determinants of tobacco consumption. Higher prices and taxes show the potential to reduce tobacco use and

demand, especially among vulnerable populations. In addition, the social and cultural context surrounding tobacco use, including peer influence and social norms, have been identified as influencing factors.

The health implications of tobacco consumption in North Macedonia are significant, with smoking-related diseases such as cardiovascular disorders and respiratory diseases imposing a significant burden on individuals and the health system. Further evaluation and monitoring of the effectiveness of these interventions is needed to measure their long-term impact on reducing tobacco demand.

This paper highlights the importance of evidence-based decision-making in the implementation of tobacco control strategies in North Macedonia. It serves as a valuable resource for policymakers, public health professionals, and researchers, providing insight into the specifics of cigarette consumption, economic factors, social impacts, health implications, and policy interventions related to tobacco demand.

Finally, it is essential to continue monitoring tobacco consumption trends, conduct additional research to address knowledge gaps, and implement targeted interventions to reduce tobacco demand in North Macedonia. By implementing comprehensive evidence-based strategies, it is possible to protect public health, reduce the burden of smoking-related diseases, and create a smoke-free environment for the population of North Macedonia.

Based on the research results, the policy recommendations are:

- To reduce smoking prevalence, the government should increase excises on all tobacco products. Higher excises would lead to higher prices and lower smoking prevalence. This measure is important and will prevent smokers from switching from expensive to a cheaper alternative and instead encourage them to quit tobacco altogether. Higher prices of all tobacco products will decrease smoking intensity.
- The government should combine price measures, such as increasing tobacco taxes, with non-price measures, such as stricter smoking restrictions, and bringing back the smoking ban in indoor places which have been proven to be highly effective in impacting the decrease of smoking rates.
- Raising awareness about the health harms of tobacco through comprehensive public and education campaigns that will likely help to decrease consumption and establish educative campaigns, especially targeting the youth.

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TOBACCO SECTOR ANALYSIS IN NORTH MACEDONIA: SUBSIDIES, PRODUCTION, AND POLICY PERSPECTIVES

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ABSTRACT

This comprehensive empirical research examines the landscape of tobacco production in North Macedonia, placing a specific focus on the historical development and economic significance of the tobacco sector within the national and regional agricultural framework. It provides an in-depth analysis of tobacco leaf production, including a comparison with other regional tobacco producers, to contextualize North Macedonia's position in the broader tobacco industry. The study also investigates the dynamics of agricultural imports and exports, with a particular emphasis on raw tobacco, delving into the complex interplay between domestic production and international trade.

Central to this empirical research is a critical evaluation of the financial support mechanisms in agriculture, particularly the extensive subsidies directed towards tobacco cultivation. These subsidies are analyzed in terms of their economic rationale and effectiveness, questioning whether the prioritization of tobacco over other crops is justified given the current economic climate and market demands. The empirical research further explores the implications of these subsidy policies in light of North Macedonia's aspirations to align with the European Union's Common Agricultural Policy, which presents unique challenges and opportunities for reforming agricultural support systems.

By integrating quantitative data with qualitative policy analysis, the empirical research aims to provide a nuanced understanding of the economic impacts and sustainability of tobacco subsidies. It assesses whether these subsidies are an economically prudent allocation of national resources, especially considering the potential for aligning with EU standards and the necessity to foster a more diversified and sustainable agricultural sector. The findings are intended to inform policymakers and stakeholders, offering strategic insights and recommendations for future agricultural policy development in North Macedonia.

Using a descriptive statistical approach, the study evaluates data on tobacco production, subsidy distribution, and trade dynamics. The findings reveal potential misalignments in subsidy allocations and recommend policy adjustments to foster a diversified agricultural sector in alignment with EU standards.

Keywords: *Tobacco Production, Agricultural Subsidies, Tobacco subsidies, Tobacco policy, North Macedonia, EU Common Agricultural Policy.*

JEL Classification: Q18, Q13, F14, H23.

1. INTRODUCTION

North Macedonia has long been recognized for its tobacco production, a sector deeply ingrained in the nation's agricultural and economic fabric. This empirical research delves into the current state and historical context of tobacco cultivation in North Macedonia, providing a detailed overview of the industry's scale, its economic contributions, and the comparative landscape of regional tobacco production.

Historically, tobacco has been one of the cornerstones of North Macedonian agriculture, with the country being renowned for its high-quality oriental tobacco. This variety is especially sought after for its unique aromatic properties, making it a prized component for blending in cigarette manufacturing. In 2022 North Macedonia produced 25,978 tons of tobacco which accounted for 0.5 percent of world tobacco production and 19.1 percent of the production in Europe marking the country as a significant player on both the regional and global stages (Mijovic Hristovska *et al.*, 2022), (FAOSTAT).

The economic role of tobacco is highlighted by its contribution to the national export economy. Tobacco and tobacco products represent a substantial portion of North Macedonia's agricultural exports, contributing 20.4 percent to the total export value of agricultural and food products. This sector not only influences the nation's GDP directly—accounting for about 1 percent of the total GDP—but also plays a crucial role in the livelihoods of approximately 20,000 agricultural households, which depend heavily on tobacco cultivation (Mijovic Hristovska, 2022), (Jugoinfo.mk, 2022).

This introduction also addresses the broader scope of agricultural trade, focusing on the import and export dynamics. Despite the strong export figures for raw tobacco, North Macedonia faces a significant trade imbalance in other agricultural sectors, often spending more on importing processed agricultural products than it earns from exporting raw agricultural goods. This imbalance prompts a reevaluation of the current subsidy strategies and their alignment with the nation's economic priorities.

Furthermore, the empirical research scrutinizes the financial support framework within North Macedonia's agricultural sector, emphasizing the substantial subsidies directed towards tobacco. Over the period from 2008 to 2022, the government disbursed approximately 318 million euros in direct subsidies to tobacco farmers (DIZ.gov.mk, 2021). These subsidies represent about a quarter of the total agricultural subsidies and 40 percent of the subsidies allocated specifically to crops. Such financial prioritization raises critical questions about the economic prudence of this approach, especially considering the evolving global market trends and the decreasing global demand for cigarettes (24.mk, 2022), (Vlada.mk, 2022). Additionally, the alignment of North Macedonia's agricultural policies with the European Union's Common Agricultural Policy (CAP) is a key focus. As the country moves towards EU integration, it faces the challenge of adjusting its subsidy practices to comply with EU standards. This transition is crucial not only for integration purposes but also for enhancing the sustainability and efficiency of the agricultural sector.

In conclusion, this introduction sets the stage for a comprehensive analysis throughout the subsequent sections of the report, which will explore the implications of current tobacco subsidy policies, assess their economic effectiveness, and discuss potential pathways for policy reform. The ultimate goal is to provide a well-rounded perspective that aids policymakers in making informed decisions that could lead to more sustainable economic development and agricultural diversification in North Macedonia.

2. LITERATURE REVIEW

The literature on tobacco production and subsidies presents a complex picture, emphasizing the intersections of economic, health, and agricultural policy. To provide a comprehensive understanding, this review is organized across three levels: global, European, and regional, with a particular focus on the role of subsidies in agricultural sustainability and policy implications for North Macedonia's tobacco sector.

2.1. Global context

Global studies frequently address the paradox of agricultural subsidies supporting tobacco production despite substantial public health concerns. The *WHO Report on Tobacco Subsidies and Health* (2018) critiques the continued support for tobacco farming and advocates for subsidy realignment to promote public health. Similarly, *Overcoming an Understated Impediment to Comprehensive Tobacco Control* by Lencucha et al., (2018) uses descriptive statistics to analyze farm-level data on tobacco production and subsidy allocation. This study highlights the economic challenges of transitioning away from tobacco and underscores the importance of subsidy reforms aligned with public health goals. The *FAO Annual Tobacco Production Reports* (2022) also apply descriptive statistical methods to compare production and subsidy impacts globally, showing the influence of subsidies on production trends across various countries.

2.2. European context

In Europe, subsidy policies have shifted towards supporting sustainable agricultural practices and reducing dependence on specific crops like tobacco. The *European Union's Common Agricultural Policy (CAP)*, as analyzed by Swinnen (2018), emphasizes the need for agricultural diversification and environmental sustainability. The *European Commission Report on Agricultural Subsidies and Tobacco* (2021) outlines the progressive elimination of direct subsidies for tobacco production in EU countries, marking a broader move toward rural development. In addition, *Agricultural Policy Adjustments in EU Candidate Countries* by Lazarevik et al. (2012) discusses the challenges for North Macedonia and other EU candidates in realigning subsidy allocations with CAP standards, as these countries transition from traditional crop-specific subsidies to broader support mechanisms.

2.3. Regional (Balkan) Context

In the Balkans, tobacco subsidies remain crucial to the economic stability of rural areas. North Macedonia's *National Focus Note on Agriculture* by the World Bank (2020) uses descriptive statistics to assess subsidy distribution, identifying inefficiencies and recommending diversification to enhance productivity. In *Tobacco Farming and the Effects of Tobacco Subsidies in North Macedonia* (Hristovska Mijovic and Spasova, 2022), descriptive statistics are used to analyze the economic effects of tobacco subsidies, with findings that highlight North Macedonia's disproportionate allocation to tobacco relative to other crops. The study aligns with Sahadewo et al.'s *Economics of Tobacco Farming in Indonesia* (2021), which uses a similar methodology to analyze the costs, income distribution, and sustainability of tobacco subsidies, demonstrating the applicability of descriptive statistics for evaluating agricultural policies. Comparative research within the region, particularly with Serbia and Greece, further highlights North Macedonia's unique emphasis on tobacco. While Greece, for example, has reduced tobacco subsidies in accordance with EU guidelines, North Macedonia continues to prioritize this crop, revealing a policy approach that may face challenges under EU accession criteria.

This literature review provides a standardized citation format and organizes studies by global, European, and regional relevance, offering a systematic perspective on the economics and policy challenges associated with tobacco subsidies. The reviewed studies support the descriptive statistical approach used in this paper to assess the impact of subsidies on tobacco production, presenting valuable insights for potential policy reform in North Macedonia.

3. METHODOLOGY

This study uses a descriptive statistical approach to analyze the economic impacts of tobacco subsidy policies in North Macedonia. Data from national and international sources, such as the Ministry of Agriculture and the FAO, were collected on various aspects of the tobacco industry, including production volumes, subsidy allocations, and export destinations.

The primary analytical technique, descriptive statistics, allows for summarizing large datasets through mean, median, and mode calculations, among other indicators. This approach directly supports the study's goal by illustrating the effectiveness of tobacco subsidies relative to economic outcomes, guiding policy recommendations for agricultural reform. By focusing on both economic outcomes and subsidy effectiveness, the findings link directly to the study's stated goals, providing actionable insights for policymakers.

This report adopts a quantitative approach to evaluate the impact and alignment of tobacco subsidy policies in North Macedonia, focusing on their integration with broader economic, agricultural, and health policies. The methodology is designed to provide a robust data-driven foundation for policymakers and other stakeholders such as farmers, enabling informed decisions regarding the ongoing use and potential reform of tobacco subsidies. The quantitative analysis conducted in this study is primarily based on secondary data sources. Comprehensive desk research was undertaken to gather existing data related to various aspects of the tobacco industry. This includes data on tobacco leaf production, area hectares planted with tobacco, numbers of agricultural holdings engaged in tobacco cultivation, and the volume of tobacco imports and exports.

Data were sourced from several authoritative national and international bodies, including the Ministry of Agriculture, the Agency for Financial Support of Agriculture, the Ministry of Finance, the State Statistical Office, the Chamber of Commerce, and the Food and Agriculture Organization. These sources provided a foundational dataset that covers the broad spectrum of tobacco production and subsidy dynamics within the country.

The primary analytical technique employed in this study is descriptive statistics, which serves as a powerful tool to outline and interpret the complex relationships and trends within the collected data. Descriptive analyses help summarize large datasets to make them understandable, focusing on key statistics such as means, medians, modes, and standard deviations, as well as distribution and range that relate to tobacco production and economic parameters. This approach allows for a clear presentation of the current state of tobacco subsidies and their economic implications. It also facilitates an examination of the effectiveness of these subsidies in terms of economic return, sectoral impact, and alignment with national economic goals.

The data and subsequent analysis aim to capture a comprehensive picture of the tobacco subsidy landscape in North Macedonia. This includes an evaluation of the subsidies' economic justification, their role in the agricultural sector, and their broader implications for national economic health. The study also considers the potential need for reforming these subsidies to better align with contemporary economic and agricultural policies, including prospective adjustments that may be necessitated by North Macedonia's efforts to align with EU standards. By employing rigorous descriptive statistical methods to analyze secondary data, this study provides a foundational understanding of the mechanics of tobacco subsidies in North

Macedonia. The findings derived from this analysis are intended to contribute to the ongoing dialogue about the sustainability and strategic direction of agricultural subsidies in the country, offering evidence-based insights that can guide policy reform and decision-making. This methodological approach ensures that the conclusions are well-supported by data, providing a reliable basis for any proposed changes to subsidy policies.

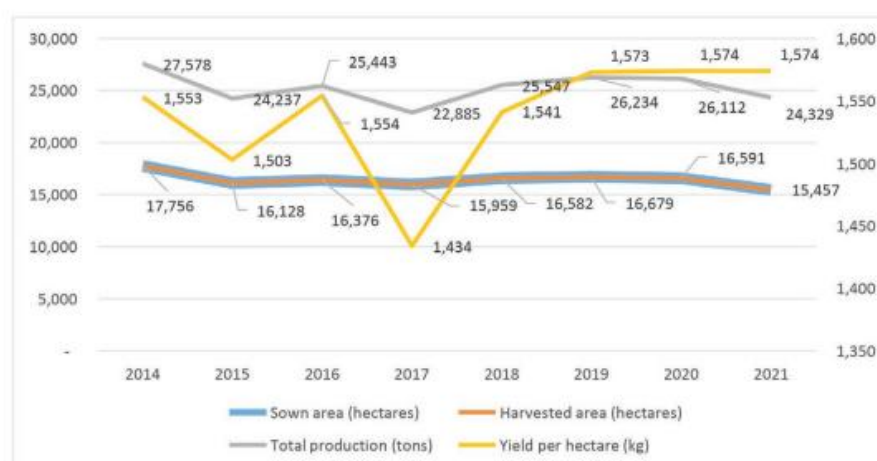
4. INTRODUCTION TO TOBACCO LEAF PRODUCTION IN NORTH MACEDONIA

Tobacco leaf cultivation has historically occupied a significant position within North Macedonia's agricultural framework, contributing not only to the economy but also to the livelihoods of rural communities. In 2006, North Macedonia ratified the Framework Convention on Tobacco Control (FCTC), which mandates a reduction in tobacco production and consumption and supports the transition of those employed in the tobacco sector to alternative livelihoods. This commitment reflects a broader trend towards sustainable agricultural practices and public health considerations.

North Macedonia has a heritage in cultivating and exporting raw tobacco, establishing itself as a pivotal player in the tobacco industry both regionally and globally. North Macedonia stands out as a significant producer of raw tobacco leaves and finished cigarettes within the region. According to the Food and Agriculture Organization (FAO), the country produced 25,978 tons of tobacco in 2022, which represented 0.5 percent of the world's production and 13.9 percent of Europe's production (FAOSTAT), (Mijovic Hristovska et al., 2022), (FAOSTAT).

This production level positions North Macedonia among the top 30 tobacco-producing countries worldwide and ranks it among the 20 major exporters of raw tobacco. In the European context, it follows only Turkey, Italy, Poland, and Spain in the production of unmanufactured tobacco.¹

Figure 1: Tobacco cultivation in North Macedonia, 2014-2021



(Source: State Statistical Office)

In the Southeastern European region, North Macedonia is the leading producer, with its closest regional competitor being Greece, which contributes 0.5 percent to the world's production. Specifically, in the production of oriental tobacco, North Macedonia is the second-largest

¹ Tobacco was introduced to North Macedonia from Turkey in 1638 and has been cultivated here since 1574, but more extensively since the XVII century. The first tobacco purchase storage was established in Prilep in 1873, marking the beginning of the tobacco industry in the country.

producer after Turkey.² The top four producers of this type of tobacco—Turkey, North Macedonia, Greece, and Bulgaria—benefit from favorable natural and climatic conditions conducive to cultivating this crop.

Despite the significant decline in raw tobacco production across the European Union, where production dropped from 400,003 tons to 170,000 tons over a decade, the production levels in North Macedonia have remained stable. This stability underscores the country's resilience and strategic importance in the tobacco sector, maintaining its legacy as a key tobacco producer under evolving economic and regulatory landscapes.

The introduction of the Common Agricultural Policy (CAP) by the European Union, which North Macedonia aspires to join, imposes further restrictions on tobacco production. These include the phasing out of subsidies for tobacco farming, aligning agricultural practices with health and environmental goals. In response, the Macedonian government adopted the Strategy for Tobacco Production (2021–2027) in 2020, outlining a phased approach to support tobacco farmers during this transition. This strategy aims to maintain income support in the short term (2021–2024) while preparing farmers for significant changes through education and counseling. From 2025 to 2027, the strategy anticipates a diversification of tobacco holdings to comply with EU CAP regulations, including adapting the direct payments system into more indirect or decoupled payments.

In 2021, tobacco leaf cultivation accounted for approximately 3.2 percent of the total arable land in North Macedonia, with a production output of 24,329 tons from 15,457 hectares. The average yield was about 1574 kilograms per hectare. The predominant variety of tobacco produced is Prilep, which constitutes 84 percent of production, followed by Yaka and Basma varieties. Geographically, the majority of tobacco production is concentrated in the Pelagonian and Southeast regions, which together produced 87.9 percent of the total yield in 2021 (Mijovic Hristovska et al., 2022).

The export market plays a crucial role in the tobacco industry, with more than 90 percent of tobacco exported globally, primarily to Greece, Bulgaria, Belgium, the United States, and Portugal. The sector's significance extends to employment, representing about 0.42 percent of total employment in North Macedonia in 2019. However, the number of tobacco farmers has seen a significant decline, from 42,622 in 2010 to 19,702 in 2020, reflecting a broader shift in agricultural priorities and the economic landscape (Mijovic Hristovska et al., 2022).

Tobacco production in North Macedonia, along with Greece, constitutes a significant portion of the tobacco output in the Southeast European (SEE) countries. Over recent years, these two countries have consistently been the largest producers in the region. Historically, Greece has often reported the highest production volumes. The combined production from North Macedonia and Greece accounted for 65 percent of the total tobacco production in the SEE region. This prominence in production figures is partly attributed to an increase in subsidies per kilogram by the North Macedonian government, which has likely stimulated growth in tobacco production. Detailed descriptions of these changes can be found in the annexes of the report (Mijovic Hristovska et al., 2022).

As North Macedonia continues its journey towards EU integration, the tobacco sector faces inevitable transformations. These changes are part of a larger effort to align the country's agricultural practices with sustainable and health-oriented policies at the European and global levels. The transition from tobacco farming to alternative crops is not merely a requirement of EU candidacy but also a response to the decreasing global demand for tobacco. This shift will

² The downward trend began with the adoption of EU's Common Agricultural Policy (CAP), when the European Community reduced the number of tobacco varieties for which subsidies were to be paid from 34 to 5 (Virginia, Burley and three types of oriental tobacco). Since then the EC has gradually reduced tobacco subsidies (Pasovska, 2020). In addition, there are production quotas assigned to producing countries which they must not exceed.

require substantial resources and a strong commitment from political leaders and the community to support farmers through this significant economic and cultural change.

6. TOBACCO AS A STRATEGIC CROP: ASSESSING THE GOVERNMENT'S PERSPECTIVE

The government of North Macedonia regards tobacco as a strategic agricultural product, essential to the nation's economy. Tobacco cultivation accounts for 3.2 percent of the total arable land, making it a pivotal industrial crop. It constitutes approximately 76 percent of the area dedicated to industrial crops, with its value representing about 94 percent of the total industrial crop output from 2000 to 2019, peaking at 97 percent in 2019 alone. The majority of the tobacco produced is exported, primarily used for blending in cigarettes due to its rich aroma, while the local industry consumes about ten percent of the output. Tobacco ranks as one of North Macedonia's most significant agricultural export commodities, accounting for one-fifth of the total export value of agricultural and food products, which equates to roughly one percent of the GDP.

The main trading partners for tobacco leaf include EU countries, which account for 49 percent of exports, and Central European Free Trade Agreement (CEFTA) countries, which make up 34.4 percent of exports and 28.1 percent of imports. The USA stands out as the largest non-European export destination, particularly for tobacco, representing 3.9 percent of the exports from the North Macedonian agri-food sector in 2019. Notably, the top export destinations for raw tobacco are Greece, Bulgaria, Belgium, the USA, and Portugal, while imports primarily consist of other tobacco varieties used for cigarette production, with around two-thirds originating from the EU.

Tobacco farming is recognized for its labor-intensive nature, providing a livelihood for approximately 20,000 agricultural households, or more than 80,000 family members. This accounts for about four percent of North Macedonia's total population. However, the dependency on tobacco farming is seen as a downside, especially given the limited alternative skills among farmers, which becomes problematic during unfavorable market conditions and amid active campaigns aimed at reducing tobacco production.

The regions of Pelagonia and Southeastern North Macedonia are particularly favorable for tobacco cultivation, especially the oriental varieties, which thrive even in poorer soils that are less suitable for other types of agriculture. These regions are the major producers, with Pelagonia accounting for 52 percent of the production and 55 percent of the cultivated area, and the Southeastern Region contributing 34 percent of the production and 32 percent of the area on average over the period from 2009 to 2019.

In recent years, about 90 percent of the tobacco produced was bought by private companies, and the remainder by Tutunski Kombinat Prilep, which is primarily government-owned. These private entities process tobacco in accordance with pre-established contracts with multinational corporations to whom they sell the processed product. The sector is robustly supported by the North Macedonian government through a system of public subsidies.

The qualitative research conducted with representatives from relevant government agencies, as outlined in the report from Analytica think tank Skopje, underscored the economic significance of tobacco. Officials from institutions closely linked to tobacco production and regulation emphasized its strategic importance for the economy. According to these officials, tobacco is recognized as a vital crop that significantly contributes to foreign exchange inflow and agricultural exports. These sentiments were echoed by representatives from agencies responsible for financial support and rural development, who highlighted the substantial financial benefits derived from tobacco exports and their role in bolstering national revenues (Spasova Mijovic et al., 2022).

Contrary to the government's claims that tobacco is a strategic crop delivering high profits to tobacco farmers, the results of the national survey with farmers show that tobacco cultivation is not as profitable as suggested (Spasova Mijovic et al., 2022). The empirical research analyzes data from a comprehensive national survey covering current, former, and non-tobacco farmers to estimate the economic returns per hectare of land dedicated to tobacco cultivation and per kilogram of tobacco produced. The findings indicate that cultivating other crops yields higher earnings than tobacco farming. Additionally, tobacco cultivation is characterized as a labor-intensive activity demanding considerable effort and numerous work hours, leading to significant unpaid household labor costs. As a result, this suggests that diversifying into other crop production could provide tobacco farmers with more economically advantageous opportunities, enabling more efficient use of labor and enhancing overall profitability.

7. FINANCIAL SUPPORT IN AGRICULTURE: SUBSIDIES as DIRECT PAYMENTS

The financing of tobacco production in North Macedonia is governed by the Law on Tobacco and Tobacco Products, alongside the more comprehensive Law on Agriculture and Rural Development. These legal frameworks are supported by seven-year strategies and annual programs for agricultural financial support. Each annual program includes specific regulations detailing criteria for direct payments, the benefits of funds, maximum amounts, and payment methods. Regarding the tobacco subsidies, there are only three types in the observed period: Subsidies for manufactured and sold raw tobacco harvested the previous year, Subsidies for hiring creditors during the purchase of raw tobacco, and Subsidies for domestic production and refinement of certified tobacco seeds. The process for tobacco production, purchase, and direct payments (subsidies) follows this sequence:

Eligibility: Tobacco farmers must be registered in the Single Registry of Agricultural Holdings to receive subsidies.

Contracts: Farmers must have a contract with a registered tobacco buyer to legally cultivate tobacco. Contracts must be concluded by March 31 and must include purchase prices and quantities. The highest association of tobacco farmers must approve these contracts before they are signed.

Data Entry: Once contracts are signed, buyers must enter the contract data into an electronic system and provide a list to the regional unit of the Ministry of Agriculture within ten working days after the contract deadline. This data is crucial for processing direct subsidy payments.

Advance Payments: Early in the growing season, buyers make an advance payment to farmers, at least 15% of the value of the agreed tobacco, calculated based on the average purchase price of the last three years. This payment can be in raw materials, agricultural machines, or financial means and is later deducted from the total payment upon delivery.

Purchase Site Inspection: Before purchasing tobacco, the State Inspectorate for Agriculture inspects purchase sites to ensure all conditions are met.

Sample Validation: A commission, including representatives from the Ministry, tobacco buyers, the highest association of tobacco producers, and the state agricultural inspectorate, validates samples of tobacco leaves, which are then displayed at purchase sites.

Purchase Period: The purchase period runs from November 15 to the end of February. During this period, authorized appraisers determine the class and type of tobacco delivered.

Payment: Upon delivery, buyers pay farmers according to the contract price, deducting any advance payments.

Data Registration: Buyers must register all purchased tobacco quantities in the electronic system by March 31 of the following year.

Direct Payments: The Agency for Financial Support of Agriculture and Rural Development makes direct payments to farmers' transaction accounts starting in April (Official Gazette,

98/19, 27/20), (Official Gazette, 49/2010, 53/2011, 126/2012, 15/2013, 69/2013, 106/2013, 177/2014, 25/2015, 73/2015, 83/2015, 154/2015, 11/2016, 53/2016, 120/2016, 163/2016, 27/2019, 152/2019, 244/2019, 275/2019).³

Agricultural subsidies, or direct payments, are vital for achieving the goals of the National Strategy for Agriculture and Rural Development. These subsidies supplement farmers' incomes, help maintain their activities, and promote development and investment among larger producers. Financial support is linked to specific agricultural products, granted per unit of product delivered, livestock head, or area, and includes support for production inputs like seeds, seedlings, and fuel. The majority of direct payments are dedicated to crop production, accounting for 61% of the total in the period from 2014 to 2020 (Mijovic Hristovska et al., 2022).

Tobacco subsidies consistently represent the largest share of these expenditures compared to other crops. Initially, tobacco subsidies comprised a smaller percentage but reached their peak during the middle years, followed by a temporary decrease. Subsequently, there was a resurgence in the allocation, culminating in a significant proportion of the central budget by the latest data point. The trend for other crops, including vineyards and field crops, shows a similar pattern, with their highest allocations also occurring around the middle period, followed by a recent upward trend in subsidies. These trends in subsidy allocations are largely in sync with the overall dynamics between nominal GDP and central government expenditure, which are strongly correlated (Mijovic Hristovska et al., 2022).

7.1. Aligning North Macedonia's Tobacco Policy with EU Standards and WHO Guidelines

Since its EU accession process began in 2009, North Macedonia has been working to reconcile EU agricultural policy requirements and WHO anti-smoking mandates with its traditional support for tobacco farming. While the WHO Framework Convention on Tobacco Control discourages subsidies for tobacco, North Macedonia continues to prioritize it as an essential export. The EU's shift away from specific tobacco subsidies, introduced in 2010, reflects a broader trend of decreasing tobacco production across the Union. In response, North Macedonia's National Strategy for Tobacco 2021–2027 aims to transition from direct tobacco subsidies to indirect payments, aligning with EU standards. This strategy is designed to support the diversification of agriculture and encourage farmers to shift to alternative crops. It outlines financial plans to assist farmers during this transition, highlighting the necessity for structural adjustments in the agricultural sector and reallocation of subsidies to promote the cultivation of alternative, high-value crops.

8. DISCUSSION OF RESULTS

In 2021, tobacco production in North Macedonia covered approximately 3.2 percent of the country's arable land, yielding 24,329 tons across 15,457 hectares. This equates to an average yield of 1,574 kilograms per hectare. North Macedonia's tobacco industry is largely focused on the Prilep variety, which constitutes 84 percent of production. Most cultivation is concentrated in the Pelagonian and Southeast regions, accounting for 87.9 percent of the total yield (Mijovic Hristovska et al., 2022).

³ According to the Law on Tobacco, the authorized representative for exercising the rights of tobacco producers is the Highest Association of Tobacco Producers which brings together all tobacco producer associations of tobacco producers. The role of the Association is to actively participate in the process of tobacco purchase, through its representatives from the smaller tobacco producer associations, for which the Highest Association is entitled to a fee for organizing and representing the representatives of the tobacco producers' associations in the purchase of tobacco. The fee is 0.35% of the purchase price. Field coordinators sent by the Association have an important role to play in achieving a good grade rating for tobacco.

From 2006 to 2019, the descriptive statistics for North Macedonia's tobacco production are as follows:

- Mean (Average) Production: 25,159.57 tons
- Median Production: 25,495 tons
- Minimum Production: 17,087 tons
- Maximum Production: 30,280 tons

These indicators suggest relatively stable tobacco production levels in North Macedonia over the years. However, fluctuations in output could be influenced by external factors such as climate, subsidies, and market demand.

Comparing North Macedonia with neighboring countries and major global producers provides further insight into the country's production scale and subsidy system. For instance:

- **Regional Comparison:** Greece and Bulgaria produce considerably more tobacco than North Macedonia, with mean production figures around 37,000 tons and 36,000 tons, respectively, from 2006 to 2019.
- **Global Comparison:** Major producers like China and India dwarf regional output, with mean annual production figures exceeding 2 million tons and 700,000 tons, respectively. (Mijovic Hristovska et al., 2022).

Tobacco production in North Macedonia has remained relatively stable, with minor fluctuations over the years. This stability in output reflects the country's consistent focus on tobacco cultivation, supported by local subsidies and a reliance on tobacco as a key agricultural product. While production levels are much smaller compared to global figures, they form an essential part of North Macedonia's agricultural economy (Mijovic Hristovska et al., 2022).

European tobacco production has experienced a noticeable decline, particularly after 2004. This reduction could be attributed to shifts in agricultural policy, decreased demand, and an increase in regulatory measures around tobacco production and consumption in European countries. The decline suggests that European countries are progressively moving away from tobacco production, likely due to stricter health policies and economic shifts.

At the global level, tobacco production shows a more stable trend with minor decreases in certain periods. Major tobacco-producing countries like China, India, and Brazil contribute substantially to this stability. The global figures highlight North Macedonia's relatively small scale in the worldwide context but emphasize the country's regional importance.

In North Macedonia, tobacco subsidies represent a significant part of the agricultural budget, heavily supporting a single crop. Unlike countries with diversified or indirect support systems, North Macedonia's subsidies directly prioritize tobacco, potentially limiting support for alternative crops and diversification. The stability of North Macedonia's tobacco production in contrast to Europe's declining trend highlights the country's reliance on tobacco subsidies and the economic role of tobacco in supporting rural livelihoods. This comparative context underscores the need for North Macedonia to evaluate its subsidy policies carefully to maintain competitiveness and production sustainability (World Health Organization, 2023).

- **Direct Financial Subsidies:** Countries like the *United States* and *EU* offer substantial funding but distribute it across multiple crops or provide general agricultural support rather than focusing on tobacco alone, unlike North Macedonia's single-crop focus.
- **Input-Based and Loan Programs:** Countries like *Brazil* and *Zimbabwe* support tobacco but also provide resources to diversify or improve other crops. North Macedonia lacks this diversification support, maintaining a high dependency on tobacco.
- **Integrated Support Systems:** *ASEAN countries* and *Argentina* use tobacco excise funds or tax revenues to support broader agricultural infrastructure, income support, and alternative farming systems, whereas North Macedonia's focus remains primarily

on maintaining tobacco production without broader agricultural investment (World Health Organization, 2023).

In the Balkan region, North Macedonia's approach to tobacco subsidies stands out for its heavy emphasis on supporting tobacco as a primary crop, whereas other Balkan countries have more diversified or smaller-scale support systems (Mijovic Hristovska et al., 2022).

- Bosnia and Herzegovina provides tobacco subsidies at different rates, including direct payments of 767 EUR per hectare or 15% of output value. However, support is relatively limited and does not focus heavily on tobacco, allowing for more balanced agricultural support across crops.
- Serbia supports tobacco farmers primarily through input subsidies such as seeds and fertilizers, often at subsidized rates, but these programs do not receive the same intensity of focus as in North Macedonia, where tobacco remains a central agricultural priority.
- Tobacco production in Albania is small-scale and generally lacks the robust subsidy programs seen in North Macedonia. Government support is minimal, and there is a stronger focus on developing other agricultural sectors.
- Tobacco subsidies in Kosovo are minimal, with limited direct or input-based support for tobacco. Like Albania, Kosovo prioritizes other agricultural areas over tobacco, reflecting a shift away from tobacco dependency.

In summary, North Macedonia's approach is narrowly focused on tobacco, unlike other countries that balance support for tobacco with incentives for crop diversification, broader agricultural infrastructure, or sustainable farming practices. This heavy focus in North Macedonia could limit diversification opportunities compared to its regional neighbors, which are gradually reducing dependence on tobacco as a major agricultural product.

9. CONCLUSION

The extensive examination of tobacco production and subsidy policies in North Macedonia has underscored the intricate balance between economic benefits and the broader implications of continued tobacco cultivation. While tobacco remains a significant economic player in North Macedonia, contributing notably to exports and supporting thousands of rural households, the evolving global and regional dynamics prompt a critical reassessment of the sustainability of this approach.

The findings of this empirical research reveal that the substantial subsidies directed toward tobacco cultivation may not represent the most economically prudent use of national resources, especially in light of shifting market demands and health considerations. Moreover, as North Macedonia aspires to align with the European Union's Common Agricultural Policy, it faces the dual challenge of reforming its subsidy structure and fostering a more diversified agricultural sector.

Moving forward, policymakers must consider a gradual shift from tobacco to alternative crops that could provide better economic returns and environmental benefits. Such a transition will require robust support systems, including retraining programs for farmers, investment in agricultural innovation, and an effective communication strategy to manage the change.

In conclusion, while tobacco has historically played a pivotal role in North Macedonia's agricultural landscape, the time has come to strategically rethink its place in the economy. This empirical research provides a foundation for informed decision-making that could lead to a more sustainable and economically diversified agricultural sector, ultimately contributing to the country's long-term development and public health objectives.

10. RECOMMENDATIONS

Based on the analysis presented in this empirical research, the following recommendations are proposed to guide the strategic reorientation of tobacco subsidy policies and agricultural practices in North Macedonia:

1. **Gradual Reduction of Tobacco Subsidies:** Begin reducing the direct subsidies for tobacco gradually, reallocating these funds to support the cultivation of alternative, more sustainable crops. This phased approach will help mitigate the impact on farmers dependent on tobacco for their livelihood.
2. **Investment in Alternative Crops:** Invest in research and development for alternative crops that can thrive in North Macedonia's climate and soil conditions. Prioritize crops that have the potential for high market demand both locally and internationally, such as medicinal herbs, essential oils, and organic fruits and vegetables.
3. **Support for Farmers' Transition:** Provide comprehensive support for tobacco farmers transitioning to alternative crops, including financial incentives, technical training, and access to new markets. Establish partnerships with academic institutions and private sector stakeholders to facilitate knowledge transfer and innovation.
4. **Enhanced Rural Development Programs:** Develop and enhance rural development programs that focus on improving infrastructure, technology access, and market connectivity for farmers. This will help diversify the rural economy and reduce dependence on any single crop.
5. **Policy Alignment with EU Standards:** Continue aligning national agricultural policies with the European Union's Common Agricultural Policy, focusing on sustainability and reduced reliance on crop-specific subsidies. This alignment is essential for facilitating North Macedonia's EU integration process.
6. **Public Health Campaigns:** Implement public health campaigns to reduce smoking rates. These campaigns should be supported by part of the funds currently allocated to tobacco subsidies, promoting a healthier population and reducing the long-term healthcare costs associated with tobacco use.
7. **Monitoring and Evaluation Framework:** Establish a robust monitoring and evaluation framework to assess the effectiveness of the new agricultural policies and the economic impact of transitioning from tobacco. This framework should include clear benchmarks and timelines to ensure accountability and continuous improvement.

By adopting these recommendations, North Macedonia can create a more resilient agricultural sector that is better equipped to meet the challenges of the 21st century, while also enhancing public health and environmental sustainability.

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BRAIN DRAIN IN NORTH MACEDONIA: KEY FACTORS AND EFFECTIVE MEASURES FOR HUMAN CAPITAL RETENTION AMONG EMPLOYEES

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ABSTRACT

This paper aims to examine the push factors influencing the intention of employees in North Macedonia to emigrate and identify potential measures to reduce the "brain drain" or "human capital flight" phenomenon. The subject of the study focuses on the attitudes of employees regarding their intention to leave the country, considering variables such as salary growth, promotion opportunities, trust in state institutions, the availability of alternative employment within the country, and employment practices in the country. The research employs a survey methodology, involving 120 respondents from various demographic backgrounds to capture diverse perspectives on the push factors driving emigration. A methodical statistical procedure was applied using simple linear regression to determine the impact of each economic factor on employees' intentions to leave. Additionally, multiple linear regression was utilized to see how various push factors together influence the employees' intention to leave the country. The results reveal that 62% of respondents are inclined to leave the country, particularly younger employees aged 31-40 with higher education levels. The primary factor influencing this intention is the lack of alternative employment opportunities in North Macedonia. These findings underscore the need for targeted policies and measures to retain human capital and prevent further economic and demographic decline.

Keywords: Brain drain, Human capital, Migration, North Macedonia.

JEL Classification: J08, J6, O15.

1. INTRODUCTION

There is increasing acknowledgment of the risks associated with the uncontrolled recruitment of skilled workers in both developed and developing nations. Even though the dangers are well-known, minimal action has been taken to address the issue. In recent years, source countries have experienced a growing outflow of skilled labor, partly due to host countries increasingly favoring skilled workers in their immigration policies. This problem is particularly severe in small developing nations. Since human capital plays a crucial role in economic growth (Lucas, 1988), a significant brain drain could greatly hinder the development of the affected countries.

Interest in the topic of brain drain has recently been renewed, with numerous new papers being published and various international organizations and universities launching long-term research projects. For a long time, economists and activists from developing countries have raised concerns about the shortage of skilled professionals in their regions. However, the recent literature on the Macedonian case appears to be somewhat disconnected from these concerns expressed by those directly affected (young and employed individuals). This paper suggests that the "brain drain" should be considered similarly to how we view capital flight, and increased capital flight is treated as an indicator of the need for policy correction.

The Western Balkan region faces a significant demographic challenge marked by a decline in population due to youth emigration and low birth rates. The fact that most people emigrating are young, educated, and highly skilled poses a serious threat to the region's development. Despite progress in improving economic and social prospects over the past decade, structural challenges and socio-economic hardships continue to incentivize emigration from the Western Balkan economies (OECD, 2022).

Over a longer period, a dominant representation of emigration is characteristic of North Macedonia. The issue of brain drain is an important subject, particularly for developing countries like North Macedonia. The total emigration from North Macedonia takes place under the influence of numerous and diverse factors: changes in the socio-economic development of the country; unemployment; disrespect for labor; underestimation of expertise and limited opportunities for advancement in the profession; established migration links, as well as favorable changes in the immigration policies of the receiving countries as a factor that must not be underestimated. In the period after 2000, the number of young highly educated persons, as well as final year students from the faculties of technical and natural sciences who are thinking or planning to go abroad, is increasing (National strategy for networking, cooperation and reducing the outflow of highly educated and professional staff 2013-2020). According to the latest data from the World Bank, about 29.1% of highly educated individuals live and work outside the country, and the total percentage of expatriates is 21.9%.

The emigration, especially of young highly educated, and professional staff from North Macedonia, is significantly reflected in the aging process of the country's population. In recent decades, North Macedonia has faced numerous challenges arising from the existing economic and social conditions that have a direct impact on the population. While birth rates are decreasing, and thus the participation of young people in the overall structure of the population is decreasing, the number of old people is increasing more and more. All that implies changes in the quality of the labor force and a decrease in the level of human capital, and thus negative effects in the area of economic growth and development of the country. In the post-COVID-19 pandemic world, it's even more important to understand why developing countries should care about human capital and protect hard-won gains from being eroded.

A major challenge for North Macedonia is its weak education system, which does not meet labor market demands and serves as a significant incentive for emigration, particularly among the youth.

To address the issue of brain drain or human capital flight problems, the focus should be on analyzing and improving incentives rather than imposing restrictions. Therefore, in the analysis of the intention of the employees to leave North Macedonia, it is extremely important to recognize their interest in leaving and the reasons behind it and to promptly take appropriate mechanisms to prevent them, from retaining the talents that contribute to the economy in the country and have a significant share in the gross domestic product.

The subject of this paper covers the issue of the "brain drain" phenomenon, observing it through the prism of the attitudes of the employees in North Macedonia in relation to the factors that can influence their intention to go abroad, as well as, the measures that can be taken by the country in order to prevent this phenomenon and keep people in the country.

This paper aims to gain knowledge about the intention of employees in the country to leave it and go abroad, by analyzing the influence of five factors, namely: salary growth in their institution, opportunities for career advancement, trust in state institutions, the possibilities for alternative employment and the employment practices in the institutions (whether employment is carried out according to the competencies and level of education), as well as to determine, according to the employees, which are the most significant measures that should be taken by the country to reduce the intensity of brain drain phenomenon. After the introduction, Section 2 provides the literature overview on the brain drain phenomenon. Section 3 contains information about the data and methodology used. Section 4 of the paper presents the empirical analysis of the impact of push factors on the intention of employees in North Macedonia to emigrate and identifies potential measures to reduce the "brain drain". Finally, section 5 summarizes the results of the theoretical and empirical research included in the paper, with some general policy prescriptions and suggestions for further research.

2. LITERATURE REVIEW

Over the past four decades, developing countries have continued to experience a significant outflow of skilled professionals, despite efforts by both developed and developing nations to address the problem. While developed countries have implemented immigration reforms to limit the influx of migrants, and developing nations have taken measures to retain their skilled workforce, brain drain remains a persistent issue. The literature on brain drain spans several generations, offering diverse economic perspectives on its causes and consequences.

Despite the positive financial aspects highlighted by early studies (Solow, 1956; Grubel and Scott, 1966), the broader economic consequences of brain drain have been more critically examined. Beginning with studies from the 1970s (e.g., Mankiw *et al.*, 1992), economists started to emphasize the negative effects of brain drain on the intellectual capital of emigrating countries. The departure of highly skilled individuals reduces the knowledge base necessary for driving economic growth and innovation, which in turn hinders long-term development. Brain drain also creates social and economic gaps, particularly in the benefits of education and fiscal policy, which are not fully captured by remittance flows.

Other studies (Haque, 2005) recognize the need to focus on the role of human capital in driving economic growth, yet note that the international movement of talent has not received as much attention as the flow of physical capital. Economic theory suggests that a strong education system can promote economic growth, but many skilled professionals from developing countries leave due to limited opportunities at home. For instance, in less developed countries, such as Africa, the main drivers of migration include low levels of development, political instability, and wage disparities (Docquier *et al.*, 2007; Marfouk, 2007). These factors, combined with the allure of better career prospects and a more supportive research environment abroad, contribute to the persistent outflow of talent.

Gungor and Tansel (2014) found that family and social considerations, along with a lack of job opportunities in specialized fields, are critical in determining whether professionals return to their home countries. Mishra (2023) reinforces this finding in his study, where limited job opportunities and career prospects are the primary causes of brain drain. According to the study, creating a conducive environment for professional growth—particularly in sectors such as healthcare, education, infrastructure, and technology—can help retain skilled workers. The brain drain phenomenon in the region, particularly in Croatia, Serbia, Albania, and North Macedonia has become a critical issue, with significant implications for each country's demographic, economic, and social structures.

Hornstain Tomic and Taylor (2018) found that the emigration of tertiary-educated young people in Croatia has increased since the economic recession and EU accession, shifting the

discourse from national disloyalty to efforts to mitigate push factors and attract skilled migrants back. They highlight that education reforms are seen as crucial, though political disagreements have hindered progress, while the potential benefits of circular migration and the involvement of NGOs in promoting practice-oriented education have influenced recent policy discussions. Radonjic and Bobic (2021) argue that the massive emigration of educated individuals from Serbia causes significant deficits that cannot be solely measured in monetary terms, with deeper impacts on demographics, social cohesion, and local democracy. They also explored contemporary transnational migration perspectives and suggested policies to harness the potential of human capital, social networks, and circular mobility, focusing on the benefits of diaspora engagement and return migration.

Tataj and Akbas (2021) analyzed the relationship between human capital and the labor market in Albania, focusing on the impact of brain drain. The study highlights the role of international migration policies, particularly the EU's role in attracting skilled workers from developing countries like Albania. They estimated that Albania has become a sending country for its workforce due to the increasing number of young people migrating to the EU. Their study identified two key consequences: a decrease in the workforce and a crisis in the pension system, while also noting that despite being one of the youngest middle-aged countries in Europe, brain drain has led to population decline.

The existing research on brain drain in North Macedonia focuses on the reasons for brain drain among students or discusses the economic and demographic effects of emigration. Also, there are studies that analyze the trends and impact of brain drain on national growth and innovation, with a focus on educational outcomes and the general migration patterns of students.

The study by Nikolovska (2004) investigates the transitional challenges faced by North Macedonia since its independence in 1991, marked by high unemployment and poverty. It focuses on the migration of skilled labor, exploring the reasons for brain drain and existing policies to address it. The paper examines the rise in domestic students and those studying abroad, assessing the potential negative impacts and any possible benefits of skilled emigration. Nikolovski (2012) analyzes emigration and remittances as mechanisms for adjusting the Macedonian labor market. The findings suggest that men, urban workers, and job seekers are more likely to emigrate, while women and married individuals show less inclination. The paper concludes that emigration and remittances are primarily survival strategies rather than investment opportunities, emphasizing the need for targeted policy measures to support the most vulnerable unemployed populations in North Macedonia.

Janeska *et al.* (2016) discuss brain drain trends from North Macedonia over the last two decades, noting that since 2008, the country has been among the top ten globally for brain drain intensity. They found that the direct effects include slower economic growth and reduced innovation due to a decrease in human capital, and that few highly educated emigrants return. Brain drain also accelerates population aging and reduces the reproductive labor force.

The study of Dinkovski and Markovska-Simoska (2018) investigated the phenomenon of "brain drain" in North Macedonia, focusing on its effects on sustainable development. It highlights the trend of highly skilled and educated professionals emigrating from North Macedonia and the broader Balkan region to developed countries. The research analyzes the implications of this migration on the labor market and the transition process in North Macedonia compared to EU countries. Utilizing detailed questionnaires from students at various public and private faculties in North Macedonia, the study found that the brain drain poses a serious threat to sustainable development and emphasizes the need for national measures to address this issue.

3. METHODOLOGY AND DATA

To address the subject and achieve the aim of this paper, the following methods have been employed: descriptive analysis, historical method, methods of analysis and synthesis, quantitative and statistical methods, and methods of induction and deduction. A survey questionnaire was used as an instrument for data collection, which was conducted in the period June - July 2024. The target group of respondents included in the survey were employees from different sectors (public sector, private sector, non-profit organization) in North Macedonia, namely, a random sample of 120 respondents with different demographic characteristics. The questions in the survey questionnaire, in addition to the scope of questions to determine demographic characteristics (gender, age, education, etc.), also contain questions to determine the impact of salary growth in their institution, opportunities for career advancement, trust in state institutions, opportunities for alternative employment and employment practices in institutions (in terms of whether employment is carried out according to competencies and level of education) on their intention to leave the country. For the purposes of this paper, this questionnaire also helped in determining what are the most significant measures that, according to the employees, should be taken by the country to reduce the intensity of this problem. Thus, on a scale of 1 - 4, the employees ranked (according to the degree of importance) each proposed measure that, according to them, should be taken by the state to balance and reduce this problem. The measures that were proposed in the survey questionnaire and ranked by the employees are the following: Creating greater employment opportunities; Employees' salary increase; Improving the quality of education at all levels; Transition from brain drain to brain gain of highly educated personnel by increasing the level and volume of return of intellectual emigration from the Republic of North Macedonia and increasing awareness of human capital development; Greater role of employment agencies for the most successful students and apprentices in their profession; Motivating scholarships and financial relief for the most successful students when continuing their education in the second and third cycle of studies; Opening of state career centers that will monitor talented and successful students and that will guarantee their appropriate employment after completing their education and Preference in the employment of the most successful students without the need to obtain consent from the relevant ministries during employment.

The questionnaire was conducted through the electronic service for collection and analysis of research data "Kwik Surveys", as well as sent electronically (via e-mail and social networks) to the respondents.

To investigate the subject and the aim set in this paper, the following hypotheses have been set:

Alternative hypothesis 1: The salary growth in the institution has a statistically significant influence on the intention of employees in North Macedonia to leave the country and go abroad.

Alternative hypothesis 2: Opportunities for career advancement in the institution have a statistically significant impact on the intention of employees in North Macedonia to leave the country and go abroad.

Alternative hypothesis 3: Trust in state institutions has a statistically significant influence on the intention of employees in North Macedonia to leave the country and go abroad.

Alternative hypothesis 4: Opportunities for alternative employment in the country have a statistically significant impact on the intention of employees in North Macedonia to leave the country and go abroad.

Alternative hypothesis 5: Employment practices in the institutions have a statistically significant influence on the intention of the employees in North Macedonia to leave the country and go abroad.

Alternative hypothesis 6: Salary growth in the institution, opportunities for career advancement in the institution, trust in state institutions, opportunities for alternative employment, and

employment practices in the country do not have an equal impact on employees' intention in North Macedonia to leave the country and go abroad.

Alternative hypothesis 7: The most significant measures that country authorities should pay more attention to reduce the brain drain phenomenon are: increasing the salaries of employees and creating greater employment opportunities.

Therefore, the question of the extent to which employees in North Macedonia agree with the existence of certain economic factors and conditions in their institution, as well as in the country, was related to the question of determining the intention of the employees to leave the country and going abroad. Therefore, the methodical statistical procedure of *simple linear regression* was applied, through which it was possible to determine the impact of each economic factor on the intention of employees to leave (*Alternative hypothesis 1 to 5*), as well as *multiple linear regression*, to identify those factors that have the greatest impact on the analyzed dependent variable – the employees' intention to leave the country, i.e. to see how various factors together influence the employees' intention to leave the country (*Alternative hypothesis 6*).

4. RESEARCH FINDINGS AND DISCUSSION

Before presenting the regression analyses, it is important to first highlight the interest of the country's employees in going abroad, based on their age and level of education. Specifically, 62% of the employed respondents expressed a willingness to leave the country, with 61% of them being aged 31 - 40. Additionally, 53% of these individuals possess higher education degrees, and 28% hold a master's degree. This profile of employees willing to emigrate poses a significant threat to the country's demographic structure, accelerating the aging population, while also undermining its economic potential and development. The loss of skilled professionals not only diminishes the labor force but also weakens the foundation for future growth and innovation.

The findings from the *simple regressions* conducted are summarized and presented in Table 1. Based on Table 1, it can be concluded that *there is a positive correlation* between all analyzed factors and the intention to leave the country among employees in North Macedonia. Pearson's correlation coefficient ranges from 0.091 for opportunities for career advancement in the institution to 0.315 for opportunities for alternative employment in the county. The coefficient of determination (r^2) measures the strength of the relationship between the fitted model and the dependent variable on a scale from 0 to 1. In this case, the coefficient of determination ranges from 0.008 to 0.099. Typically, the higher the value of r^2 , the better the regression model matches the observed observations. But models with a low value of r^2 (as in the example analyzed), are also well-fitted models, and this is so for several important reasons. Namely, certain scientific fields exhibit inherently higher unexplained variation, and in these, the value of r^2 is lower. For example, analyses of the coefficient of determination in which the focus is placed on the person and his behavior, show values that are lower than 0.5. This is because human resources are more complex to predict than other types of resources. Also, if the model shows a low value of r^2 , and at the same time the independent variables are statistically significant, significant conclusions can still be made about the relationship between the analyzed variables. A low value of the coefficient of determination does not negate or reduce the importance of any significant variables, as statistically significant p-values continue to identify relationships, and hence the coefficients have the same interpretation.

Table 1: Simple regression – economic factors and conditions in the institution/country and the intention of the employees in North Macedonia to go abroad

	Coefficient b_1	Pearson correlation coefficient (r)	Coefficient of determination (r^2)	p -value
Salary growth in the institution	0.076	0.155	0.024	0.091
Opportunities for career advancement in the institution	0.043	0.091	0.008	0.322
Trust in state institutions	0.136	0.143	0.020	0.120
Opportunities for alternative employment in the country	0.187	0.315	0.099	0.000
Employment practices in the country	0.090	0.124	0.016	0.175

(Source: Authors' calculations)

In this analysis, the slope coefficient b_1 ranges from 0.043 for opportunities for career advancement in the institution to 0.187 for opportunities for alternative employment in the country. In other words, it means that if the opportunities for alternative employment in the country (in terms of lack) increase by 1 unit, the intention to leave the country among employees will increase by 0.187 units.

The p -value for the opportunities for alternative employment in the country is the only which is lower than the significance level " α ", which means that we can *accept the fourth alternative hypothesis*, or *opportunities for alternative employment in the country have a statistically significant impact on the intention of employees in North Macedonia to leave the country and go abroad*.

In terms of *multiple regression*, five independent variables (regressors) and one dependent variable (regressand) are included. The independent variables are the five push factors (salary growth in the institution, opportunities for career advancement in the institution, trust in state institutions, opportunities for alternative employment in the country and employment practices in the country), while the dependent variable refers to the employees' intention to leave the country and go abroad.

Table 2 presents the slope coefficient (b_1) and the p -value. In multiple regression, there is a change in the values of the b_1 coefficient of each of the analyzed factors, as well as in the p -value, because this statistical method measures the influence of mutual dependencies and interactions of several phenomena at once. The slope coefficient ranges from -0.017 for employment practices in the country to 0.176 for the opportunities for alternative employment in the country. Again, it is essential to state that the coefficient of multiple determination r^2 has a low value and is 0.106.

Table 2. Multiple regression – economic factors and conditions in the institution/country and the intention of the employees in North Macedonia to go abroad

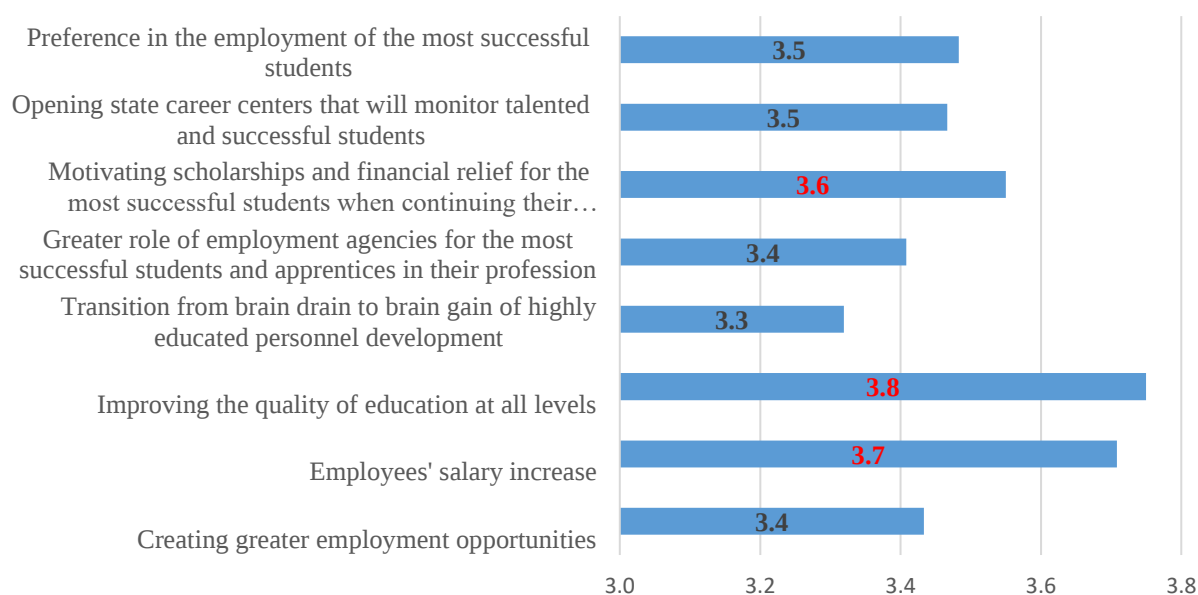
	Coefficient b_1	p -value
Salary growth in the institution	0.044	0.430
Opportunities for career advancement in the institution	-0.020	0.702
Trust in the state institutions	0.039	0.667
Opportunities for alternative employment in the country	0.176	0.004
Employment practices in the country	-0.017	0.818

(Source: Authors' calculations)

As shown in the analysis, opportunities for alternative employment in the country have the most significant influence on the intention to leave the country. This is supported by a p -value that is lower than the significance level " α ," indicating statistical significance for this variable. In contrast, the p -values for the other independent variables show statistical insignificance, highlighting that alternative employment opportunities play the most critical role in shaping employees' decisions to leave the country. This confirms the sixth alternative hypothesis, i.e. *the growth of the salary in the institution, the opportunities for career advancement in the institution, trust in state institutions, opportunities for alternative employment in the country, and employment practices in the country do not have an equal impact on the intention of employees in North Macedonia to leave the country and go abroad.*

According to the employees surveyed, the most impactful measures the government can adopt to reduce the outflow of young intellectuals and increase retention include improving the quality of education at all levels (mean value 3.8), employees' salary increase (mean value 3.7) and motivating scholarships and financial relief for the most successful students when continuing their education in the second and third cycle of studies (mean value 3.6). These measures are closely related to the increase of greater employment opportunities. The improvement of the quality of education on its part guarantees greater and better opportunities for employment, and also the facilitation of the best students by providing scholarships with which they would be stimulated to continue their education at higher cycles may contribute to greater employment opportunities as a result of the expertise that this highly qualified personnel would bring with them to their workplaces. The analysis of the mean values supporting these conclusions is presented in Figure 1.

Figure 1: Employee views on government strategies to mitigate brain drain in North Macedonia – mean value



(Source: Excel analysis, 2024)

Based on the results, *the last alternative hypothesis is also accepted, that is, the most significant measures that country authorities should pay more attention to reduce the brain drain phenomenon are: increasing the salaries of employees and creating greater opportunities for employment.*

5. CONCLUSION

The findings of this study underscore a critical issue facing North Macedonia: a significant portion of its skilled labor force, especially younger professionals, is considering emigration due to unfavorable economic and professional conditions. With 62% of surveyed employees expressing an intention to leave, particularly those aged 31 - 40 and those with higher education or advanced degrees, the country faces a potential loss of intellectual capital, which could severely impact its economic and social development. This trend threatens to accelerate the aging of the population, exacerbate skill shortages, and reduce the pool of future leaders, innovators, and entrepreneurs who are vital for national growth. This is consistent with the European Commission study “Social Impact of Emigration and Rural-Urban Migration in Central and Eastern Europe” for 25 countries (based on the World Bank data), where North Macedonia stands out with the highest emigration rate of the tertiary educated persons in the group of the candidate countries for membership in the European Union.

The study identifies the lack of alternative employment opportunities as the most significant factor influencing the decision to emigrate, more so than other factors analyzed in the paper. The results indicate that the most urgent and impactful measure is to create diverse and sustainable employment opportunities that align with the skills and aspirations of the country’s labor force.

According to the European Training Foundation (2021), engineers, then medical staff, and more recently also staff from other areas are covered by emigration movements. Regardless of the growing interest of young people in the faculties of technical sciences and the doubling of the number of students of medical sciences, and consequently, the increase in the number of

graduates from these fields, a continuous shortage of engineering staff and doctors is evident. High-skill emigration exists in other sectors, too (sales and marketing support, economic consultancy). Therefore, while alternative employment opportunities are identified as the most significant factor, North Macedonia should delve deeper into these specific sectors which could most effectively retain talent.

The issue of brain drain in North Macedonia has been acknowledged by policymakers as a critical challenge. The primary document addressing this matter, The Resolution of Migration Policy of the Republic of North Macedonia 2021-2025, outlines the current migratory trends and establishes a policy framework aimed at mitigating the migration issue. This resolution includes tools designed to reduce the impact of migration and sets forth specific goals and actions to address it.

The objectives and actions according to the Resolution should focus on:

1. Establishing conditions to reduce the intensity of emigration by identifying and addressing the key factors driving large-scale permanent migration;
2. Supporting temporary emigration and promoting labor force circulation from North Macedonia; and
3. Encouraging return migration while facilitating the reintegration of Macedonian citizens back into the country.

In addition to the first objective, implementing targeted scholarship and job placement programs in critical sectors, such as IT or engineering, would include incentives for graduates to remain in the country, such as competitive salaries, career development opportunities, and housing subsidies, to reduce the push factors driving permanent emigration. Creating bilateral agreements with EU countries that allow North Macedonian workers to engage in temporary employment abroad while ensuring their return would support temporary emigration and promote labor force circulation from North Macedonia. As part of the third action, engagement and information strategies are key, alongside financial incentives. Reintegration support includes a range of services like counseling, tailored advice, and assistance with employment, housing, education, and welfare. In practice, North Macedonia could adopt a comprehensive "return migration" program offering such incentives and support, including tax breaks, business start-up grants, and reintegration services, to help returnees transition smoothly and contribute to the domestic economy.

Therefore, by implementing well-designed, inclusive, and sustained measures, North Macedonia can reduce the outflow of skilled professionals and turn this challenge into an opportunity for growth.

While this study provides valuable insights into the factors influencing the brain drain phenomenon in North Macedonia, it suggests avenues for future research. The analysis primarily focuses on a sample of employees from diverse sectors within the country but could be extended to capture a more comprehensive range of educational levels, age groups, and other demographic and sector characteristics to better understand the degree of emigration intentions among different segments of the population. Additionally, future studies could benefit from including comparative analyses with similar countries experiencing brain drain, particularly those in the Western Balkans or other developing regions. Such comparisons could help identify common patterns, shared challenges, and effective policy measures tailored to each country's specific context, thereby offering a broader perspective on how to mitigate the impact of brain drain across various socio-economic landscapes.

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PLASTIC WASTE MANAGEMENT IN NORTH MACEDONIA: A COMPARATIVE ANALYSIS WITH WESTERN BALKANS AND SELECTED EU COUNTRIES

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ABSTRACT

This paper aims to compare North Macedonia as an EU candidate country, to the Western Balkan countries in circular economy movements. It shows that the country still struggles with advancing circularity and is more focused on waste management practices, which also do not function well. Lack of waste separation, weight equipment, and qualitative waste data with limited access to funds, finance, and knowledge are possible reasons. Plastic as a future raw material which is gaining more attention at a global scale is not even a priority in the Macedonian economy. This paper gives for the first time a link between plastic waste and the circular economy in North Macedonia, highlighting the economic sectors and the role that EPR schemes are playing in increasing higher recycling rates, compared with other materials used for packaging. In the end, the authors compare the country with developed EU countries like Slovenia and Germany to examine the effects of higher communal fees would contribute to a more efficient municipal waste system, by using the municipal costs as a percentage of GDP per capita, minimal wage and Income and Living Conditions Indicator.

Keywords: *Western Balkan, Municipal waste, Waste management, Circular economy, European Union, Republic of North Macedonia, Plastic, Resource productivity.*

JEL classification: *F63, Q53, Q52.*

1. INTRODUCTION

Faced with threats from the negative effects of climate change and standing at the door of the European Union as a full membership candidate country, North Macedonia, as well as the countries of the Western Balkans, are very interested in the benefits of the circular economy model. The replacement of the classic linear model in which resources are used once and end up being thrown away as waste at a landfill, simultaneously losing their added value, with the concept of a circular economy is of particular importance for the countries of the Western Balkans. Their economies are based mainly on economic sectors that further undermine linear resources, such as mining, agriculture, construction, or tourism, and the citizens of these national economies face air quality that is among the worst in the world.

The competitiveness of the companies from North Macedonia and the Western Balkans is also under attack from the high competition from the EU, which is the region's largest trade partner, with a share of 70% of the region's total trade exchange (Aspen Institute Germany, 2022, p.41). Therefore, the circular economy should contribute through sustainable development, the

creation of additional jobs, and more efficient use of resources from the region to enable a safer economic transition to the European family. However, unlike most EU countries, the Macedonian as well as Western Balkans economies still associate the circular economy primarily with activities in the area of waste management and its management, at a rather low basic level.

Although the amount of waste generated per capita is increasing both in North Macedonia and the region, the waste management system is not efficient enough to respond to the growing expansion of resource utilization in these economies. Instead, it is mostly thrown into landfills, and the low rates of recycling compared to the European average, as well as the selection by citizens at the place of generation of waste in households is a challenge that has yet to be implemented in the Macedonian economy. Positive rates in terms of increased participation in the selection and recycling of individual types of waste can be attributed primarily to extended responsibility schemes, which try to encourage innovation and increase the participation of recycled waste. However, in the absence of a state functional system that will complement them and jointly cooperate with producers of extended responsibility by offering them adequate infrastructure, the challenge for a detailed restructuring of the entire national system of waste management in the Macedonian economy remains.

Yet, one of the most important problems is the reliability of data on the waste amounts in the WB countries, not only due to the lack of equipment for adequate waste measurement, but also due to the suboptimal access to quality reliable databases for individual countries. More detailed sectoral analyses are also missing in this section, but also in the section of materials that can be future raw materials and resources on the market, such as the case of plastic.

This paper is the first attempt in North Macedonia to look at the circular economy through the lens of plastic. In a society where households are not in the habit of sorting waste, we cannot expect plastic data to be available for academia research. While global and European trends place plastic high on the agendas of circular development strategies, in WB countries, plastic is prioritized only in the Circular Economy Roadmap strategies of Albania and Serbia.

The idea behind the research in this paper is to show that not always due to lack of finances, the state can find excuses for non-functionality in waste management. The examples of more developed countries from the EU such as Slovenia and Germany through descriptive examples give an idea of how our economy can profit from the selection of waste, at the same time not raising the price of waste management which is paid by the citizens as a communal fee. Another added value of the paper is the attempt of the authors to give an overview of plastic through circularity in the country with the available data for processing and in certain areas of the circular economy to compare the situation of Macedonia with the countries of the Western Balkans. The role of EPR schemes and the application of European legislation is clearly captured here, which indirectly creates development in recycling rates through harmonization and adoption of experiences and rules from more developed countries. This can be noticed in the area of plastic and plastic packaging.

For the first time, the relative participation of plastic is calculated, and a clear picture is given of how much the Macedonian business community participates in the fulfillment of European and national goals in the management of plastic waste. The EU dictates the pace, but does the Macedonian economy, apart from declaratively, follow the European trend qualitatively as well?

2. LITERATURE REVIEW

Since the publication of the first report Towards the Circular Economy, quantifying the possibility of the Circular Economic Forum in 2012 (Ellen MacArthur Foundation, 2013), the Western Balkan countries need a whole decade to finally put the circular economy model into

Strategy Roadmap on a national level. Serbia was the first country who develop the *Roadmap for Circular Economy* document (UNDP, 2020) highlighting the manufacturing industry, agriculture and food, plastics and packaging, and construction as priority sectors. Two years later in that country also the Circular Economy Development Programme (2022 – 2024) was adopted, as a complex and comprehensive document that defines the areas of waste management, water, renewable energy sources, and energy efficiency (The Government of the Republic of Serbia, 2022). As an outcome of collaboration between the Montenegrin Chamber of the Economy, UNDP, Circular Change and Deloitte BiH, Montenegro has developed such a Roadmap in 2022 (UNDP, 2022) with five focus areas (food and forest systems, the built environment, tourism and manufacturing) that are highly interconnected and, through the principles of industrial symbiosis and synergies, can result in systemic change, followed by strategy for circular transition with an action plan (Ministry of Economic Development and Tourism of Montenegro, 2022). Kosovo developed such a Roadmap in 2023, and North Macedonia together with Albania developed Roadmap in 2024 (OECD, 2024). Bosnia and Hercegovina is the only WB countries that still do not have a developed Roadmap toward the circular economy.

In comparison, the EU had the first circular economy action plan adopted in 2015, followed by a new one, who was adopted in 2020, with the European Strategy for Plastics being part of it, adopted in January 2018, putting plastic among the priority areas as a key element of Europe's transition towards a carbon neutral and circular economy. As the European Commission lately pays attention to microplastics as part of the circular economy, unfortunately, the WB countries have still trouble making a difference between circular economy and waste management approaches. Although the EU in May 2023 has revised the Circular Economy Monitoring Framework (European Commission, 2023) with Waste Management being only one of 5 indicators measuring the circularity progress, WB countries are lacking a comprehensive approach towards measuring circular economy progress. Waste management stays in focus in WB countries, but here also data and information stay largely insufficient, although many initiatives are in place to improve data quality (EEA, 2022). The lack of comprehensive, innovative, and comparative academic research in the circular economy field, especially in plastic, is noticed by the authors of this paper. While OECD through the Report for *Western Balkans Competitiveness Outlook 2024: Regional Profile*, 2024 gives under the Greening Cluster insight into the Circular economy progress in WB countries underlying that „the circular economy is gaining momentum in the WB, to transition to a circular economy, the region will need to shift its focus from waste management to policies that also target more circular production and consumption”. From the research from EEA, OECD, Eutopia, and Eunomia, authors agree that only minimal positive trends can be seen in waste collection offer and recycling rates in the EPR schemes, but appropriate waste management is still a challenge for the WB, which is one more reason why EU and other international funds have to stay open and available for further WB development in this field. This manner speaks also to the fact that North Macedonia and other WB countries (especially Skopje, Tirana, and Podgorica) have one of the highest plastic leakage rates into the Mediterranean through rivers (estim.3,2kg per person in the year for NM) (Boucher, J.et al., 2020). Cross-border pollution from WB in the EU can be evident also in air pollution where “the air quality across WB is among the lowest in the world” (JRC, 2022), and annual average concentrations of PM 2,5 remain on average almost four times higher than WHO recommended levels of 5UQ/m3” (EEA, 2023). With the fact that microplastic have the potential to travel a long distance and undergo several cloud processes through atmospheric transport (Xu *et al.*, 2023), the EU should not close funds to help WB countries towards a cleaner and more circular economy in the future. For this, according to Ingnjatovic *et al.* (2024) circular economy might be an appropriate approach toward green transition, since the WB region has 5 times lower resource productivity than the

EU, while the generation of waste (excluding major mineral waste) per GDP is almost the same.

From above it is clear that academic research in the field of circular economy, waste management improvements, and plastic analyses are more than welcome to spread awareness among all stakeholders in every WB national economy and raise a discussion from which often ideas for further collaborations and projects could be introduced.

2. CIRCULAR ECONOMY, MUNICIPAL WASTE AND PLASTICS IN NORTH MACEDONIA

2.1. Circular economy scores in North Macedonia and WB countries

From its initial focus on minimizing the generation of waste and recycling it, the circular economy has undoubtedly grown into a broad approach to resources aimed at making them more sustainable, while creating more jobs, less dependency, and a cleaner environment. While interest in the circular economy model is growing, "the global economy is only 9% circular" (WBCS online), a clear indication that "one possible reason for this is that it is still more cost-effective and requires lower costs to produce products." from natural primary resources and discard them after use than to preserve goods, components, and materials in use at their highest utility at any time" (Steinfatt, 2020). In other words "...efficiency in production and spreading waste is higher than efficiency in collecting and removal of that waste" (Hardin, 1998, p.10). Compared to the environment policy of the countries of the Western Balkans, North Macedonia is keeping pace with the WB6 countries average. However, in the area of evaluation of the national efforts for a circular economy, the country records below-average achievements (OECD, 2024, p.190).

Table 1: North Macedonia's scores for circular economy and environment policy

North Macedonia's scores for environment policy					
Dimension	Sub-dimension	2018 score	2021 score	2024 score	2024 WB6 average
Environment	13.1: Climate action			2.3	2.5
	13.2: Circular economy			2.0	2.2
	13.3: Protection of ecosystems			2.3	2.1
	13.4: Depollution			2.3	2.3
North Macedonia's overall score		1.6	2.3	2.3	2.3

(Source: OECD, Western Balkans Competitiveness Outlook 2024, North Macedonia, OECD Paris, 2024, p.190)

The first Circular Economy Roadmap in the country was published on March 26th, 2024, with the help of the OECD. Compared with the countries of the Western Balkans, North Macedonia together with Albania is the last country to develop a circular economy strategic document. Serbia published such a document in 2020, Montenegro in 2022, and Kosovo in 2023. The priority areas in which the Macedonian economy decided to develop the circular economy are circular business models for small and medium enterprises, construction, bioeconomy (biomass and food), textile products, mining, and metallurgy. In these priority areas, between seven and 10 recommendations for the short, medium, and long term, as well as relevant examples of good practices with appropriate indicators for evaluation and monitoring, are foreseen.

However, unlike Serbia and Albania, North Macedonia does not place plastic as a priority area for the development of the circular economy. In the world and the European streams of circular economy, plastic ranks high on the agendas of governments of developed economies, because plastic is a material created from polymers, and cannot be decomposed in nature within five

centuries when it breaks down into microplastics that never disappears (Prairie Research Institute, 2021 online).

2.2. Waste management and plastics

The conditions in North Macedonia show that the country is up to the challenge of managing waste and, above all, affecting its reduced new production, which is the first principle in the EU hierarchy for waste management. Even the country's foreign trade relations should be seen through the prism of waste management and the circular economy, and plastic is gaining more and more importance in those flows as well. "...The annual trade in plastics currently accounts for about 5% of the total global trade or over 1.2 trillion US dollars in 2020, of which 2% is actually waste..." (WTO online, 2021). Yet statistics and data available for detailed research in this area, especially in the part of plastics are limited and the authors of this paper tried to come up with some kind of analysis to reflect the situation in the Macedonian market.

In North Macedonia, the total waste in 2023 amounted to 873,303 tons, of which 621,686 tons were collected as municipal waste. Compared to 2022 (when the total generated waste in the country was 856,766 tons), the collected waste increased by 2.6%, due to the increased number of populated areas included in the municipal waste collection system (State Statistical Office of the Republic of North Macedonia, 2023).

A comparison of the types of waste by quantity shows that mixed municipal waste takes the first place (85.4%), followed by organic municipal waste (6.4%), and plastic at 2.3%. Paper accounted for only 1.7%, glass for a minimal 0.5%, and metals such as iron, steel, and aluminum for 0.3%. The least amount collected was rubber waste (See Table 2, State Statistical Office of the Republic of North Macedonia, 2023).

Table 2: Amount of collected municipal waste in 2023 in North Macedonia, by type

Amount	Waste type	% of total
621686	total	
531033	mixed municipal waste	85,41
39690	organic waste (food, leaves, etc.)	6,38
14532	plastic	2,34
11920	other	1,92
10914	paper	1,75
6695	textile	1,08
3397	glas	0,55
1301	rubber	0,21

(Source: State Statistical Office, Republic of North Macedonia, Municipal waste 2023)

The annual amount of municipal waste generated per capita was 503 kilograms (7.7% more than the previous year), and the majority of the waste is disposed of in landfills (99.8%). A more detailed analysis reveals that 82% of the collected municipal waste comes from households, while 18% comes from legal and citizens (commercial waste). This means that North Macedonia urgently needs a circular approach that views waste management from a business perspective, as an irreversible consumption of resources. A full 18% of the waste, or nearly one-fifth, comes from the business sector, which, unfortunately, fails to find a way to offer it as a resource for the needs of related industries or to recycle it. When comparing the total collected municipal waste in our country to the European average in 2022, according to Eurostat, North Macedonia is below the European average of 513 kilograms of waste per capita for the same year (See Table 3).

Additionally, when comparing our national economy to economies from WB, only Montenegro and Serbia had higher municipal waste per capita for 2022. In Germany, municipal waste in 2022 amounted to 593 kilograms per capita, which is 80 kilograms more than the European average. Considering that Germany has over 80 million residents, this represents an enormous amount of municipal waste, yet they lead in its processing. In Slovenia, which has a population size similar to North Macedonia, each resident produced an average of 487 kilograms of municipal waste annually in 2022, which is below the European average. Macedonian citizens, compared to Slovenians, generate 20 kilograms less municipal waste per capita annually (2022 data) (Eurostat, 2024).

Table 3: Municipal waste generated, kg per capita, 1995-2022

	1995	2000	2005	2010	2015	2020	2022	Change 2022/1995 (%)
EU	467	513	506	503	480	521	513	10.0
Germany	623	642	565	602	632	641	593	-4.8
Slovenia	596	513	494	490	449	487	487	-18.2
Bosnia and Herzegovina	:	:	:	340	352	352	:	:
Montenegro (*)	:	:	:	494	530	486	537	:
North Macedonia	:	:	:	381	441	441	467	:
Albania	:	:	:	:	491	369	295	:
Serbia	:	:	:	363	259	427	472	:
Türkiye	441	465	458	410	424	415	382	-13
Kosovo (*)	:	:	:	:	252	255	:	:

(Source: Eurostat, Municipal waste statistics, Eurostat, Brussels, 2024)

Data provided by the State Statistical Office of North Macedonia is concerning, indicating that only 86% of citizens in our country use the municipal waste collection system, while a high 14%, especially in rural areas, dispose of waste wherever convenient, often along roadsides or by burning it in the open, polluting the environment (State Statistical Office of the Republic of North Macedonia, 2023).

According to the 2021 report by the European Environment Agency on North Macedonia, the main problem lies in the lack of funds and resources to improve waste management in the country. "...The budget needs to be allocated to improve waste management, close illegal landfills, introduce separate collections, and expand the area where municipal waste is collected. The structure of fees does not encourage waste prevention and recycling. The introduction of landfill taxes could promote increased recycling, but dumping waste in landfills will remain a challenge as long as it is considered the cheapest option (European Environment Agency, 2021, p.4). The report also states that the dominant method of waste collection is without separation, and the separation rate hovers around 0.3%, which is a very low level. In comparison, the average recycling rate of waste in the EU in 2022 was 48% (Eurostat, 2024). The EEA report also highlights that "...municipal waste is collected for recycling mainly by informal waste collectors, who collect waste from landfills, containers, and bins..." (EEA, Ministry of Environment and Physical Planning of the R.N. Macedonia, 2021, p.15). The same applies to the collection of plastic.

According to the Ministry of Environment and Physical Planning, more than 150 registered entities collect, store, and treat waste such as paper, plastic, and scrap metal, employing a total of 4,385 people in 2019. However, unofficial estimates suggest that around 5,000 people actively contribute to the collection and separation of waste from landfills and containers (EEA, 2021, p.15). The information above makes it clear that the issue of financial subsistence for all informal and unofficial waste collectors adds an additional burden to the state, which must address it alongside the already cited problems of insufficient funds for waste management, its separation, and recycling. The black market on which informal collectors continue to operate will fall on the shoulders of the state (social insurance), and without a national plan for solving

the problem, it remains overlooked by political authorities. Additionally, most of these waste collectors belong to the Roma community, and every administration in the country avoids addressing inter-ethnic issues. However, the state is making small steps toward improvement. For example, Eunomia states that "...at the Drisla landfill, some collectors of PET plastic bottles, which they used to bring to the landfill, are now formally employed there..." (EEA, 2021, p. 15).

If we can rely on the accuracy of the waste data in North Macedonia according to the State Statistics Office, the comparison of the total plastic waste (14 532 tons in 2023) with the data from EPR collective operators for collected plastic waste in 2023 (8856.7 tons) show that about 61% of the total plastic collected in the country is directly related to the work of the EPR actors. Statistics Office data are disappointing on selected waste by Macedonian households. Hence, the EPR schemes mandated by the EU legislation, which our economy follows and implements as a candidate country, are of positive significance, because it offers the opportunity for businesses to perform where the state cannot easily organize, usually due to a lack of finances, staff or unattractive political moves.

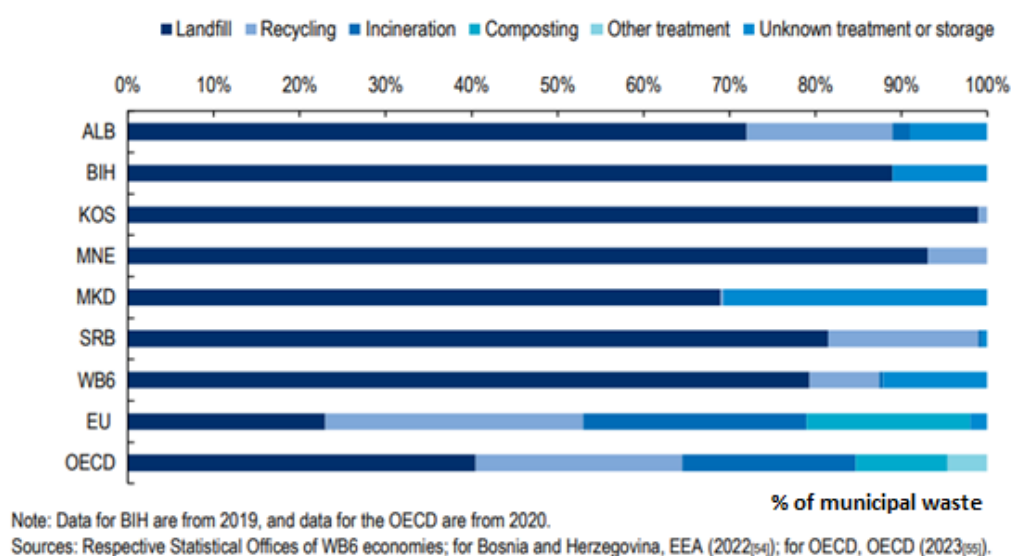
2.3. EPR analyses for plastic packaging and waste in North Macedonia

The analysis of the Macedonian market, Ministry of Environment and Spatial Planning of the RN. Macedonia, 2022) reveals that out of a total of 22,309.2 tons of plastic released by collective operators on the Macedonian market, only 8856.76 tons collective actors manage to collect plastic, which is about 40% of it. Of that 40% collected plastic, a total of 3,663.91 tons are recycled, and 5,192.85 tons are exported. In terms of percentages, a total of 16.4% of the plastic placed on the Macedonian market (produced or imported) is recycled, and 23.3% is exported from the country. The rest of the registered plastic, unfortunately, ends up in mixed waste and landfills, becoming a big concern for all eco-activists and a burden we leave unresolved for future generations.

A more detailed analysis of the data points to the fact that the interest in collecting paper among collective operators is much greater and they manage to collect as much as 24 547.47 tons of paper or 93%, which is a much higher percentage than plastic. Most of the paper collected ends up as export, 81%, and only a small percentage of 12.1% is recycled. There is similar interest in collecting metal as a type of material, which out of a total of 3971 tons, even 2814 tons are collected again, which is a percentage of 71%, of which the largest part ends up as export 70%, and only 30% of the collected metal is recycled with us. In the case of glass, the data show that almost half of the glass put into circulation by collective operators is collected again and most of it, almost all of it, is exported from the country.

In developed countries, landfill is the last circular economy waste treatment option, but in the Western Balkan countries, more than 83% of waste is disposed of in landfills, with only a small amount recycled (OECD, 2024, p.232). This is probably because illegal waste disposal in dumpsites or unsanitary landfills requires no fees. Also, open burning of waste is not a rare case in rural areas in North Macedonia and WB countries, and sometimes plastics are part of it. In comparison to the EU landfill situation, WB countries are far behind, which is alarming, keeping in mind that WB economies have witnessed a constant increase in waste generation per capita.

Figure 1: Municipal waste treatment in WB, EU and OECD countries



(Source: OECD, *Western Balkan Competitiveness Outlook 2024, Regional Profile*, OECD, Paris, 2024, p.232)

Plastic waste in 2022 in North Macedonia, calculated by the sector of economic activity in which it is generated, is mostly present (in quantity) in the sector of water supply, wastewater disposal waste management, and environmental remediation activities, with the participation of 6,313 thousand tons. In second place, the most plastic waste is created in the processing industry with a total of 5588 thousand tons, followed by construction with 1325 thousand tons of plastic waste. There are 32 thousand tons of plastic waste in mining, and 27 thousand tons of plastic waste in the energy sector (supply of electricity, gas, steam and air conditioning). The remaining 15,300 thousand tons of plastic waste were generated in other service activities. All plastic waste falls into the category of non-hazardous waste. According to the State Statistics Office, 1,397 thousand tons of waste were created in 2022, of which 70.5% is non-hazardous waste, which also includes plastic waste listed according to the sectors where it was generated (State Statistical Office of the Republic of North Macedonia, 2023, p. 4).

Table 4: Generated plastic waste by section of economic activity in North Macedonia, 2022

Agriculture, forestry, and fishing	Mining and quarrying	Manufacturing	Electricity, gas, steam, and air conditioning supply	Water supply, sewerage, waste management, and remediation activities	Construction	Other service activities
n.a.	32	5.588	27	6.313	1.325	15.300

(Source: State Statistical Office of the R. N. Macedonia, *Waste by section of economic activity 2022*, Makstat 29.03.2024, p.4.)

Through the prism of the circular economy model, a more detailed sectoral analysis should be made in North Macedonia and the model of connecting the sectors in the country should be approached, so that what is plastic waste for a company or industry can be seen as possible

resource for another company or industry. Before approaching the last stage of recycling, the possibility of using plastic waste unprocessed for the needs of some other related industry should be considered, if that model does not fit, it is logical to approach recycling.

North Macedonia also lacks a national circular economy platform, where the business community, the state, citizens, non-governmental organizations, and academics can be informed and share information and positive practices from this area. Compared to the countries of the Western Balkans, only Serbia is a pioneer, and Montenegro through the Chambers offers such platforms, thus keeping businesses motivated and more informed to actively participate in the circular economy (Direct links for Serbia <https://circulareconomy-serbia.com/> and Montenegro <https://www.ce-hub.me/en/homepage>).

3. MUNICIPAL WASTE PRACTICES IN GERMANY AND SLOVENIA AND WHAT CAN NORTH MACEDONIA LEARN FROM IT

3.1. Useful practices in Germany

In the Federal Republic of Germany, which is the most populous and strongest economy in the EU with a total population of 83.4 million (2022 census), each citizen, according to Eurostat, generated an average of 593 kilograms of municipal waste in 2022, which is 80 kilograms per person more than the European average. Given that Germany has over 80 million inhabitants, this represents a massive amount of municipal waste generated. However, Germany leads in waste processing and serves as an example of proper municipal waste management. According to data from the European Environment Agency in 2021, Germany managed to recycle 67.8% of the total collected municipal waste, and two decades earlier, in 2004, it still managed to recycle more than half, or 56.4%. This reflects decades of experience and consumer behaviour with a high level of awareness and culture of waste sorting where the process of teaching starts in kindergartens. Waste separation in Germany is mandatory for every citizen.

Waste management in Germany is not a cheap service and costs for waste collection vary from one municipality to another, or from one region or state to another. The fees depend on the services and companies responsible for waste collection and management. According to a study by the Zentralverband der Deutschen Haus et al., in 2022, waste collection every two weeks in Wolfsburg costs 128.44 euros per year for a family of four (two adults and two children) who separate their waste by bin. In contrast, in Hamburg, the same service costs an average of 267 euros, and in Freiburg, as much as 309.60 euros. The cheapest city to live in Germany in terms of waste collection is Nienburg. These costs are calculated annually (Haus und Grund Germany, 2022).

According to the same study, which covered 100 German cities, the average cost of waste management has increased by 8% over the past three years to 312 euros per year. Only 19 out of the 100 cities have managed to reduce waste management costs. However, in Germany, the cost of waste depends not only on where one lives but also on the amount of waste generated, which indirectly depends on the number of family members living under the same roof. If a family produces less waste and collection occurs every two weeks instead of weekly, this affects the final price that households must pay. Only 17 of the 100 cities offer a calculator where residents can transparently calculate the waste management fees they must pay (Haus und Grund Germany, 2022). Citizens often complain about overly complicated methods of calculating municipal charges, which makes it difficult to compare German systems quantitatively with Macedonian ones.

3.2. Useful practices from Slovenia

Research on waste management within the framework of a circular economy often highlights Slovenia as a country that has successfully become a green European leader in recycling rates

within the EU. The interest in comparative qualitative analysis, specifically with Slovenia in this study, is aimed at comparing two national economies with several shared characteristics. The goal is for the Macedonian economy to learn and adopt positive practices from its Slovenian partners. Both countries have similar population sizes, share a history in the former Yugoslavia, are NATO members, and also have similar land areas. Slovenia has become a model for sustainable municipal waste management in Europe, achieving significant success in recycling and reducing waste generation through well-developed political measures and engaging the public in the fight against increasing waste and its improper disposal.

In Slovenia, as in the German example, households have been required for over a decade to separate waste into categories such as plastic, paper, glass, bio-waste, and mixed waste that doesn't fit into other categories (disposed of in black bins). Municipalities are responsible for waste collection, transportation, and management. Data from EUROSTAT shows that Slovenians produced 487 kilograms of waste per capita in 2022, which is below the European average of 513 kilograms per capita for the same year. North Macedonia, in the same year, produced 20 kilograms less waste per capita than Slovenia, although both countries remain below the European average.

In 1995, the average EU citizen produced 467 kilograms of municipal waste annually, and over nearly two decades, this increased by 10%, with Europeans generating 513 kilograms of municipal waste annually in 2022—an increase of 46 kilograms per capita. Slovenia's progress in waste management is evident, as in 1995, each Slovenian citizen produced 596 kilograms of waste annually, but by 2022, this was reduced to 487 kilograms per capita, a decrease of 109 kilograms. (Eurostat, 2024) This shows that Slovenia is not only working on recycling and increasing recycling rates but also actively raising public awareness about waste reduction and encouraging adherence to the hierarchy of circular economy principles in waste management, which prioritize avoiding waste creation, reducing waste, reusing products, and recycling. How has Slovenia achieved this?

A case study by Zero Waste on the city of Ljubljana reveals how the largest public sanitation company, Snaga, has not only made Ljubljana the cleanest and greenest city in terms of municipal waste but also reduced the cost of waste management for citizens. Snaga is a public company that manages municipal waste in Ljubljana and 10 other suburban municipalities, serving a total of 395,328 citizens. Snaga is responsible for managing waste for around 19% of Slovenia's total population of 2.1 million. Snaga's approach of collecting separated waste through a door-to-door system was first tested in the smaller municipality of Brezovica. After seeing that the system was highly effective, with recycling rates for packaging tripling and mixed municipal waste decreasing by 29% within just a few months, Snaga decided to implement this system across the entire area it serves. A second principle that the company focused on was reducing the frequency of collecting mixed waste (unsorted waste in black bins), while maintaining a high frequency of collecting separated waste. In less densely populated areas (single-family homes), mixed waste was collected every three weeks instead of weekly. In more densely populated areas (apartment complexes), mixed waste was collected weekly, while sorted waste was collected several times a week. This incentivized residents to sort their waste, as they did not want unsorted waste lingering in their homes or yards, thus indirectly stimulating waste separation (Zero Waste Europe, 2019).

Initially, there was resistance in less populated areas, and significant waste separation was not achieved. However, through strong media and political support, residents were shown how little mixed waste remains if it is properly sorted. As a result of these efforts, the amount of separated waste grew, reaching a 55% separation rate by 2013 and rising to 68% by 2018. What is particularly interesting is that the average monthly waste management costs per household fell to 8.20 euros in 2018, one of the lowest in all of Slovenia. If the average annual waste

management cost in Slovenia is around 150 euros, in Ljubljana it decreased to an average of 100 euros per year (Zero Waste Europe, 2019).

This waste management approach by Snaga resulted in each resident in the area producing only 358 kilograms of waste on average in 2018, of which 68% was recycled, composted, or recovered. By 2018, the amount of waste sent to landfills had decreased by 95%, and total waste generation had dropped by 15% (Zero Waste Europe, 2019). Avoiding the creation of waste is a key factor in Slovenia's success in waste management. „...While the European average waste generation was 486 kilograms per EU citizen in 2018, residents of Ljubljana were already 31% below that average...“ (Zero Waste Europe, 2019). Snaga's system also offers eight waste centers where citizens can dispose of waste that cannot be separated through the door-to-door system, such as hazardous waste, metals, plastics, electronics, garden waste, construction materials, car parts, wooden products, bulky waste, and textiles. Once a year, Slovenians can leave bulky waste outside their homes on a specified date, and the waste is collected by the municipal company.

All these practices led Ljubljana to be named the European Green Capital in 2016 and, „...The city's future goals include achieving a waste separation rate of 78% by 2025, 80% by 2035, and reducing waste generation per capita to 280 kilograms annually...“ (Zero Waste Europe, 2019).

3.3. Municipal waste costs comparison between North Macedonia, Slovenia and Germany

In Skopje, the public enterprise responsible for municipal waste management (collection and transportation) is the Public Enterprise for Communal Hygiene – Skopje (PE Komunalec). It operates in the city of Skopje and in most rural areas within the Skopje municipalities, such as Kisela Voda, Gazi Baba, Butel, Karpoš, Aerodrom, and Saraj (serving 20,004 households in rural areas). „...The frequency of waste collection is six times a week, with plastic waste being collected twice a week, and in rural areas, waste is collected once a week using 8 to 10 specialized vehicles...“ (JP Komunalna higijena Skopje, 2022). Komunalec Skopje collects and transports municipal waste for Skopje, which, according to the latest census, has a total population of 526,502 residents. This accounts for managing waste for around 28.7% of the total population of North Macedonia, which, according to the latest census, consists of 1.8 million residents (Authors calculations). Comparing Slovenia's Snaga with Macedonia's Komunalec, it is evident that North Macedonia could achieve greater economies of scale and manage a larger financial input to organize waste management more efficiently.

Unlike Slovenia, in North Macedonia, waste separation is only possible at designated locations in containers meant for this purpose across the city. The population does not separate waste at home, as is the practice in Slovenia and Germany. Waste separation is not a legal obligation in our country, unlike in Germany and Slovenia. The largest percentage of revenue for the enterprise comes from fees that Macedonian households pay for municipal waste management. According to a decision by the City of Skopje, these fees amount to 3.59 denars per square meter and are calculated based on the living space owned by citizens, without including the yard areas. According to the latest census, the number of apartments in Skopje has increased by over 50,000 in the last two decades, reaching 213,850 apartments, which affects the total revenue collected by Communal Hygiene Skopje. Unlike in Germany and Slovenia, where the cost is determined based on the frequency of waste collection and the size of the waste bins, in our country, the basis for calculating municipal waste fees does not provide an incentive for waste separation, nor is it economically justified.

Even if someone with greater environmental awareness attempts to separate more waste, there is no way for them to be incentivized. Even though some people produce less waste, they must pay more simply because they live in larger homes. In rural areas, households pay a flat rate of 286 denars per household, or approximately 4.6 euros. Annually, families in rural areas pay

around 56 euros for municipal waste management. An additional 5% tax is applied, bringing the total to 300 denars per month, or around five euros, which amounts to 60 euros annually, including tax (JP Komunalna higiena Skopje, 2022).

In our country, the sorted waste in Skopje is handed over to PAKOMAK and Nutrivet, companies that are part of the extended producer responsibility system. The waste separation efforts in our country are largely attributed to the work of these companies, which manage the separated waste. The State Statistical Office of North Macedonia informs us that an average Macedonian household allocates about 70.4% of its consumption to basic needs such as food, clothing, housing, and household items. A more detailed analysis of household consumption distribution shows that the costs for housing, water, electricity, gas, and other fuels (which include municipal waste management costs) account for 10.7% of the total household expenses. The cost-of-living indices indicate that in 2022, compared to the previous year, these costs increased by as much as 14.2% (MAKSTAT, 2023, p. 31). Such trends will undoubtedly encounter resistance from Macedonian citizens regarding the implementation of the Ministry of Environment and Spatial Planning's commitments. In the Waste Management Plan of North Macedonia for 2021-2031, based on the National Waste Management Strategy 2006-2020 and EU legislation, it is stated that "...in addition to capital investments, municipalities must improve cost recovery, mainly by establishing appropriate fees... The estimated cost would be 10 to 15 euros per household in the medium and long term..." (Ministry of Environment and Physical Planning of the R. N. Macedonia, p.66) Currently, the fees stand at 5 euros per month, meaning a doubling or tripling of costs. "...To raise awareness at the municipal level among the population and companies, the plan proposes maintaining a budget of 1.5 euros per household (0.8 million euros annually)..." (Ministry of Environment and Physical Planning of the R.N. Macedonia, p.64). These extra costs, amid rising inflation and living expenses, will be highly unpopular for implementation.

Our analysis shows that municipal costs as a percentage of gross domestic product (GDP) per capita in Slovenia, Germany, and Macedonia show a disparity, but this is not a sufficient indicator to reflect the situations in these countries. Therefore, we compared the share of municipal costs in the respective countries with the minimum wage, and while they amount to 1.22% in Slovenia, 1.70% in Germany, in North Macedonia, they are somewhere between the two countries at 1.40% (see Figure 2).

However, a better indicator for comparative analysis is the Income and Living Conditions Indicator, with the latest available comparative data from Eurostat for 2020. This set of statistical measures is used to assess the economic well-being and quality of life of individuals or households in a country or region. It is often used by governments worldwide to shape policies and is primarily based on indicators of income, living conditions, social and economic factors, and subjective indicators. Therefore, it is a more relevant indicator than GDP per capita, which represents the total value of all goods and services produced in a country divided by the total population. According to the Income and Living Conditions Indicator, we see from the chart below that Slovenia is ranked about five times better than the Macedonian national economy, and Germany is ranked about twice as well as Slovenia. However, municipal costs expressed as a percentage of the Income and Living Conditions Indicator do not differ much between Slovenia and Germany (1.01% and 1.22%), while in North Macedonia, this percentage is twice as high at 2.01% (Authors' calculations). This clearly shows that Macedonian citizens bear waste management costs that are reflected in a quality of life and economic power that is twice as poor compared to other countries, even though in absolute numbers, these costs are the lowest.

Figure 2: Municipal waste management costs comparison between Slovenia, North Macedonia and Germany

Municipal waste management costs

(annual in EUR)

	<i>Slovenia</i>	<i>Germany</i>	<i>N.Macedonia</i>
Estimated average municipal management costs*	150	318	60
GDP per capita (WBG, 2023)	23845	39876	5.906
Municipal costs as % of GDP per capita	0,63	0,79	1,01
Minimum wages (Eurostat 2021, half yearly,S2)	1024	1602	358
Municipal costs as % of minimal wages	1,22%	1,70%	1,40%
Income and Living Conditions Indicator (Eurostat 2020)	14774	26008	2983
Municipal costs as % of Income and Living Conditions Indicator	1,01%	1,22%	2,01%

(Source: Author's calculations based on data from EUROSTAT 2021 and World Bank Group 2023)

4. CONCLUSION

This paper is the first attempt in North Macedonia to look at the circular economy through the lens of plastic. In a society where households are not in the habit of sorting waste, we cannot expect plastic data to be available for academic research. While global and European trends place plastic high on the agendas of circular development strategies, in the countries of the Western Balkans, plastic is prioritized only in the Circular Economy Roadmap strategies of Albania and Serbia. Lack of data for plastics is also an issue in WB countries and North Macedonia. Our research shows that ERP schemes play a crucial role in collecting and recycling plastics. About 61% of the total plastic collected in the country is directly related to the work of the EPR actors. The EPR schemes mandated by the EU legislation, which our economy follows and implements as a candidate country, are of positive significance because they offer the opportunity for businesses to perform where the state cannot easily organize, usually due to a lack of finances, staff, or unattractive political moves. In this manner, collaborations on the international level should be a priority for our country as we can provide more advanced solutions from more developed circular economies.

The 2022 Report on EPR in Macedonia shows that out of 22,309.2 tons of plastic released on the market, only 40% is collected, with 16.4% being recycled and 23.3% exported, while the rest ends up in mixed waste and landfills, posing significant environmental concerns. The waste management system needs a core restructuring, focusing on waste separation, digitalization, and accurate waste tracking, as only 86% of citizens use municipal collection services, while a significant portion still improperly disposes of waste, contributing to environmental pollution. Instead of advocating for an increase in municipal waste costs, the state could turn to a strategy of waste separation and, through capital investments or citizen obligations, provide waste separation bins for every household along with a brochure on their use. This would directly start waste separation at the family household level, and then, in cooperation with companies under the extended producer responsibility system, work together to collect the separated waste. What nowadays North Macedonia must begin with is spreading awareness for not making too much waste. Prevention is the key and first recommendation in the never-ending battle with waste, and second step is to reuse it.

About 18% of the waste in North Macedonia, or nearly one-fifth, comes from the business sector, which, unfortunately, fails to find a way to offer it as a resource for the needs of related industries or to recycle it. Macedonian authorities and municipalities can work closely also with the business sector to find out where to reuse these 18 % and give a platform where business sector can communicate for using waste materials like a resource for another related industry sectors. Our conclusion leads to a recommendation that also paying more for

municipality waste management services does not mean better quality of this service in the future. Municipal costs as percentage of income and living conditions indicator that are already paid by Macedonian citizen in comparison with the Germany and Slovenian citizen show that we are already paying too much money for having bad quality services and no offer in proper waste selection options.

Acknowledgment: *Elena Makrevska Disoska is the coordinator of the project "Strengthening the Knowledge of the EU Internal Market—Widening the Perspectives of Candidate Countries", co-funded by the European Union under the Erasmus+ Jean Monnet Chair program. Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union or EACEA. Neither the European Union nor the granting authority can be held responsible for them.*

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MACROECONOMIC DETERMINANTS OF LABOUR PRODUCTIVITY: AN EMPIRICAL ANALYSIS OF THE REPUBLIC OF NORTH MACEDONIA

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ABSTRACT

This study examines the determinants of labour productivity in the Republic of North Macedonia, with a particular emphasis on key macroeconomic variables such as gross investment, employment, workers' compensation, inflation, gross national income per capita, and human capital. Labour productivity is recognized as a pivotal indicator of labour market efficiency, and worker welfare, and a crucial driver of sustainable economic growth. Despite improvements in employment levels and reductions in unemployment, labour productivity in North Macedonia remains suboptimal, exhibiting stagnation and insufficient growth, especially when contrasted with increasing wages. Through the application of both correlation and regression analyses, this paper explores the strength and causal relationships between labour productivity and macroeconomic variables, highlighting their role in shaping national competitiveness and economic development. The findings align with both theoretical and empirical literature, reinforcing the significance of human capital, gross investment, and overall economic performance in driving productivity improvements. This study contributes to the discourse on structural challenges within North Macedonia's labour market and provides a basis for policy interventions aimed at fostering sustainable productivity growth and enhancing international competitiveness.

Keywords: Labour market, Productivity of labour, Determinants.

JEL classification: J11, J20, J24.

1. INTRODUCTION

The productivity of the factors of production constitutes a critical determinant of sustainable economic growth. Factor productivity accounts for a substantial proportion of the variation in GDP per capita across national economies. In assessing the characteristics and performance of the labour market, in addition to employment and unemployment as a basic indicator of labour market conditions and characteristics, labour productivity is one of the most significant indicators of labour market performance. Labour productivity not only provides valuable insights into the functioning of labour markets but also serves as a fundamental indicator of workers' material well-being and the prospects for sustainable rates of economic growth and development.

This study focuses on the concept of partial productivity, specifically labour productivity, as a core indicator of labour market performance in the Republic of North Macedonia. The level of labour productivity affects not only the competitiveness of national economies but also reflects the efficiency and effectiveness with which production factors are allocated (Samuelson and Nordhaus, 1995). Thus, sustained increases in labour productivity are essential for enhancing national economic performance and improving international competitiveness (Porter, 1990) (Krugman, 1994). In developing countries such as North Macedonia, labour productivity is generally characterized by relatively low levels and insufficient growth rates. These pronounced disparities in productivity, coupled with suboptimal growth rates, contribute to widening the gap between labour productivity in developed and developing countries. From 2015-2023, labour productivity in North Macedonia exhibited lower growth rates compared to the increase in real wages, particularly in sectors such as manufacturing, construction, and the public sector, where wage growth significantly exceeded average levels (World Bank, 2024). In this analysis, labour productivity is defined as the annual output per worker, representing a critical indicator of labour market performance in North Macedonia. This study concentrates on the macroeconomic variables influencing labour productivity, namely gross investment, employment, workers' compensation, inflation, gross national income per capita, and human capital. The selection of these variables as determinants of labour productivity is both theoretically sound and empirically grounded, as their causal relationships with productivity have been thoroughly examined in numerous studies (Verdoorn, 1998; Diewert and Nakamura, 2007; Fischer *et al.*, 2009; Cruz, 2023). Additionally, theoretical literature provides substantial support for the links between macroeconomic indicators and labour productivity (Romer, 1990; Hsieh and Klenow, 2010). Empirical analyses focusing on Southeast European countries, including North Macedonia, support the thesis that economic development, labour market characteristics, and price stability significantly influence labour productivity (Trpeski *et al.*, 2022; Trenovski *et al.*, 2023; Trpeski *et al.*, 2024).

This paper is structured as follows: the introduction addresses the relevance of the research topic and justifies the selection of the macroeconomic determinants. The subsequent section provides a review of the theoretical and empirical background, outlining key research contributions and the theoretical framework guiding the analysis. The methodology and data section presents a detailed description of the variables and methodological approach adopted in the study. The results section reports the findings from econometric, correlation, and regression analyses. Finally, the conclusion summarizes the key findings and their implications for policy and future research.

2. THEORETICAL AND EMPIRICAL BACKGROUND

The macroeconomic determinants analysed in this study—namely human capital, employment, workers' compensation, inflation, and Gross National Income (GNI) per capita—are recognized as key drivers of labour productivity from both theoretical and empirical

perspectives. Human capital is consistently linked to productivity improvements, as a more skilled workforce enhances efficiency and innovation. Employment trends provide insights into the labour market's absorptive capacity, though a trade-off between rising employment and stagnant productivity has been observed in certain sectors. Workers' compensation, particularly through the lens of efficiency wage theory, suggests that higher wages can incentivize productivity growth, while inflation's impact on labour productivity is debated, with perspectives ranging from cost-push to demand-pull dynamics. Finally, GNI per capita, as an indicator of economic development, reflects the broader relationship between economic progress and labour productivity, with higher levels of development fostering more productive labour environments.

Theoretical and empirical literature emphasizes the pivotal role of human capital in achieving sustainable increases in labour productivity, which is essential for achieving sustainable economic development (Temple, 1999; Fischer *et al.*, 2009). Empirical research consistently demonstrates a positive correlation between higher levels of human capital and the rate of labour productivity growth (Temple, 1999; Fischer *et al.*, 2009; Syverson, 2011). In addition to this direct relationship, several studies also investigate the effects of increasing human capital in contexts characterized by labour market disequilibria and significant disparities (Kahn, 2010). The Macedonian labour market continues to experience persistently high unemployment, low participation rates, and a pronounced mismatch between workers' skills and market demand. This misalignment hampers the optimal allocation of labour and results in the underutilization of human capital. The low degree of alignment between the supply and demand for labour, particularly due to skill mismatches, leads to suboptimal allocation of workers. Consequently, many individuals with higher education, qualifications, and skills are employed in positions that do not fully utilize their potential, thereby limiting overall productivity. This misallocation exacerbates the underutilization of human capital, which should otherwise play a crucial role in promoting sustainable productivity growth and enhancing labour market performance in North Macedonia. This, the inclusion of human capital as a key determinant of labour productivity, is well-supported by both theoretical and empirical framework (Syverson, 2011).

The inclusion of employment as a factor influencing labour productivity provides critical insights into the labour market's absorptive capacity, as well as its overall performance. Several empirical studies on the relationship between employment and labour productivity have concentrated on developed economies (Calligaris, 2023). In North Macedonia, despite the upward trend in employment in recent years, labour productivity has remained stagnant or even declining in certain sectors, suggesting that the labour market is absorbing non-productive employment. This trend indicates a potential trade-off between employment and productivity, where increases in employment occur at the expense of productivity, resulting in a rise in unproductive employment (Morris, 1958). Therefore, the inclusion of employment as a variable in the analysis is both justified and essential.

Regarding the relationship between workers' wages and labour productivity, this study examines both classical economic theories and the Keynesian approach, with a particular focus on efficiency wage theory. According to efficiency wage theory, causality flows from real wages to productivity, positing that higher wages incentivize greater productivity by increasing the costs of job loss and enhancing worker motivation (Akerlof, 1984). Conversely, marginal productivity theory suggests that increases in labour productivity drive real wage growth (Snowdon and Vane, 2005). Classical economic thought asserts that wage levels follow the labour productivity trend (Mankiw, 2000), while efficiency wage theory contends that wages are set above equilibrium to enhance worker efficiency and reduce turnover and moral hazard (Mankiw, 2000).

A significant labour force deficit, combined with the considerable mismatch between workforce skills and labour market demand, contributes to low levels of labour productivity and weakens the relationship between productivity and workers' compensation (McGowan and Andrews, 2017). Empirical evidence from the Western Balkans, particularly after 2015, suggests a weak or nonexistent correlation between wage growth and labour productivity (Trenovski *et al.*, 2023). In North Macedonia, wage growth, particularly in the manufacturing, construction, and public sectors has outpaced labour productivity, further exacerbating the disparity between the two (World Bank, 2024). Therefore, workers' compensation, measured as the average monthly gross wage, is included as a variable in this analysis. Gross wages are included as an indicator of total worker compensation for two reasons. First, there is a lack of publicly available data on total compensation, including financial, material, and non-material benefits. Second, in the context of the Macedonian labour market, financial bonuses and tangible or intangible rewards remain rare, benefiting only a small portion of the workforce. Thus, the monthly gross salary is considered a realistic indicator of the total compensation of the average Macedonian worker and is therefore justified as a key variable in the analysis.

When analysing the causal relationship between labour productivity and the general price level in the economy, two primary theoretical postulates typically emerge, offering opposing views on the nature of this relationship. The first, the conventional theoretical conception, assumes a cause-and-effect relationship that originates in labour productivity and subsequently influences the inflation rate. It posits that changes in labour productivity directly impact the dynamics and level of inflation. According to this view, improvements in labour productivity reduce the likelihood of inflationary pressure. In other words, as labour productivity rises, firms can produce greater output with the same resources, exerting downward pressure on prices. This causality is referred to as the "cost-push perspective," wherein higher labour productivity reduces production costs, leading to lower product prices and, consequently, reduced inflation. The second, alternative theoretical perspective posits that the causal relationship runs from inflation to labour productivity, suggesting that changes in inflation levels significantly influence labour productivity. This perspective highlights the role of inflation in affecting real wages. Higher inflation erodes the purchasing power of wages, demotivating workers and increasing the likelihood of a decline in labour productivity. From this "demand-pull perspective," inflationary pressures negatively impact labour productivity (Akerlof, 1984; Snowden and Vane, 2005). Empirical research on Western Balkan countries points to the existence of short-term causality between wages and labour productivity (Slaveski and Kozheski, 2024).

Gross National Income (GNI) per capita, a key macroeconomic determinant included in this analysis, reflects the level of economic development and the purchasing power of a country's population. Several empirical studies examining the relationship between GDP per capita and labour productivity are based on the assumption that higher levels of economic development exert a direct influence on labour productivity (Syverson, 2011). A higher degree of economic development suggests a more advanced technical-technological infrastructure, which leads to a shift in the production structure, favouring sectors that generate higher value-added products (Verdoorn, 1998; Macdonald, 2010).

3. METHODOLOGY AND DATA

To examine the causal relationship between specific macroeconomic indicators and labour productivity, one of the key indicators of labour market performance in North Macedonia for the period 1992–2022, a regression analysis was conducted using the ordinary least squares (OLS) method. The logarithmic value of labour productivity, represented as output per worker, serves as the dependent variable in the regression model. The independent variables in the

regression analysis include human capital, gross capital formation, employment, workers' compensation, inflation, and gross national income per capita. Table 1 below provides a detailed description of these variables.

Table 1: Description of variables

Variable	Definition and description of variables	Source
Labour productivity	Labour productivity represents the total output (measured in gross domestic product, GDP) produced per unit of labour (measured by the number of employed persons) over one year. It measures the efficiency of resource utilization in the economy to produce goods and services. Labour productivity serves as an indicator of the economy's competitiveness and labour market performance.	International Labour Organization (ILO) database
Human capital	The human capital index reflects the level of human capital in North Macedonia. It is based on the human capital a child born today can expect to attain by age 18, considering health and educational risks. This index highlights the effects of improvements in health and education systems on future labour productivity.	World Bank database
Gross capital formation	Gross capital formation (gross investment) includes all expenditures on fixed assets in the economy, along with net changes in inventory levels. Investments in fixed assets include investments in land, plant, machinery, and equipment, as well as infrastructure projects such as roads, railways, schools, hospitals, industrial facilities, and residential complexes.	World Bank database
Employment	Employment is defined as individuals capable of working who, during a specified reference period, were engaged in any activity related to the production of goods or provision of services for compensation or profit. The employment rate is the ratio between individuals engaged in formal, paid productive activity and the total working-age population.	International Labour Organization (ILO) database
Workers' compensation	Workers' compensation is represented by the annual average of workers' monthly gross wages. Gross wages consist of net wages received by employees plus contributions for social security, health insurance, and pensions.	State Statistical Office Database
Inflation	Inflation is the annual percentage change in the general price level, represented by the Consumer Price Index (CPI).	World Bank database
Gross national income per capita	Gross national income per capita is the sum of GDP and net income from abroad (dividends, interest, and profits), divided by the population. It serves as an indicator of economic well-being, representing the annual income per capita.	World Bank database

(Source: Authors' contribution)

To analyse the individual relationships between labour productivity and various macroeconomic indicators, five regression estimations using the ordinary least squares (OLS) method are employed in this study. The use of the OLS method minimizes the sum of squared residuals, thus providing objective and unbiased estimates of the individual coefficients. Consequently, this method is deemed appropriate for examining the causal relationship between specific macroeconomic variables and labour productivity, as evidenced by its extensive application in the empirical literature (Kahn, 2010; Vergeer and Kleinknecht, 2010). The rationale for incorporating five separate and independent regression estimations lies in the need to analyse the individual causal effects of each independent variable on labour productivity, which is a fundamental indicator of labour market performance in North Macedonia. Each regression equation includes an additional independent variable to assess its impact on labour productivity. The regression estimates are presented below:

- (1) $\text{Log(Productivity of labour)} = \beta_0 + \beta_1 \text{Employment} + \beta_2 \text{Human Capital} + \varepsilon$
- (2) $\text{Log(Productivity of labour)} = \beta_0 + \beta_1 \text{Employment} + \beta_2 \text{Human Capital} + \beta_3 \text{Gross capital formation} + \varepsilon$
- (3) $\text{Log(Productivity of labour)} = \beta_0 + \beta_1 \text{Employment} + \beta_2 \text{Human Capital} + \beta_3 \text{Gross capital formation} + \beta_4 \text{Workers' compensation} + \varepsilon$
- (4) $\text{Log(Productivity of labour)} = \beta_0 + \beta_1 \text{Employment} + \beta_2 \text{Human Capital} + \beta_3 \text{Gross capital formation} + \beta_4 \text{Workers' compensation} + \beta_5 \text{Inflation} + \varepsilon$
- (5) $\text{Log(Productivity of labour)} = \beta_0 + \beta_1 \text{Employment} + \beta_2 \text{Human Capital} + \beta_3 \text{Gross capital formation} + \beta_4 \text{Workers' compensation} + \beta_5 \text{Inflation} + \beta_6 \text{Log(Gross national income per capita)} + \varepsilon$

In the model, β_0 represents the intercept coefficient, while $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$ represent the coefficients associated with the individual independent variables. ε denotes the random error term in the model. To ensure the validity, objectivity, and impartiality of the results, diagnostic tests were conducted to detect the presence of autocorrelation, heteroskedasticity, and multicollinearity in the regression models. The potential presence of autocorrelation was assessed using the Breusch-Godfrey test (Stock and Watson, 2007). It is important to note that, in certain cases, autocorrelation in regression models may arise from the multiplicative and prolonged effects of individual independent variables included in the model. However, for the purposes of this analysis, the presence of autocorrelation is treated as problematic, as it may result in a spurious regression. The results of the Breusch-Godfrey test indicate that there is no significant autocorrelation among the residuals in the model. To assess heteroskedasticity—i.e., the presence of varying degrees of residual variance—White's test was applied. The results demonstrate that, at a 5% significance level, the assumption of homoscedasticity cannot be rejected.

Concerning the issue of multicollinearity among the independent variables in the model, it is important to note that when specifying the regression models—particularly in the selection of independent variables—there exists the potential for high multicollinearity. However, a certain degree of correlation between independent variables should not be considered problematic. In fact, it is both justified and logical, given that economic processes and relationships are inherently interconnected, making it practically impossible to have a complete absence of correlation between macroeconomic indicators. Therefore, the analysis of multicollinearity in the regression models is focused on identifying instances of high multicollinearity, specifically whether the independent variables are correlated to an extent that would compromise the stability of the model or result in a heightened degree of bias in the regression results. For this analysis, the degree of multicollinearity was assessed using the variance inflation factor (VIF).

The application of the VIF involves the formation of auxiliary regressions, where each independent variable is treated as a dependent variable and expressed as a function of all other independent variables. The results indicate that the observed degree of correlation among the variables does not undermine the stability of the model.

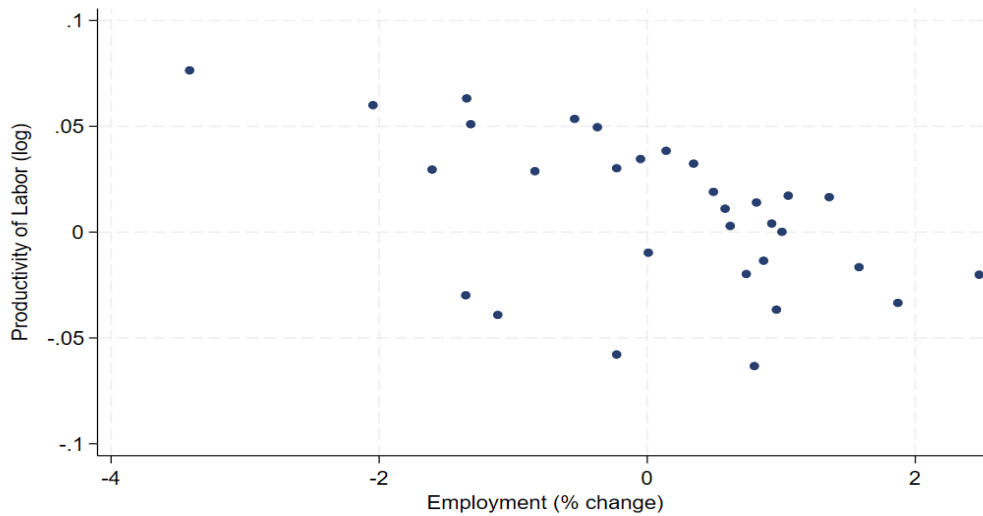
4. RESULTS

4.1. Results from correlation analysis

The analysis of the economy through the lens of the new structural economics employs a neoclassical approach to examine the impact of macroeconomic determinants on the performance and structure of national economies, as well as the prospects for establishing sustainable economic growth rates (Lin, 2011). This approach is based on the assumption that a country's economic structure is endogenous, meaning it is shaped by specific internal factors, and that the primary role of the state is to maintain macroeconomic stability while fostering an optimal business environment. This environment, in turn, provides the business sector with opportunities to leverage comparative advantages, enabling the efficient allocation of resources and the establishment of sustainable growth rates in labour productivity. In terms of labour market performance, particularly the relationship between macroeconomic determinants and worker productivity, this approach emphasizes the economic structure of the country. Labour productivity is influenced by various factors, including price stability, income levels, labour market characteristics and performance, employment characteristics, and the level of human capital (Limakunnas *et al.*, 2004; Winden and Reitsma, 2016). Among these labour market characteristics, the focus is particularly on the so-called dual labour markets, which are a common feature of developing countries. A key division in the labour market is between the formal and informal sectors. The formal labour market is typically associated with higher wages and labour productivity, largely due to better access to technology and capital. In contrast, the informal sector is characterized by lower wages, inadequate labour productivity, and a lack of access to additional capital. Consequently, labour productivity in North Macedonia is also influenced by the prevalence of informal economic activities and the informal labour market. This approach contrasts with classical economic thought, which emphasizes labour supply and demand, the presence of complete information, and the flexibility of economic agents operating under perfectly competitive conditions as the basis for determining workers' wages.

The results of the correlation analysis provide valuable insights into the intensity and direction of the relationship between individual macroeconomic determinants and labour productivity, which is a fundamental indicator of labour market performance. The analysis reveals a low (0.1849) and statistically insignificant correlation coefficient between labour productivity and the employment rate. This suggests an absence of a significant relationship between labour productivity and employment, indicating that employment growth in North Macedonia does not have a statistically significant impact on changes in labour productivity. The scatter plot depicted in Figure 1 further illustrates a negative relationship between these two variables, showing that an increase in the employment rate is accompanied by a decrease in the logarithmic values of labour productivity. These findings suggest that rising employment in North Macedonia may be associated with a decline in labour productivity, indicating the presence of the phenomenon known as "unproductive employment" (Morris, 1958).

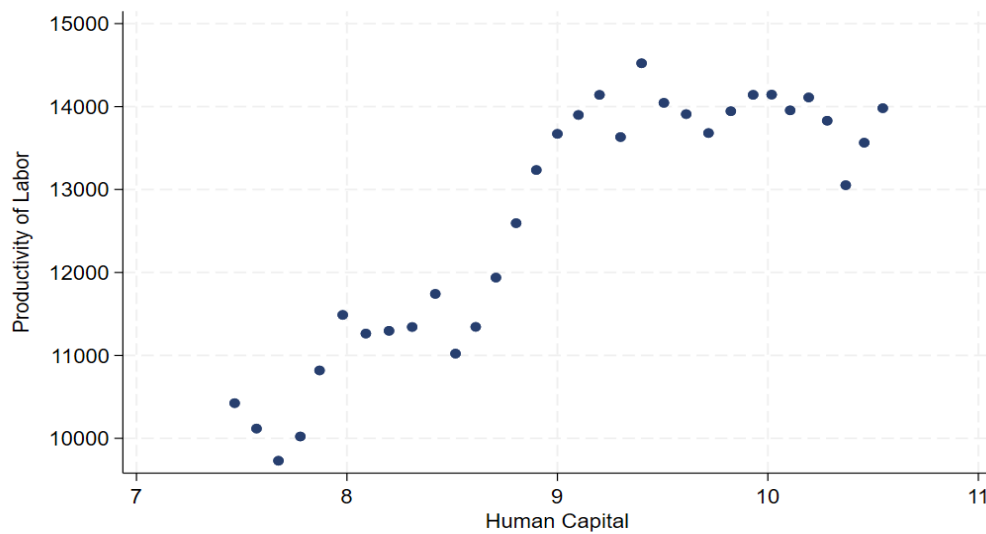
Figure 1: Correlation between labour productivity and employment



(Source: Authors' calculations)

The analysis of the positive relationship between labour productivity and other macroeconomic determinants reveals a statistically significant and positive correlation between labour productivity and changes in human capital, gross investment, workers' earnings, and the logarithmic value of gross national income per capita. Specifically, the correlation coefficient between human capital and labour productivity is 0.88, indicating a strong, positive, and statistically significant relationship between the two variables in North Macedonia. This positive correlation is visually represented by the scatter plot in Figure 2, which demonstrates that improvements in human capital are associated with increased labour productivity. The findings suggest that the growth of human capital has a substantial positive impact on labour productivity, particularly up to a human capital index level of 9 points. Beyond this level, further increases in human capital indices continue to have a positive, albeit less significant, impact on labour productivity. This positive relationship between human capital growth and labour productivity is consistent with numerous empirical studies that underscore the importance of human capital in enhancing productivity (Windén and Reitsma, 2004; Ezoji *et al.*, 2019). In their analysis of highly developed countries, Windén and Reitsma (2004) emphasize that the accumulation of human capital and improvements in labour force participation positively affect labour productivity. Additionally, empirical research highlights that increases in human capital, particularly in terms of improved educational and health indicators, have a significant positive impact on labour productivity. In conclusion, the empirical data on the relationship between labour productivity and human capital in North Macedonia are consistent with other studies analysing this relationship. Therefore, increasing investments in human capital, particularly in education and health, is expected to lead to long-term growth in labour productivity in North Macedonia.

Figure 2: Correlation between labour productivity and human capital

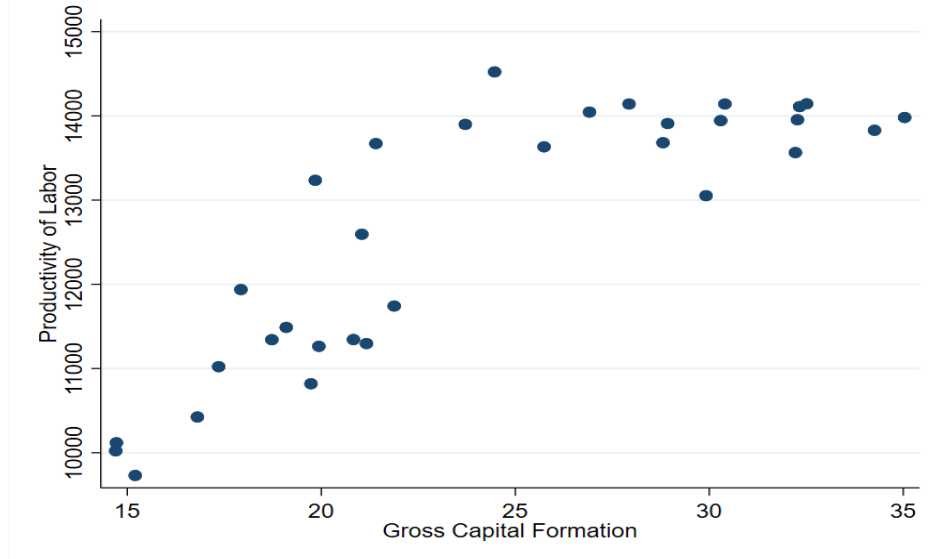


(Source: Authors' calculations)

Labour productivity is a critical factor in establishing and sustaining stable economic growth. The significant disparities in economic development between countries are largely attributed to variations in productivity levels, as well as the factors that influence it, such as human capital, technological progress, gross capital formation, and institutional efficiency (Mendez-Guerra, 2017). Gross capital formation, or gross investment, refers to the net inflow of resources directed towards the production of goods and the provision of services in the economy. This includes expenditures on physical capital, machinery, equipment, and infrastructure, forming the foundation for enhancing a nation's productive capacity. As such, gross capital formation is one of the key determinants of labour productivity. Increased investment leads to improvements in technology, expanded production capacities, and the creation of infrastructure, all of which enhance worker efficiency and production effectiveness. Empirical literature highlights the substantial contribution of gross investments, particularly in the public sector, to labour productivity, as well as their multiplier effects on private sector investments (Nourzad, 1995; Trpeski *et al.*, 2019). The results of the scatter diagram presented in Figure 3 indicate a positive relationship between gross capital formation and labour productivity. The distribution of data points suggests a strong correlation between these two variables in North Macedonia, reflecting the positive effect of physical capital investments on labour productivity. In other words, investments in physical capital have a beneficial impact on improving the efficiency and effectiveness of workers in the production process. However, the data distribution on the graph reveals that the correlation between gross capital formation and labour productivity is not entirely linear, with certain deviations observed. This suggests an incomplete transfer of the positive effects of increased gross capital formation on labour productivity, pointing to the existence of factors that limit labour efficiency. According to the empirical literature, key constraints on labour productivity growth in developing countries include the level and quality of education, the technological base, and the alignment between workers' skills and job requirements—particularly those emerging from advanced technologies. Moreover, the sectoral composition of Gross Domestic Product (GDP) can significantly influence labour productivity levels. Certain sectors, by nature, are capital-intensive and tend to exhibit higher labour productivity due to increased investments in advanced technology, whereas labour-intensive sectors require substantially higher investments for labour productivity growth to match that of capital-intensive sectors.

In conclusion, the correlation analysis underscores that increased investments in gross capital—particularly in technology, infrastructure, and equipment—serve as a foundation for generating higher output per unit of labour, thereby contributing to enhanced labour productivity in North Macedonia.

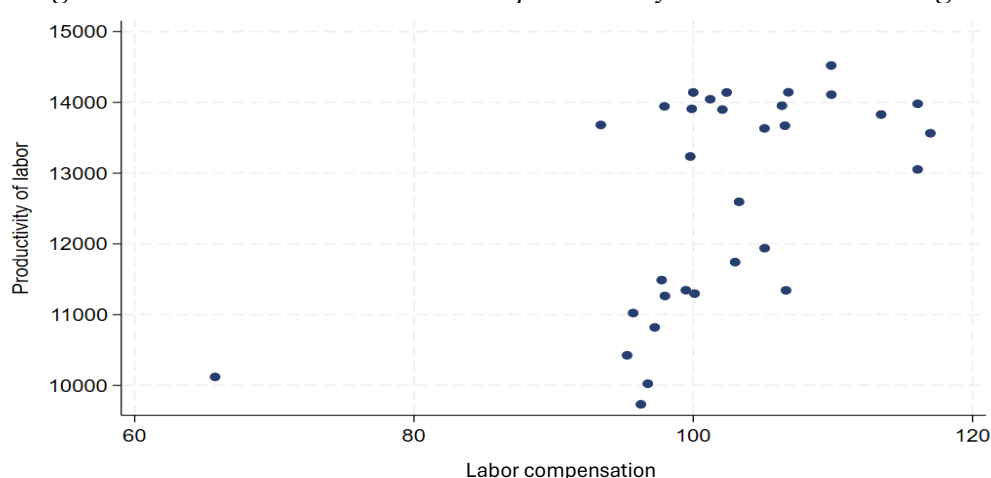
Figure 3: Correlation between labour productivity and gross capital formation



(Source: Authors' calculations)

The correlation coefficient between labour productivity and workers' earnings reflects the relationship between the output produced by workers and the compensation they receive in the form of wages. A coefficient value of 0.57, along with a statistically significant relationship, indicates a stable and positive connection between these two variables. However, both the value of the correlation coefficient and the scatter plot shown in Figure 4 suggest considerable potential for improving this relationship. Specifically, the scatter plot illustrates that the increase in labour productivity and the movement of workers' compensation do not exhibit a proportional relationship. While a positive correlation exists, there remains scope to strengthen this connection. These results imply that a significant portion of labour productivity growth is not adequately reflected in higher wages or other forms of financial compensation for workers.

Figure 4: Correlation between labour productivity and workers' earnings



(Source: Authors' calculations)

The relationship between labour productivity and inflation has been explored both through theoretical frameworks and empirical research (Akerlof, 1984; Freeman and Yerger, 2000; Snowden and Vane, 2005; Kumar *et al.*, 2012). Theoretical concepts generally emphasize that high inflation rates negatively affect labour productivity, primarily by reducing workers' purchasing power and disrupting price signals, which leads to suboptimal resource allocation and reduced efficiency and effectiveness. In the case of North Macedonia, the correlation coefficient between inflation and labour productivity is -0.42, indicating a negative and statistically significant correlation between these two variables.

Table 2: Results of correlation analysis

Correlation Probability	Log (Productivity of labour)	Employment	Human capital	Gross capital formation	Workers' compensation	Inflation	Log (Gross national income per capita)
Log (Productivity of labour)	1.0000						
Employment	0.1849 <i>0.3111</i>	1.0000					
Human capital	0.8818 <i>0.0000</i>	0.5312 <i>0.0018</i>	1.0000				
Gross capital formation	0.8452 <i>0.0000</i>	0.5794 <i>0.0005</i>	0.9494 <i>0.0000</i>	1.0000			
Workers' compensation	0.5685 <i>0.0007</i>	0.2475 <i>0.1721</i>	0.6658 <i>0.0000</i>	0.6083 <i>0.0002</i>	1.0000		
Inflation	-0.4180 <i>0.0240</i>	0.2306 <i>0.2288</i>	-0.3879 <i>0.0376</i>	-0.2533 <i>0.1848</i>	-0.2325 <i>0.2248</i>	1.0000	
Log (Gross national income per capita)	0.8666 <i>0.0000</i>	0.6450 <i>0.0001</i>	0.9602 <i>0.0000</i>	0.9454 <i>0.0000</i>	0.5694 <i>0.0007</i>	-0.1669 <i>0.3868</i>	1.0000

(Source: Authors' calculations)

Although this analysis does not delve into the causal relationship, the results align with established theoretical frameworks and correspond with relevant empirical studies. Specifically, the findings suggest that rising inflation, represented by an increase in the general price level—an indicator of price instability—coincides with a decline in labour productivity.

4.2. Results from regression analysis

To determine the causal relationship between specific macroeconomic indicators and labour productivity trends in the Republic of North Macedonia, a regression analysis was conducted using the Ordinary Least Squares (OLS) method. While the previously conducted correlation analysis provides insights into the intensity and direction of the relationship between macroeconomic indicators and labour productivity, applying regression analysis is deemed essential for assessing the performance of the Macedonian labour market, particularly in establishing causality. Table X presents the results of five regression estimations, which include

additional independent variables—namely, additional macroeconomic determinants of labour productivity—thus enhancing the robustness of the regression analysis.

The results of the first regression model indicate that human capital exerts a positive and statistically significant impact on labour productivity growth. Specifically, the coefficient for the human capital variable is 0.14, suggesting that a 1% increase in human capital, on average, leads to a 0.14% increase in labour productivity, *ceteris paribus*. Additionally, this regression model incorporates employment as one of the key determinants of labour productivity dynamics. The results for the employment variable reveal a statistically significant, negative relationship between employment growth and labour productivity. In particular, the findings show that a 1% increase in employment corresponds to a 0.1% decline in labour productivity. This outcome confirms earlier findings that the Macedonian labour market absorbs "non-productive employment," implying that the expansion of employment includes workers whose participation reduces overall labour productivity.

The second model builds upon the previous regression model by incorporating gross capital formation (gross investment) as an additional independent variable. The regression results indicate a statistically significant causal relationship between gross investment and labour productivity. Specifically, the coefficient for gross investment is 0.0082367, suggesting that a 10% increase in gross investment, on average, leads to a 0.8% increase in labour productivity, *ceteris paribus*. Although the effect is moderate, gross investments exert a positive influence on labour productivity. In terms of other independent variables, human capital continues to exhibit a positive and statistically significant relationship with labour productivity, while employment maintains a statistically significant, inverse causal relationship with labour productivity. The adjusted coefficient of determination is 0.8951, indicating a good fit for the model and high explanatory power for the variability in labour productivity based on changes in the independent variables.

In the third model, workers' compensation is added as an independent variable. The results show a negative but statistically insignificant causal relationship between workers' compensation and labour productivity. Conversely, employment maintains a statistically significant and negative relationship with labour productivity, while human capital and gross investments continue to have a positive and statistically significant impact on labour productivity. The fourth model introduces inflation as an additional determinant of labour productivity. In this model, human capital and gross investment remain statistically significant and continue to show a positive association with labour productivity. Employment retains its statistical significance and reflects an inverse causal relationship with labour productivity, with a coefficient of 0.268671. Regarding inflation, the model identifies a statistically significant, yet weak, relationship with labour productivity, indicating that changes in inflation do not substantially influence labour productivity trends.

Table 3: Results of the conducted regression analysis using the method (OLS)

Estimation	Metric	Employment	Human Capital	Gross capital formation	Workers' compensation	Inflation	Log(Gross national income per capita)	Constant	Adjusted R ²
(1)	Coef. p-value	- .0124 702 0.000	.144467 9 0.000					8.61166 6 0.000	0.882 0
(2)	Coef. p-value	- .0138 394 0.000	.095395 6 0.001	.008236 7 0.040				8.90858 5 0.000	0.895 1
(3)	Coef. p-value	- .0142 71 0.000	.107178 2 0.000	.007953 5 0.045	- .001388 8 0.201			8.96717 5 0.000	0.897 7
(4)	Coef. p-value	- .0268 671 0.000	.154335 3 0.000	.008918 6 0.012	.000503 6 0.700	.004395 9 0.000		8.77619 6 0.000	0.914 0
(5)	Coef. p-value	- .0212 218 0.000	- .037191 8 0.060	.003027 8 0.034	.000925 6 0.074	- .000202 9 0.706	.829625 8 0.000	3.58424 8 0.000	0.917 5

(Source: Authors' calculations)

The fifth regression model, the most comprehensive within this analysis, includes the following independent variables: employment, human capital, gross investments, workers' compensation, inflation, and the logarithmic value of gross national income per capita. For employment, the regression coefficient of -0.0212218 indicates a statistically significant negative impact on labour productivity, suggesting that an increase in employment results in a further decline in labour productivity. Additionally, the coefficient for human capital is -0.0371918, suggesting a negative association between human capital and labour productivity in this model. However, it should be noted that this relationship loses its statistical significance at the 95% confidence level. In contrast, gross investments (gross capital formation) maintain their statistical significance and exhibit a positive impact on labour productivity. At the 95% significance level, the workers' compensation and inflation variables are found to be statistically insignificant. The logarithmic value of gross national income per capita demonstrates a strong positive effect on labour productivity (coefficient = 0.8296258, p-value = 0.000), which significantly increases the adjusted coefficient of determination. This highlights that the model explains nearly 92% of the variability in labour productivity.

4.3. Discussion of the results of the regression analysis

The regression models presented in this analysis provide a comprehensive overview of the causal relationships between key macroeconomic determinants and labour productivity, which is a critical indicator of labour market performance in North Macedonia. The analysis includes five models, each incorporating different combinations of independent variables (employment,

human capital, gross capital formation, workers' compensation, inflation, and gross national income per capita) to assess their impact on the dependent variable, labour productivity. Below is a summary of the significance of individual variables in determining labour productivity.

With respect to human capital, this variable consistently exhibits a strong, positive, and statistically significant relationship with labour productivity, particularly in the first three models. These findings underscore the importance of investments in education, healthcare, and the development of skills and qualifications, which collectively enhance the overall quality of human capital. The statistical significance of human capital in models (1) through (4) suggests that it plays a critical role in determining labour productivity. However, in the final regression model (5), its significance diminishes, primarily due to the inclusion of other variables such as gross national income per capita, which absorbs some of the explanatory power that human capital held in previous models.

Employment, as an independent variable, demonstrates a statistically significant negative impact on labour productivity across all models. Although this finding contradicts conventional economic theory, which suggests that higher employment levels typically enhance productivity, the characteristics of employment in the Macedonian labour market reveal a trend of increasing employment accompanied by stagnant or declining labour productivity. This negative coefficient reflects the "quality" of additional employment, specifically the phenomenon of "unproductive employment," which reduces overall labour productivity. A considerable proportion of employment is concentrated in sectors such as agriculture, manufacturing, services, and retail, which produce low-value-added goods and are characterized by low efficiency, thereby contributing to the negative relationship between employment growth and labour productivity.

Moreover, the structure of employment is a significant constraint on higher labour productivity growth rates. A substantial portion of workers in the Macedonian labour market have either no formal education or only primary education. Additionally, there is a significant mismatch between workers' qualifications and the skills demanded by the labour market, further hindering productivity growth. The severe labour force deficit results in the employment of workers in roles for which they lack adequate qualifications, a key factor limiting the establishment of sustainable labour productivity growth rates.

Gross investments, represented by the independent variable gross capital formation, demonstrate a positive and statistically significant effect on labour productivity in North Macedonia. This relationship aligns with other empirical studies and theoretical postulates, which emphasize the importance of capital investments in enhancing productivity and promoting economic growth. However, in the case of North Macedonia, while the effects of gross investments on labour productivity are positive, they are not fully transmitted to employment and overall labour productivity. Specifically, the incomplete transfer of the positive effects of gross investments is attributed to the insufficient multiplier effect these investments generate within the Macedonian economy. Apart from primary employment, often resulting from public investments, particularly long-term infrastructure projects—there is a lack of multiplier effects on additional labour hiring and economic activities. Some empirical studies analysing public expenditure in North Macedonia conclude that public spending has a negative multiplier effect, contributing to a reduction in economic activity and crowding out private-sector investment (Filipovski *et al.*, 2016).

The relationship between workers' earnings and labour productivity is a fundamental indicator of labour market performance and reveals the extent to which the benefits of labour productivity growth are shared with workers. Labour productivity reflects the total output produced per unit of labour over a given period, while workers' compensation represents the earnings received on that basis. This relationship offers insight into the share of wages in the distribution of total income. In North Macedonia, the data suggest that increases in workers'

compensation negatively impact labour productivity. This outcome is primarily due to the fact that rising compensation translates into higher labour costs for companies, particularly when labour costs constitute a significant portion of total production expenses. If wage growth outpaces labour productivity growth—leading to higher costs per unit of output—this may result in higher prices for final products, potentially creating inflationary pressure.

Regarding the impact of inflation—or price stability—on labour productivity, the regression analysis suggests that inflation does not play a significant role in determining labour productivity. Over the past decade, labour productivity in North Macedonia has exhibited low and insufficient growth, while the economy, except for the COVID-19 pandemic (2020–2021) and the global financial crisis (2008–2009), has been characterized by price stability. Thus, the combination of low productivity growth and stable inflation rates during most of the analysed period points to a weak or insignificant causal relationship between these two indicators.

In summary, the results of the separate regression estimations highlight the significant influence of human capital, gross investments, and gross national income as key determinants of labour productivity. These findings align with relevant empirical research that underscores the positive impact of human capital and gross investments on labour market performance (Fischer *et al.*, 2009; Trpeski *et al.*, 2024). Conversely, the negative impact of unemployment on labour productivity suggests inefficiencies in resource allocation and structural weaknesses within the labour market, leading to the underutilization of the economy's most crucial resource—human capital.

5. CONCLUSION

The analysis conducted through Ordinary Least Squares (OLS) regression models has provided valuable insights into the causal relationships between key macroeconomic determinants and labour productivity in the Republic of North Macedonia. While the correlation analysis offered a preliminary understanding of the intensity and direction of these relationships, the regression analysis was crucial in establishing causality and assessing the overall performance of the labour market.

The findings of the analysis highlight the significant positive impact of human capital, gross investments, and gross national income per capita on labour productivity. These results emphasize the importance of investing in education, healthcare, and skill development, as these factors collectively enhance human capital, which in turn plays a vital role in improving labour productivity. Moreover, gross investments, particularly in infrastructure and technology, were found to positively influence productivity, although their full impact was not entirely transferred to the broader labour market due to limited multiplier effects within the economy.

The negative relationship between employment growth and labour productivity, as observed in all regression models, reveals structural weaknesses in the labour market. The phenomenon of "unproductive employment" and the concentration of labour in low-efficiency sectors such as agriculture and retail suggest that additional employment does not necessarily lead to higher productivity. Furthermore, the high proportion of workers with low educational attainment and the mismatch between worker qualifications and labour market demands have been identified as significant constraints on achieving sustainable labour productivity growth.

Although the data indicates a negative relationship between rising workers' compensation and labour productivity, this outcome is likely attributable to the increased labour costs that contribute to higher overall production expenses and exert inflationary pressures on the economy. This finding suggests that wage growth, when not aligned with corresponding increases in productivity, can lead to cost inefficiencies, thereby reducing the overall competitiveness of firms. Moreover, the results indicate that inflation, or the prevailing level of price stability, does not exert a significant influence on labour productivity. This is

particularly true in the case of North Macedonia, where inflation rates remained relatively stable during the majority of the analysed period, thus mitigating any potential impact on the productivity of labour.

Despite a significant reduction in the unemployment rate and a corresponding increase in employment in recent years, the labour market in the Republic of North Macedonia remains far from equilibrium. Labour productivity has stagnated over a long period of time, with some sectors even experiencing declines. The simultaneous rise in employment alongside declining labour productivity suggests that the labour market in North Macedonia is operating sub-optimally, reflecting inefficiencies in the allocation of labour resources and broader structural issues within the economy.

In conclusion, the findings of this analysis are consistent with relevant empirical research, which underscores the critical role of human capital and gross investments in improving labour productivity and enhancing labour market performance. However, structural inefficiencies and the underutilization of human capital in the Macedonian labour market continue to pose significant challenges that must be addressed to achieve sustainable productivity growth and foster long-term economic development.

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THE ROLE OF INSTITUTIONS IN THE ECONOMIC GROWTH OF OECD COUNTRIES

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ABSTRACT

This paper analyses the role of institutional quality in determining the economic growth in the OECD countries from 1995 to 2021 concerning the institutional economics framework developed by North (1990) and further advanced by Rodrik (2000) and Acemoglu et al. (2005). Institutions are viewed as the formal and informal structures that regulate economic, political, and social activities and are considered the key to influencing economic performance through the minimisation of transaction costs, encouragement of innovation, and human capital development. The theoretical framework assumes that inclusive institutions foster sustained economic growth while extractive institutions stifle development by consolidating power and assets. This paper hypothesises that institutional quality positively influences economic growth in OECD countries. Using panel regression models and Employing the Fraser Institute's Economic Freedom Index and the Heritage Foundation's Index of Economic Freedom as measures of institutional quality, it examines how government size, property rights, regulation, and trade freedom affect growth. The findings reveal that institutional quality has a positive but varying impact on economic growth. In particular, small government, low taxes, and good monetary policy are positively related to higher growth rates. However, factors such as property rights and trade freedom have either weak or negative coefficients of correlation with growth. The results suggest that fiscal prudence and sound money supply policies are conducive to growth, but other institutional factors are not as straightforward in their influence on growth. This study is useful for policymakers who wish to improve economic growth through institutional change.

Keywords: *Economic growth, Institutions, OECD countries.*

JEL classification: *O43, O47, P48.*

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THE ROLE OF INDUSTRY 5.0 IN ADVANCING AI-DRIVEN PREDICTIVE ANALYTICS IN BUSINESS OPERATIONS

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ABSTRACT

This paper analyzes the synergistic integration of AI-driven predictive analytics within Industry 5.0, emphasizing its transformative impact on business operations across various sectors. It highlights the role of artificial intelligence in enhancing human-machine collaboration to create more responsive, sustainable, and personalized manufacturing environments. Through detailed analysis, the paper notes how AI not only optimizes operational efficiencies but also enables the personalization of products and services, thus meeting diverse consumer needs with unprecedented precision. The study proposes a theoretical model comprising three main elements: the enterprise, AI-driven predictive analytics, and the enterprise in Industry 5.0. The paper offers comprehensive strategies for governments, enterprises, and individuals to improve problem-solving and foster innovation within the rapidly evolving industrial landscape.

Keywords: Industry 5.0, AI solutions, Predictive Analytics, Business.

JEL classification: L60, M11, M21.

1. INTRODUCTION

Industry 5.0 represents a pivotal movement towards the integration of human creativity and craftsmanship with the advanced capabilities of smart machines. This new industrial phase emphasizes collaboration between humans and machines, aiming to improve productivity, sustainability, and personalization in manufacturing. Unlike its predecessor, Industry 4.0, which focused primarily on automation and efficiency, Industry 5.0 seeks to bring a human touch back to the industrial processes, underscoring the importance of co-creation between man and machine (Coelho *et al.*, 2023; Leng *et al.*, 2022). Artificial Intelligence (AI) plays an important role in this evolution, serving as a bridge that connects digital systems and human ingenuity. In the context of Industry 5.0, AI is not just a tool for automating routine tasks but is increasingly seen as a collaborator that can augment human capabilities. AI algorithms can analyze vast amounts of data to predict trends, optimize operations, and provide decision-making support that complements human intuition and experience. This synergy enables

businesses to respond more effectively to complex challenges and customer demands (Fraga-Lamas *et al.*, 2021).

The impact of AI in Industry 5.0 extends beyond manufacturing to encompass all facets of a business. By integrating AI with human-centric approaches, companies can foster a culture of innovation where personalized products and services are the norms. This approach not only improves the efficiency of production processes but also improves the quality and customization of products, meeting diverse consumer needs with greater precision. Furthermore, AI-driven solutions can support sustainability initiatives, helping companies to minimize waste and energy consumption through smarter resource management (Đorđević *et al.*, 2023; Djordjevic *et al.*, 2023). Industry 5.0, buoyed by advancements in AI, marks a significant step forward in how businesses operate and innovate. By embracing the collaborative potential of humans and machines, businesses are set to transform their operations, offering tailored solutions that cater to an increasingly complex and dynamic market environment. This integration promises not only to improve economic outcomes but also to forge a path towards a more sustainable and human-centric future.

The main goal of this paper is to develop a theoretical model for improving the competitiveness of enterprises. In addition, suggestions and guidelines for improving business are discussed. The paper consists of six main sections: Introduction, Industry 5.0 and AI technologies, Predictive analytics with AI, Model for improving business, Suggestions and guidelines, and Conclusion.

2. INDUSTRY 5.0 AND AI TECHNOLOGIES

Industry 5.0 represents a significant evolution in manufacturing, emphasizing a strategic shift from the automation-heavy focus of Industry 4.0 to a more integrated and collaborative model. This new industrial model doesn't just utilize technology for efficiency; it reincorporates the human element at the heart of production processes. The core philosophy of Industry 5.0 is to marry the capabilities of humans and machines to create a more responsive, sustainable, and personalized manufacturing environment. This approach emphasizes creativity, craftsmanship, and the social impact of industrial activities, promoting not only economic growth but also a greater alignment with environmental and societal goals (Aslam *et al.*, 2020; Tiwari *et al.*, 2022). Artificial Intelligence (AI) serves as a central pillar in this transformative approach. In Industry 5.0, AI extends beyond its conventional applications of automating routine tasks to becoming a facilitative tool that augments human capabilities. For example, AI-driven systems in smart factories can predict machine failures before they occur, schedule maintenance, and even adapt production processes in real time based on changing conditions or requirements. These capabilities significantly improve operational efficiencies and reduce downtime. Moreover, AI contributes to the customization of production, allowing for the manufacture of bespoke products at a scale that mirrors mass production methods (Rane, 2023). The implementation of AI technologies within the Industry 5.0 framework involves several key applications that redefine how businesses operate. Advanced robotics equipped with AI can perceive their environment and make decisions with minimal human intervention. These robots can collaborate safely alongside human workers, adapting their behaviours to human actions and instructions. This collaborative environment not only improves safety but also improves worker satisfaction by relieving them of monotonous and physically demanding tasks (Doyle Kent and Kopacek, 2021).

Furthermore, the Internet of Things (IoT) plays an important role in the integration of AI in Industry 5.0 by connecting machines, devices, and systems across the entire production chain. IoT devices collect vast amounts of data from production environments, which AI systems analyze to optimize processes and predict needs. This interconnectedness enables a seamless

flow of information and a high degree of automation and customization. For instance, IoT sensors can track the conditions of products throughout the supply chain, with AI algorithms processing this data to ensure optimal storage conditions and timely delivery (Laghari *et al.*, 2021). AI also significantly impacts supply chain management in Industry 5.0 by enhancing visibility and responsiveness. AI algorithms analyse global trends, supply conditions, and logistical data to anticipate disruptions and propose alternative strategies. This predictive capability ensures that businesses can react swiftly to external pressures, such as fluctuating market demands or supply chain interruptions, thereby maintaining steady production flows and reducing waste (Jefroy *et al.*, 2022). Customer experience is equally transformed under Industry 5.0, where AI enables a higher degree of personalization in products and services. By leveraging data on consumer behavior and preferences, AI tools can tailor product offerings to individual needs and preferences, improving customer satisfaction and loyalty. This level of customization was once the privilege of bespoke artisans but can now be delivered on an industrial scale thanks to AI (Maddikunta *et al.*, 2022; Sindhwani *et al.*, 2022). Industry 5.0, powered by AI, aims not just to improve the efficiency and productivity of industrial processes but to do so in a way that is sustainable and beneficial to society. The goal is to build smarter, more adaptable factories that prioritize worker well-being, environmental sustainability, and economic viability, all harmonized through the thoughtful integration of technology. As industries embrace this new paradigm, the role of AI will be significant in ensuring that these ambitious objectives are met, guiding the transition towards a more collaborative, intelligent, and humane industrial future.

3. PREDICTIVE ANALYTICS WITH AI

Predictive analytics with AI is revolutionizing business strategy and operations by leveraging sophisticated algorithms to predict future trends and behaviours based on historical data. This approach utilizes various forms of artificial intelligence, including machine learning and deep learning, to analyse large datasets and extract actionable insights. By integrating AI with predictive analytics, businesses can not only anticipate outcomes but also make decisions that strategically align with future market conditions and consumer behaviours (Doleck *et al.*, 2020). The process begins with the collection and cleaning of vast amounts of data from multiple sources such as transaction records, customer interactions, social media, and even IoT devices. This data is then fed into machine learning models that are trained to identify patterns and anomalies. Over time, as these models are exposed to new data, they become increasingly accurate in their predictions. For instance, in the retail sector, predictive analytics can forecast seasonal demand, helping stores manage their inventory more effectively to avoid overstocking or stockouts. This improved inventory management directly translates to cost savings and improved customer satisfaction, as products are available when needed.

In finance, predictive analytics is used to assess credit risk, detect fraudulent transactions, and automate trading decisions. Financial institutions utilize historical transaction data to predict which customers may default on a loan or which transactions might be fraudulent. By identifying these risks early, companies can implement preventative measures, thereby reducing potential losses. Automated trading algorithms can analyse market data to make real-time trading decisions that capitalize on market trends, improving profitability. Predictive analytics also plays a significant role in operational efficiency. For example, manufacturing firms use AI to predict equipment failures before they occur. This predictive maintenance allows companies to carry out repairs during scheduled downtimes rather than after a failure, which minimizes disruption to operations and reduces repair costs. Similarly, predictive analytics can optimize supply chain operations by forecasting potential delays and suggesting

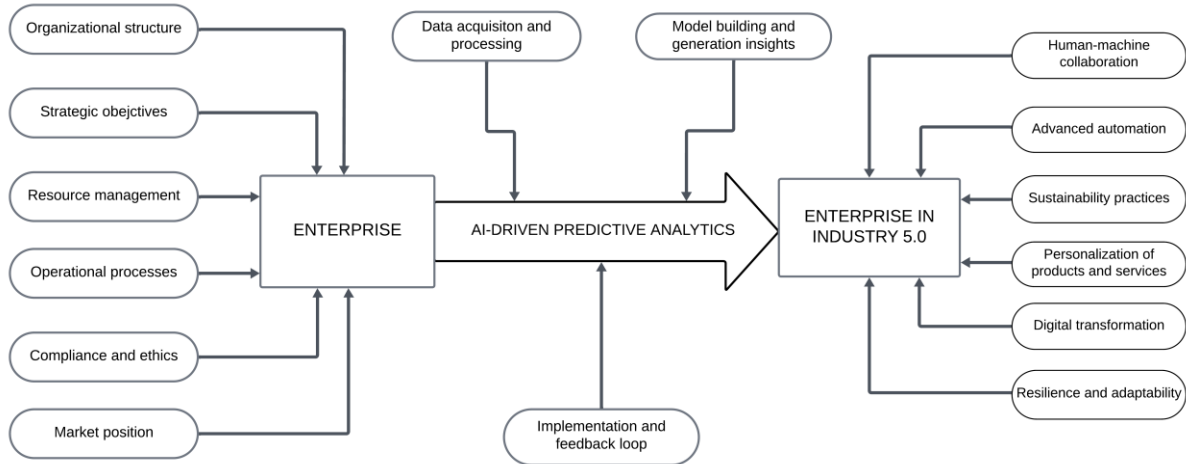
alternative strategies, such as adjusting delivery routes or suppliers in response to predicted changes in the market (Agrawal, 2022; Dev *et al.*, 2022; Zhang *et al.*, 2022).

AI-driven predictive methods, particularly machine learning (ML) and deep learning (DL), are integral to transforming enterprises in Industry 5.0. These methods analyse extensive datasets to forecast future trends, events, and behaviours, providing actionable insights for informed decision-making. Machine learning involves algorithms that learn from historical data to identify patterns and make predictions. Deep learning uses neural networks with multiple layers to model complex patterns in large datasets. Data collection and preprocessing include gathering, cleaning, normalizing, and feature extraction. Training and validation ensure models learn patterns effectively, and continuous learning updates predictions based on new data.

AI predictive methods improve various aspects of enterprise operations, aligning with Industry 5.0 goals of creating responsive, sustainable, and personalized environments. Predictive maintenance allows proactive maintenance by forecasting equipment failures and reducing downtime and costs. In supply chain optimization, AI algorithms predict disruptions and optimize logistics, ensuring steady production flows. Customer personalization benefits from AI-driven predictive methods, allowing for tailored marketing campaigns and retention strategies. AI models analyze customer data to recommend products and predict churn, improving engagement and loyalty. In finance, AI assesses credit risk, detects fraudulent transactions, and automates trading decisions, reducing losses and improving profitability. AI provides data-driven insights, augmenting human capabilities in creativity, strategic thinking, and complex problem-solving. Collaborative robots work alongside humans, improving safety and job satisfaction. Continuous learning in AI systems ensures accurate and relevant predictions, fostering innovation and adaptation. Ensuring ethical AI usage is important, particularly in handling data responsibly and maintaining transparency. Compliance with data protection laws and ethical standards ensures AI benefits without compromising privacy and trust.

Furthermore, the impact of predictive analytics extends to marketing and customer relationship management. By analysing customer data, companies can identify potential high-value customers and understand the purchasing behaviours of different segments. This insight allows businesses to craft personalized marketing strategies that resonate with specific customer groups, improving engagement and conversion rates. Additionally, predictive analytics can help companies predict customer churn, enabling them to implement retention strategies proactively. In strategic business planning, predictive analytics offers a significant advantage by enabling companies to foresee industry trends and shifts in consumer preferences. This foresight allows businesses to adapt their products and services to meet future needs, thus staying ahead of competitors and maintaining relevance in the market. Companies can also use predictive analytics to simulate various business scenarios and their outcomes, allowing for better-informed decision-making. Predictive analytics with AI provides businesses with a powerful tool to navigate the complexities of modern markets. It transforms large datasets into a strategic asset, enabling companies to make more informed decisions that improve their operational, financial, and marketing efficiencies. As AI technology continues to evolve, its integration with predictive analytics will become even more profound, offering businesses unprecedented capabilities to predict and shape their futures actively.

Figure 1: Model for improving business operations



(Source: Authors' work)

The relationships and influences among the sub-elements and main elements in the theoretical model reveal a complex interplay that shapes the enterprise's operations and strategic direction within the Industry 5.0 framework. The organizational structure of an enterprise determines how seamlessly AI-driven technologies and Industry 5.0 initiatives can be integrated across departments. This structure influences whether new technologies are adopted quickly and how collaborative the work environment is. Strategic objectives serve as a compass for predictive analytics, focusing efforts on particular outcomes such as improving customer experience or operational efficiency and guiding the adoption of Industry 5.0 to meet these goals. Resource management impacts the enterprise's ability to fund and support AI-driven and Industry 5.0 technologies. Effective allocation of resources ensures that necessary tools and skills are available for transformation. Operational processes are important, as they are directly improved by AI-driven analytics, which can optimize these processes for greater efficiency. However, the design of these processes also affects how effectively AI solutions can be implemented. Compliance and ethics play a vital role when integrating AI-driven solutions, especially in responsibly handling data and ensuring ethical AI usage. These considerations are significant in Industry 5.0 to ensure technological advancements are balanced with ethical standards. The market position of the enterprise can be improved through the effective use of AI and Industry 5.0 technologies, enabling better product development and competitive strategies. Within AI-driven predictive analytics, data acquisition and processing form the foundation for effective predictive models, as the quality and breadth of data collected directly impact the accuracy of AI predictions. Model building, centered on this data, is essential for generating reliable predictions that inform enterprise decisions. The actionable insights generated from these models can be implemented to bring real-world benefits, affecting everything from operational efficiency to strategic adjustments.

The implementation of these insights actualizes the potential of AI, influencing a wide range of enterprise activities. The feedback loop is significant, ensuring that AI models are continuously refined and adapted to the changing business environment and evolving industry standards. In the context of an enterprise operating within Industry 5.0, human-machine collaboration emphasizes the integration of human expertise with machine efficiency, affecting all operational and strategic aspects of the enterprise. Advanced automation improves operational capabilities, enabling more reliable and efficient production processes.

Sustainability practices influence both the enterprise's ethical standing and strategic objectives, impacting brand reputation and compliance with regulations.

The personalization of products and services, informed by predictive analytics, tailors offerings to individual customer preferences, directly improving customer satisfaction and enhancing market position. Digital transformation, driven by the adoption of AI and Industry 5.0 technologies, reshapes every facet of the enterprise from internal processes to customer interactions. Finally, resilience and adaptability are improved, ensuring the enterprise can maintain operations and remain competitive amid market and technological changes. This comprehensive integration not only improves operational efficiencies but also aligns the enterprise with future-ready practices that prioritize sustainability and innovation.

4. SUGGESTIONS AND GUIDELINES

Based on the analysed literature and the developed model, strategies, actions, and guidelines for improving business operations are noted:

- Develop regulatory frameworks that encourage the adoption of AI and Industry 5.0 technologies while ensuring compliance with ethical standards and data protection laws, thus fostering an environment where enterprises can safely innovate.
- Offer financial incentives such as tax breaks or grants for enterprises that invest in advanced technologies aimed at improving operational efficiency and sustainability, motivating more businesses to embrace innovative solutions.
- Support educational and training programs that focus on skills necessary for the Industry 5.0 workforce, including data science, machine learning, and human-machine collaboration, to prepare individuals for the evolving job market.
- Invest in AI-driven predictive analytics to gain deeper insights into market trends, customer behaviour, and internal operations, enabling more informed decision-making and strategic planning.
- Foster a culture of continuous learning and innovation within the organization by providing regular training and development opportunities, ensuring that employees are equipped to handle new technologies and methodologies.
- Implement a robust feedback loop for AI systems to continuously collect data on their performance, allowing for ongoing adjustments and improvements in real-time decision-making processes.
- Improve resilience and adaptability by developing strategies that anticipate and respond to changes in the market and technology landscapes, ensuring that the enterprise remains competitive and responsive to external pressures.
- Engage in lifelong learning and stay informed about the latest developments in AI, machine learning, and Industry 5.0, to maintain relevancy in the job market and contribute effectively to enterprise problem-solving.
- Cultivate a mindset that values collaboration and openness to technology, recognizing that human skills such as creativity and significant thinking are essential complements to machine efficiency.
- Participate in professional networks and forums that discuss and share best practices on integrating AI into business processes, leveraging collective knowledge to improve personal and organizational problem-solving capabilities.
- These strategies and actions aim to create a supportive ecosystem for enterprises to thrive in the face of technological advancements and market challenges, promoting effective problem-solving and sustainable growth.

5. CONCLUSION

The exploration of AI-driven predictive analytics within the context of Industry 5.0 has elucidated a transformative approach to modern industrial operations, where technology and human ingenuity are integrated to a degree previously unattained. This integration is manifest not only in the improved operational efficiencies and reduced downtimes but also in the personalization of products and the sustainability of manufacturing processes. The synergistic relationship between AI and human workers improves the adaptability and resilience of enterprises, allowing them to meet contemporary market demands and anticipate future challenges more effectively. Furthermore, the pivotal role of IoT in augmenting AI capabilities emphasizes the significance of interconnected systems in achieving a seamless flow of information, which is important for real-time decision-making and process optimization. This technological synergy fosters a dynamic environment where predictive analytics can flourish, offering enterprises robust tools to navigate and thrive in the increasingly complex global marketplace.

The theoretical model proposed in this study, encompassing the enterprise, AI-driven predictive analytics, and the enterprise within Industry 5.0, provides a structured framework that delineates the interaction between these elements. This model not only highlights the potential for AI to revolutionize business practices but also sets a foundation for further empirical research to validate and refine the effectiveness of AI integration across different sectors. As industries continue to embrace the paradigms of Industry 5.0, the role of AI will become more significant in ensuring that these ambitious objectives are achieved. The successful implementation of AI-driven predictive analytics promises not only to improve the efficiency and productivity of industrial processes but also to contribute to a more sustainable and human-centric economic future. Therefore, continued investment in AI technologies, coupled with strategic management and policy support, is essential for realizing the full potential of this industrial evolution.

ACKNOWLEDGEMENT

This paper has been supported by the Provincial Secretariat for Higher Education and Scientific Research of the Autonomous Province of Vojvodina, number: 142-451-2963/2023-01.

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ADVANCING JOB DESIGN THROUGH ARTIFICIAL INTELLIGENCE: BIBLIOMETRIC DATA-BASED INSIGHTS AND SUGGESTIONS FOR FUTURE RESEARCH

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ABSTRACT

As the digital transformation of businesses reshapes jobs to delegate tasks to technology, human resource professionals and managers find themselves at a crossroads when it comes to designing and redesigning jobs, especially under the influence of artificial intelligence (AI). Being an emerging topic, this article aims to synthesize the current state-of-the-art literature regarding the application of AI for job design purposes using a multi-technique bibliometric analysis followed by a literature review in compliance with the rigorous Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines. The research presents the findings grounded in data from 67 Scopus-indexed publications, which was analyzed with a combination of descriptive bibliometric analysis, co-authorship, bibliographic coupling, and co-occurrence analysis, helping us identify past scientific directions as well as draft a future research agenda. As one of the first bibliometric analyses in the field, it contributes to the scientific discourse by revealing the core themes of the literature, including job characteristics impacted by AI and data-driven human resource (HR) practices, group-level AI integration in job design, AI-related job skills of the future of the workforce, human-AI trust and labor relations and the role of algorithmic human resource management (HRM) in job design. Further, we stress seven distinct pathways for future research.

Keywords: Job design, Work design, Artificial intelligence, Bibliometric review.

JEL classification: M12.

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EVOLVING LEADERSHIP IN THE DIGITAL ERA: COMPETENCIES AND STRATEGIES FOR NAVIGATING INDUSTRY 4.0

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EXTENDED ABSTRACT

Purpose The rapid implementation of Industry 4.0, driven by the integration of digital technologies, automation, big data analytics, and cyber-physical systems, represents a transformative shift in industrial paradigms. This Fourth Industrial Revolution is unique in its fusion of technologies, which blur the boundaries between the physical, digital, and biological domains (Schwab, 2017). The technological advancements embedded within Industry 4.0 significantly impact leadership in organizations. As the complexity and dynamism of Industry 4.0 environments grow, there is a pressing need for new leadership competencies that emphasize agility, digital fluency, and collaborative capabilities (Faller and Feldmüller, 2015). In parallel, the education sector within the European Union has recognized the importance of preparing future leaders to address not only the digital challenges of Industry 4.0 but also the societal and economic complexities of the 21st century. The concept of entrepreneurial leadership in EU education acknowledges these emerging trends and seeks to cultivate leaders equipped with emotional intelligence and intercultural competence. This chapter aims to conceptualize a model of entrepreneurial leadership that bridges the gap between theoretical learning and real-world applications, particularly in the context of rapidly evolving industrial and educational landscapes.

As traditional leadership models may no longer be adequate to meet the demands of Industry 4.0, leaders must evolve, becoming facilitators of digital transformation and enablers of innovation within their organizations (Kagermann, 2015). Similarly, the proposed model of entrepreneurial leadership in EU education emphasizes the development of leaders who can foster experiential learning and cross-cultural collaboration, skills that are essential for thriving in the interconnected, technology-driven world of Industry 4.0.

Digital transformation technologies have changed contemporary organizational environments and operations (Ly, 2023). The practitioners agreed on visionary thinking, agility, understanding the value of data, data-driven decision-making, knowledge of strategy, and accepting change as the most important requirements for managing digital transformation (Philip *et al.*, 2023).

Table 1: Key competencies of leaders in the era of Industry 4.0

Competency	Description	Source
Digital Literacy	Ability to understand and apply digital tools	Faller and Feldmüller (2015)
Strategic Vision	Long-term planning and forecasting trends	Kagermann (2015)
Emotional Intelligence	Managing emotions and communicating with diverse teams	Schwab (2017)
Intercultural Competence	Ability to work in a global, intercultural environment	Oberer and Erkollar (2018)
Agility	Rapid adaptation to changing circumstances	North, Maier, and Haas (2018)

(Source: Authors analysis)

By integrating the core elements of Industry 4.0 into leadership education, this research seeks to explore how educational strategies and leadership competencies can be aligned to foster innovation, adaptability, and workforce engagement. Both Industry 4.0 and the evolving leadership models within EU education converge on a common objective: equipping future leaders with the tools and skills necessary to navigate the complexities of a rapidly changing technological and societal landscape.

Methodology The proposed research will adopt a qualitative approach to explore the evolving leadership competencies required in Industry 4.0. By focusing on the qualitative dimension of leadership, this study aims to capture in-depth insights into how leaders are navigating the challenges of digital transformation and fostering innovation in their organizations. This approach will provide a more nuanced understanding of the leadership styles and strategies that are most effective in the context of the Fourth Industrial Revolution.

Data collection will occur through two primary methods: semi-structured interviews and case studies. Firstly, a series of semi-structured interviews will be conducted with a select group of participants who have demonstrated leadership success in the digital age. These participants will be chosen based on their experience and proven track record in leading organizations through digital transformation initiatives. The interviews will explore key aspects of their leadership practices, including decision-making processes, approaches to fostering collaboration, and strategies for overcoming the complexities associated with Industry 4.0. The semi-structured format will allow for flexibility in the interviews, enabling participants to share their experiences while ensuring that key themes relevant to Industry 4.0 leadership are addressed. Thematic analysis will be applied to the interview data to identify recurring patterns, themes, and insights (Guest *et al.*, 2012). In addition to interviews, this research will employ case studies of organizations that have successfully embraced Industry 4.0 technologies. These case studies will provide concrete examples of leadership practices in action, offering valuable contextual insights. Through an examination of these organizations, the research will explore how leadership competencies, organizational culture, and strategic decision-making have influenced the successful implementation of digital technologies. The case studies will help to illuminate the specific factors that contribute to leadership efficacy in the Industry 4.0 environment, providing practical examples of leadership models that can be applied across different sectors.

In parallel, this study will draw on the conceptual framework of entrepreneurial leadership in EU education. The qualitative data gathered from interviews and case studies will also be

analyzed in light of the evolving educational strategies aimed at developing entrepreneurial leadership competencies. By comparing leadership practices in Industry 4.0 with educational models that emphasize emotional intelligence, intercultural competence, and experiential learning, the research aims to offer a comprehensive perspective on how leadership can be cultivated in both industrial and educational settings.

This combined methodological approach—semi-structured interviews, thematic analysis, and case studies—offer a detailed, context-rich understanding of the leadership competencies required for success in the rapidly changing landscape of Industry 4.0, as well as provide insights for enhancing leadership education in the EU.

Findings The research is anticipated to yield several significant insights into the evolving role of leadership within the context of Industry 4.0. Through an in-depth analysis of qualitative data gathered from interviews and case studies, the study aims to uncover essential leadership competencies that will define success in this technology-driven era. One of the primary findings is the identification of a core set of competencies, including digital literacy, strategic vision, and the ability to lead diverse, cross-functional teams. These skills are crucial for leaders to navigate the complexities of a rapidly changing technological landscape, where traditional boundaries between departments and roles are increasingly blurred. Emotional intelligence and intercultural competence, as emphasized in the entrepreneurial leadership model in EU education, will also emerge as critical competencies for managing global and interconnected teams in this new industrial paradigm.

In addition to identifying core competencies, the research is expected to provide empirical evidence on the relationship between leadership styles and organizational outcomes, particularly in fostering innovation and employee engagement. Leadership styles that prioritize transformational and servant leadership are likely to be associated with higher levels of organizational adaptability and creativity. These styles, which emphasize fostering a culture of continuous improvement and putting people first, are expected to play a vital role in navigating the challenges of digital transformation in Industry 4.0 environments.

The study will also offer practical recommendations for leadership development programs designed to equip leaders with the skills necessary for Industry 4.0. These programs will need to emphasize continuous learning and agility, ensuring that leaders remain adaptable in the face of rapidly evolving technologies and market conditions. Developing interdisciplinary knowledge that blends technical, strategic, and interpersonal skills will be critical to preparing leaders for the multifaceted challenges posed by Industry 4.0.

Qualitative findings will provide further insights into how leaders manage the interplay between technology and human factors in practice. As organizations become more automated, leaders will need to address ethical concerns related to automation, data privacy, and artificial intelligence, while ensuring that technological advancements align with organizational values. Maintaining a human-centric approach in leadership, which balances the increasing role of automation with the need to preserve human creativity and collaboration, will be vital for fostering a cohesive and motivated workforce.

Finally, the case studies will serve as valuable models of best practices, offering a roadmap for leaders guiding their organizations through digital transformation. These case studies will highlight effective leadership strategies for integrating Industry 4.0 technologies, overcoming common challenges such as resistance to change, and ensuring the workforce is equipped to thrive in a technology-driven environment. Overall, the research is expected to bridge the gap between theoretical leadership models and their real-world application, providing valuable insights for both industry leaders and educators who are shaping the next generation of leaders.

Value of the study The value of this research lies in its significant contribution to the evolving understanding of leadership in the digital age. While much of the existing literature on Industry 4.0 has focused on its technological aspects—such as automation, big data, and cyber-physical

systems—there is a notable gap in research on the human element, particularly the role of leadership in guiding organizations through these profound changes. By emphasizing leadership, this study addresses a critical gap in the literature and offers practical implications for industry practitioners (Avolio and Yammarino, 2013).

One of the primary contributions of this research is its exploration of the leadership competencies required to navigate the complexities of Industry 4.0. The findings will provide a deeper understanding of the skills, styles, and strategies that leaders must adopt to foster innovation, drive digital transformation, and engage their workforce in technology-driven environments. For organizational leaders and policymakers, these insights will be invaluable in developing leadership frameworks and training programs tailored to the demands of Industry 4.0. The study will guide efforts to cultivate leadership that is agile, technologically fluent, and capable of managing cross-functional, diverse teams.

Moreover, the interdisciplinary approach of this research—combining leadership theory with insights from technology management and organizational behavior—adds a valuable dimension to the existing body of knowledge. By integrating perspectives from multiple fields, the study will provide a more holistic understanding of how organizations can thrive in an era of rapid technological change. This comprehensive perspective is essential as it highlights the intersection between human factors and technology, offering a balanced view of how leaders can effectively manage both the technological and human challenges posed by Industry 4.0.

As the digital era continues to reshape the industrial landscape, the insights from this research will be instrumental in helping leaders guide their organizations toward long-term success and sustainability. The study's findings will serve not only as a resource for industry practitioners seeking to implement effective leadership strategies but also as a foundation for future academic research on leadership in the context of technological transformation. By shedding light on the evolving role of leadership in Industry 4.0, this research will ultimately contribute to the development of more adaptive, innovative, and resilient organizations.

Conclusion Leadership in the age of Industry 4.0 presents both significant challenges and unprecedented opportunities for those responsible for guiding organizations through the complex processes of digital transformation. This research will make a vital contribution to understanding how leadership must evolve to remain effective within this new industrial paradigm. By focusing on the human element of Industry 4.0, the study will help fill a critical gap in the current literature, providing valuable insights into the competencies, leadership styles, and strategies that are essential for success.

The findings will serve as a blueprint for developing leadership that is not only adaptable and innovative but also ethically grounded, enabling leaders to navigate the complexities of technological disruption while maintaining organizational values and fostering human-centric approaches. Ultimately, this research aims to offer practical solutions for industry practitioners and policymakers, helping them shape leadership frameworks that ensure long-term organizational success and sustainability in an increasingly digital and automated world. As technological advancements continue to reshape industries globally, the study's contributions will be instrumental in preparing leaders for the future challenges and opportunities of Industry 4.0.

Keywords: *Industry 4.0, Leadership competencies, Digital transformation, Entrepreneurial leadership, Innovation management.*

JEL classification: *JEL O32.*

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FOSTERING SUSTAINABILITY IN THE BALKAN WINE INDUSTRY: CHALLENGES AND STRATEGIC SOLUTIONS

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ABSTRACT

The wine industry in the Balkans holds significant potential for fostering sustainable regional development, but it also faces numerous environmental, economic, social, and regulatory challenges. Through a qualitative study based on semi-structured interviews with professionals in the Balkan wine industry, this article explores the most pressing sustainability challenges and proposes strategic solutions for overcoming these barriers. Grounded in sustainability theories, including the Triple Bottom Line (TBL) framework and Stakeholder theory, the findings highlight the collaborative initiatives, technological innovation, implementation of circular economy principles, policy reform, and social initiatives as pivotal to fostering sustainable practices. This research contributes to the literature on regional sustainable development by offering new insights into industry-specific challenges and solutions, providing a conceptual framework for further exploration and policy formulation in the context of the Balkans.

Keywords: Sustainability, Balkan wine industry, Regional development, Qualitative study.

JEL classification: Q13.

1. INTRODUCTION

Sustainability has become an essential focal point for industries seeking to adapt to modern environmental and economic challenges (Signori *et al.*, 2017). The wine industry faces challenges stemming from production and consumption differences across territories, with operational synergies and program integration varying significantly between countries (Christ and Burritt, 2013). Hence, the wine industry is adapting to changing consumer trends, regulatory requirements, and climate change (Annunziata *et al.*, 2018). Wine production in the Balkan region holds historical, cultural, and economic significance, making it a crucial player in the local economy. However, as climate change intensifies, resource scarcity and consumer expectations for environmentally friendly practices further pressure the industry.

This study focuses on identifying the sustainability challenges and solutions specific to the Balkan wine industry and examines how these findings contribute to broader discussions on sustainable regional development. Sustainability in this context refers to the capacity of the wine industry to meet current production needs without compromising future environmental, economic, and social outcomes. Furthermore, the adoption of sustainability not only stimulates innovation and creates opportunities, but also enhances competitive differentiation (Gupta *et al.*, 2013; Choi and Gray, 2008). Addressing sustainability is particularly important for the Balkan region, where wine production often relies on small and medium-sized enterprises (SMEs) with limited resources to navigate these complex issues (Moore and Marning, 2009; Gupta *et al.*, 2013).

Grounded in Triple Bottom Line (TBL) framework and Stakeholder theory, this article addresses the following research question: What are the main sustainability challenges facing the Balkan wine industry, and what strategic solutions can be implemented to overcome these barriers for long-term regional development? This article seeks to fill a gap in the literature by providing qualitative insights from industry professionals on the unique sustainability challenges and opportunities in this region, focusing on practical and theoretical contributions.

2. LITERATURE REVIEW

Sustainability has become a central topic in the context of regional development, particularly in resource-dependent industries like wine production (Gilinsky *et al.*, 2016; Santini *et al.*, 2013). One of the foundational theories underpinning the discourse on sustainability is the Triple Bottom Line (TBL), introduced by Elkington (1997). The TBL framework goes beyond the traditional focus on financial performance by including environmental and social dimensions, making it highly relevant to sectors that directly interact with the environment, such as agriculture and viticulture (Joyce and Paquin, 2016), thereby having a substantial impact on economic viability, worker health, land use, society, and local and regional development (Baiano, 2021; Corbo *et al.*, 2014). Within the context of viticulture, TBL suggests that sustainable wine production requires strategies that balance these three pillars, addressing environmental impacts such as water usage and soil erosion while ensuring economic growth and community benefits (Christ and Burritt, 2013; Gabzdylova, *et al.*, 2009; Fiore *et al.*, 2017).

Studies focusing on sustainable wine production, particularly in well-established regions such as France and Italy, have explored innovative techniques like organic farming, energy efficiency measures, and sustainable packaging to reduce environmental impacts (Annunziata *et al.*, 2018; Baiano, 2021; Lichy *et al.*, 2023; De Steur *et al.*, 2019; Cantino *et al.*, 2019; Borsellino *et al.*, 2016). However, fewer studies have addressed how sustainability can be promoted in smaller, less resourced wine regions such as the Balkans, where SMEs dominate the market and lack the capital to invest in large-scale sustainability initiatives. Although the wine sector plays a significant role in regional economic growth, tourism, and rural development, the challenge of sustainable regional development, particularly in terms of comprehensive environmental and social strategies, is still evolving (Trišić *et al.*, 2019; Licastro and Sergi, 2021). Historical factors, including political instability and economic constraints, have further delayed progress in these areas. Regional development through wine production must therefore consider not only economic and agricultural outputs but also the sustainability of the entire ecosystem in which the industry operates.

Research on organizational sustainability has shown that people within organizations play a crucial role in promoting sustainable strategies, mainly driven by the stakeholders' concerns and internal motivations (Szolnoki, 2013; Corbo *et al.*, 2014; Gabzdylova *et al.*, 2009; Giacomarra *et al.*, 2016; Santini *et al.*, 2013). Therefore, in tandem with TBL, the Stakeholder

Theory, proposed by Freeman (1984), highlights the broader responsibilities of businesses to all stakeholders, including employees, customers, local communities, and the environment. In the wine industry, this means that producers must consider the impact of their practices not just on financial outcomes, but also on the ecosystems and communities they affect (Dodds *et al.*, 2013; Gabzdylova *et al.*, 2009; Pomarici *et al.*, 2015). Aligning the diverse interests of these stakeholders is crucial to achieving long-term sustainability (Darnall *et al.*, 2010; Dyllick and Hockerts, 2002; Bansal, 2005) driving competitive advantage (Lucas, 2010, Marco-Lajara *et al.*, 2023), product differentiation (Bonifant *et al.*, 1995), cost reductions (Christmann, 2000) and enduring success for future generations (Marco-Lajara *et al.*, 2023; Lamastra *et al.*, 2016; Broccardo and Zicari, 2020). New technology and green management strategies can facilitate this shift, making sustainability a competitive component, market-driving strategy, and innovation process driver (Glinsky *et al.*, 2016; Fiore *et al.*, 2017). Accurate tools to quantify sustainability contributions are crucial for effective management of sustainability issues and identifying areas for improvement (Martins *et al.*, 2018). However, producers often struggle to distinguish between sustainable agricultural approaches, such as sustainable, organic, or biodynamic (Flores and Medeiros, 2019; Szolnoki, 2013). Although the European Union has made attempts to promote sustainability through initiatives like the circular economy (CE) pillar, the wine sector has not yet adopted tactics to encourage a more circular approach. The potential contribution of wine production to the 3R strategy (reduce, reuse, recycle), particularly in waste management, has been explored, as waste is a major environmental concern in wine production (Arvanitoyannis *et al.*, 2006; Oliveira and Duarte, 2016; Ruggieri *et al.*, 2009). This research extends Stakeholder Theory by exploring how collaboration among stakeholders in the Balkan wine industry can drive both environmental and economic sustainability, creating shared value for the region as a whole.

3. METHODOLOGY

This research employs a qualitative methodology designed to capture in-depth insights into the sustainability challenges and opportunities within the Balkan wine industry. The study utilized semi-structured interviews with eight industry professionals, including vineyard owners, sustainability managers, and government officials involved in agricultural policy. These participants were selected based on their expertise and hands-on involvement in the industry, ensuring that the interviews reflected a comprehensive range of perspectives on sustainability. Sampling was conducted using a purposive method, targeting individuals whose roles directly related to sustainability in the wine industry. This allowed the research to focus on obtaining rich, detailed accounts of the challenges and solutions specific to sustainability. Each interview lasted between 60 and 90 minutes, following a semi-structured format that enabled flexibility in exploring topics while ensuring that key areas, such as environmental impacts, economic pressures, and regulatory frameworks, were consistently covered.

Thematic analysis was used to identify recurring themes and patterns across the interviews. This approach enabled us to draw connections between the challenges identified by participants and existing theoretical frameworks, such as TBL and Stakeholder theory. By coding the data and mapping it onto these frameworks, the analysis provides both theoretical insights and practical solutions for addressing the identified sustainability challenges.

4. RESULTS AND DISCUSSION

4.1. Identifying sustainability challenges

The results of the thematic analysis revealed several major sustainability challenges faced by the Balkan wine industry. Economic pressures emerged as a dominant theme, with participants consistently citing the high costs of sustainable practices as a significant barrier. The high

upfront costs associated with sustainable farming techniques, renewable energy adoption, and waste management systems were identified as prohibitive, particularly for SMEs with limited financial capital. One vineyard owner remarked: “Sustainability is important, but the costs are simply too high. We don’t have the budget to invest in renewable energy or advanced irrigation systems.”

Environmental degradation was another key challenge identified by participants. Several interviewees highlighted the impact of climate change on their vineyards, including increased temperatures and unpredictable weather patterns. These changes have affected grape quality and yield, making sustainable agricultural practices even more urgent. A sustainability manager noted, “We’ve seen a marked difference in the climate over the past decade. The summers are hotter, and we have less predictable rain. This has a direct impact on our vineyards, and we need sustainable solutions to cope.”

The lack of government support was also a prominent theme in the interviews. Participants expressed concern about the absence of coherent policies and financial incentives to promote sustainability within the wine industry. Policymakers acknowledged that while sustainability is on the political agenda, concrete measures to support the industry are lacking. As one policy advisor explained: “There’s a lot of talk about sustainability, but not enough action from the government. What we need are subsidies or tax breaks for businesses that invest in sustainable technologies.” Without coherent policy guidance, sustainability often takes a backseat to short-term economic concerns. The absence of subsidies or tax breaks for sustainable practices exacerbates this issue, leaving many producers with little motivation to prioritize environmental goals.

In addition to these challenges, the social dimension emerged as a critical concern. Participants discussed the impacts of wine production on local communities, highlighting issues such as labour conditions, social equity, and local engagement. Participants emphasized the need for training programs to enhance the skills of workers in sustainable practices. A vineyard owner stated, “We need to invest in our people. If we want to be sustainable, our workers need to be trained in eco-friendly methods.” This focus on social responsibility can help foster a culture of sustainability within the industry.

Territorial challenges also surfaced, particularly in the context of preserving local identities and landscapes. Participants pointed out that wine production should respect local conditions and promote rural development, emphasizing the importance of maintaining land use and landscape preservation. They noted that failing to consider these aspects could lead to a loss of cultural heritage and undermine the unique characteristics that define regional wines.

Finally, participants recognized the need to account for various other factors that influence sustainability, such as heritage, historical significance, and cultural aspects. These dimensions encompass the preservation of traditional winemaking methods and the promotion of cultural events related to wine. A winemaker highlighted, “Our wines tell the story of our land and culture. We cannot forget where we came from while trying to innovate.” The participants also noted the aesthetic dimensions of the wine landscape, arguing that preserving the natural beauty of vineyards is vital for tourism and regional identity. Addressing these factors is vital for enhancing the industry's overall sustainability and fostering a sense of identity among local communities.

4.2. Proposing strategic solutions

The interviews also uncovered potential strategies for addressing these challenges. Collaboration between stakeholders emerged as a vital solution. Participants suggested that wine producers, local governments, and international organizations should engage in knowledge and resource-sharing initiatives to promote sustainable practices. A vineyard owner

stated, “If we work together as an industry, we can pool resources and reduce the costs of going green.” Additionally, partnerships with research institutions could provide the industry with access to cutting-edge innovations, such as precision farming technologies and smart agriculture which could mitigate the environmental impact of wine production, as also noted by other scholars (Annunziata *et al.*, 2018, Mainar-Toledo *et al.*, 2023). This collective approach can lead to shared innovations and reduce individual burdens, making sustainability more attainable.

The adoption of green technologies was another widely discussed solution. Several participants noted that while the initial costs of technologies such as water-saving irrigation systems or renewable energy sources are high, the long-term benefits outweigh the costs. “Investing in sustainable technologies is expensive, but in the long run, it’s necessary to preserve the environment and maintain high-quality production,” remarked one participant. Furthermore, the implementation of circular economy principles was identified as a strategic avenue. Participants suggested that adopting eco-efficiency programs and waste management practices, such as recycling and upcycling, could promote environmental management and resource efficiency. As noted by one respondent, “Closing the resource loop is essential for mitigating our ecological footprint while also creating economic benefits.” This approach aligns with contemporary trends in sustainable production and can significantly contribute to the industry’s resilience (Flores and Medeiros, 2019; Bocken *et al.*, 2016; Ghisellini *et al.*, 2016). Circular economy practices, such as optimizing packaging design by using biodegradable or compostable materials, can further promote sustainability by reducing waste and carbon emissions associated with wine transportation (Annunziata *et al.*, 2018). This proactive approach extends to eco-design, life cycle assessment (LCA), and sustainable mobility, creating a closed-loop system that enhances the industry’s overall eco-efficiency.

Moreover, participants called for policy reform to provide stronger incentives for sustainability. Recommendations included clearer regulatory frameworks, financial support for green initiatives, and the promotion of sustainability certification schemes for wine producers. By implementing these reforms, participants argued, the Balkan wine industry could become a model for sustainable agriculture in the region. Policy incentives, such as subsidies or grants, could also enhance the industry’s resilience to climate change by supporting adaptation strategies, including dry farming, sustainable pest management, and planting climate-resilient grape varieties (Baiano, 2021).

Social initiatives aimed at improving workforce training and community engagement were also recommended. Participants highlighted the importance of developing training programs for workers to ensure they are equipped with the necessary skills for sustainable practices. Additionally, regenerative agriculture, such as biodynamic and organic farming, can restore soil health and promote biodiversity, contributing to a more resilient ecosystem while supporting the social and environmental dimensions of sustainability. As such, transitioning to these practices is vital for both environmental stewardship and the long-term productivity of vineyards.

To address the broader dimensions of sustainability, the proposed strategies also encompass cultural and territorial considerations. For instance, promoting local heritage through the marketing of traditional winemaking practices can foster community pride and support regional development. Emphasizing the unique cultural and historical aspects of the Balkan wine industry can enhance consumer connection and loyalty, particularly as global interest in alternative wines like organic, natural, or sustainable wines grows (Baiano, 2021). Integrating transparency and traceability systems also allows consumers to track the origin of products, further supporting responsible consumption and production (Annunziata *et al.*, 2018).

This article proposes a conceptual framework for sustainable development that integrates stakeholder collaboration, technological innovation, and policy reform. By aligning the

interests of producers, policymakers, and consumers, the framework presents a pathway for addressing the multifaceted challenges facing the industry. It also highlights the need for a robust policy infrastructure that incentivizes sustainable practices through subsidies, tax benefits, and grants, ensuring a holistic approach that considers economic viability, social responsibility, environmental stewardship, and the preservation of local heritage and culture (De Steur *et al.*, 2019; Annunziata *et al.*, 2018; Flores, 2018; Santini *et al.*, 2013; Darnall *et al.*, 2010).

5. CONCLUSION

This study provides a comprehensive exploration of the sustainability challenges faced by the Balkan wine industry, offering practical strategies for overcoming these barriers. By grounding the research in qualitative insights from industry professionals, this article expands upon existing theories such as TBL and Stakeholder theory, applying them to a region-specific context. Through a combination of strategic approaches, the industry has the potential to overcome these obstacles and become a leader in sustainable agriculture. Collaboration among stakeholders, green technology adoption, and policy reforms are foundational elements for driving this transformation. Furthermore, implementing circular economy principles, investing in technological innovations, and developing strategies for climate change resilience and regenerative agriculture are essential for fostering both environmental and economic sustainability. By adopting these strategies, the Balkan wine industry can not only reduce its environmental impact but also enhance its competitiveness in the global market.

This research not only enriches the academic discourse on sustainability in the agricultural sector but also provides practical insights for industry practitioners and policymakers aiming to navigate the complexities of sustainable development. Ultimately, this article contributes to a deeper understanding of the unique sustainability challenges faced by the Balkan wine industry and offers actionable strategies for addressing them, highlighting the potential for the sector to serve as a model for sustainable practices in other regions. This article underscores the need for a coordinated effort involving producers, governments, and consumers to create a more resilient and sustainable wine industry in the region. Moving forward, the integration of these innovative practices presents a promising path toward balancing profitability with environmental stewardship and social responsibility.

6. LIMITATIONS AND FUTURE RESEARCH

This study, though insightful, is limited in scope due to the small sample size and its focus on qualitative data. While the findings provide valuable insights, they are specific to the participants and may not fully capture the diversity of experiences within the entire Balkan wine industry. Future research could benefit from a mixed-methods approach, combining qualitative interviews with quantitative analysis to broaden the scope and increase the generalizability of the findings.

Secondly, longitudinal studies examining the long-term effects of the proposed collaborative initiatives and policy reforms on sustainability outcomes would greatly contribute to understanding the efficacy of these strategies over time. Such research could help identify which approaches yield the most significant improvements in sustainability metrics, such as reduced carbon emissions, enhanced biodiversity, and economic resilience. The insights gained from this study serve as a foundation for ongoing discussions on sustainability in the wine sector, offering a roadmap for practitioners and policymakers seeking to navigate the complex landscape of sustainable development in the Balkans.

Additionally, future research could incorporate Multi-Criteria Decision Making (MCDM) frameworks to systematically evaluate the feasibility and impact of various sustainability strategies.

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**EXPERIMENTING OR ITERATING? EXPLORING ENTREPRENEURIAL
RETAILERS' DIGITAL BUSINESS ACTIVITIES THROUGH VISUAL DATA
GENERATION** - Insights from a research-based teaching and learning project

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ABSTRACT

Scholars and policymakers have discussed the emphasis on entrepreneurial growth, especially the importance of cooperation with local and regional stakeholders (e.g. local politics, social or innovation networks, or collaboration with regional universities) to gain inner-city economics resilience and to attract owner-managed retail (OMR) and support entrepreneurial SMEs. We aim to contribute to the discussion by adding an entrepreneurial learning perspective, using insights from an exploratory case study research project, which examined efforts made by entrepreneurial retailers in terms of digitalization during the COVID-19 pandemic through the support of their social network. In doing so, we are introducing and discussing the use of visual data collection within an ego-centered qualitative network analysis (ENA) framework, introducing the method in an entrepreneurship and business management research context.

Keywords: *Entrepreneurship, Digital business, Retail, Ego-centred network analysis.*

JEL classification: *I25, L81, O00, R11.*

1. INTRODUCTION

Following the collapse of the German Democratic Republic, and the dawn of the internet East Germany's inner cities are facing heavy economic and structural changes leading to shrinking economies and urban development challenges (Liebmann and Kuder, 2012). On a micro-level, an effect of this structural change is the decline of inner-city owner-managed retail (OMR), marked by increasing storefront vacancies. This is especially true for structurally weaker regions such as the city of Magdeburg, the capital of Saxony-Anhalt, where shifting demographics, lower income, and a negative influx of residents are worsening the problem (SPD, 2020). Scholars and policymakers have discussed the emphasis on entrepreneurial growth (Bernt, 2009), especially the importance of cooperation with local and regional stakeholders (e.g. local politics (Bernt, 2009), social innovation networks, or collaboration

with regional universities) (Welter and Neumann, 2007) in support of digitalisation of SMEs to gain inner city economics resilience and to attract OMR and support entrepreneurial SMEs (Martinelli *et al.*, 2018; Hardaker *et al.*, 2022).

We aim to contribute to the discussion of entrepreneurial learning, by providing insights into an exploratory empirical (a subset of a research-based teaching and learning project “Shopping 4.0” held in Winter and Summer 2019/20), which examined owner-managed retailers in Magdeburg during the COVID 19 pandemic, asking the following research question: *How (and what for) did retail entrepreneurs engage their networks to cope with digitalisation needs within the pandemic?*

The additional scope of this paper is to provide an example for other scholars and teachers of entrepreneurship using visual methods of data collection within an ego-centred qualitative network analysis (ENA) framework. In doing so we are contributing to the spread of visual methods within the field of qualitative network research within an entrepreneurship and business management context.

2. METHODOLOGY

In general, network research distinguishes between two research paradigms: qualitative and quantitative methods. Quantitative methods are used to collect data on entire networks and prefer to examine groups (e.g. science and research networks) at the meso level or the structures of larger systems (e.g. states) at the macro level. The specific forms of network analysis are differentiated at the levels of analysis (micro, meso, and macro) and aggregation levels (dyad, triad, ego-centred network, group, and entire network). The results obtained using quantitative overall network surveys are limited in their explanatory scope. It can be shown how many network partners are involved in a network, but this cannot explain why and how these relationships are defined in their functionality. They are purely descriptive-mathematical approaches that lack qualitative justifications. In addition, overall network surveys are extremely time-consuming to collect.

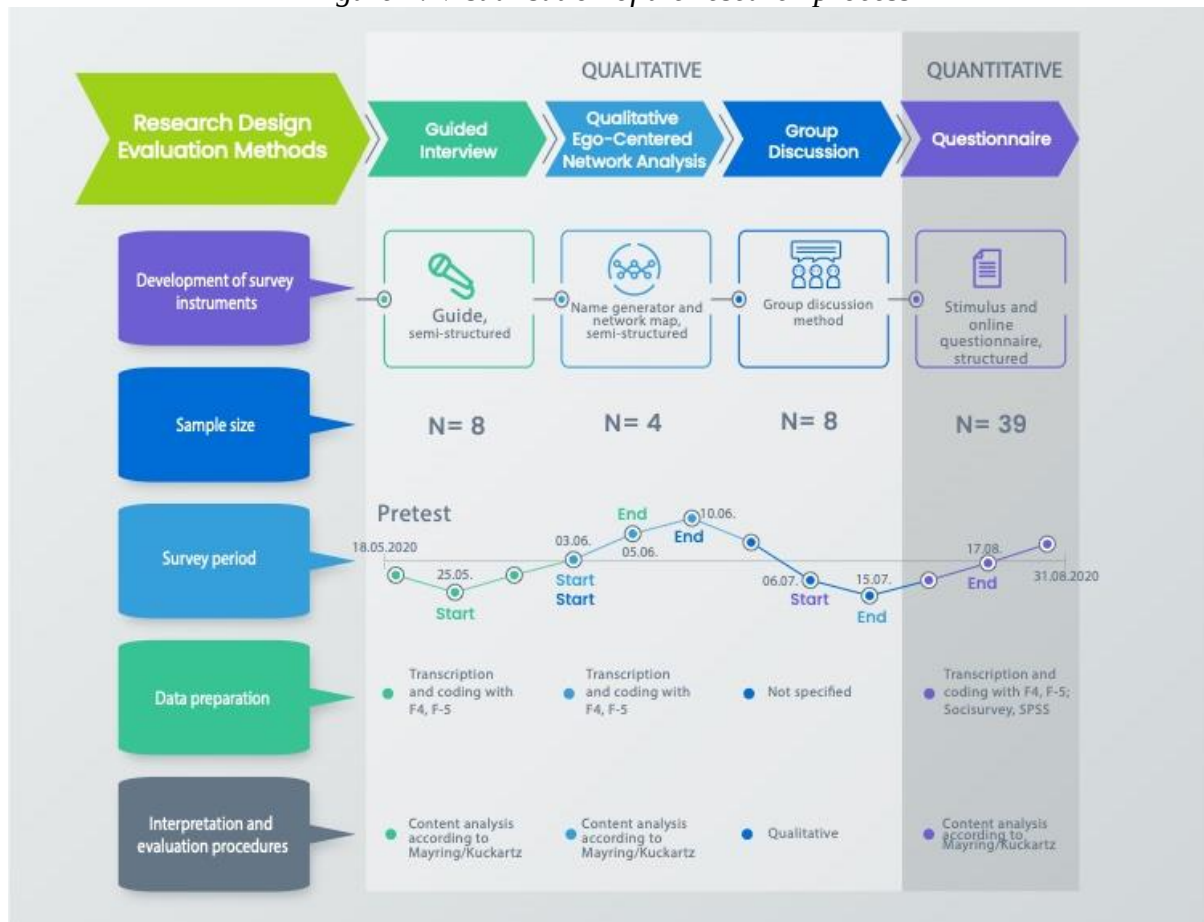
This is contrasted by the paradigm of qualitative network research. Our research aims to depict network structures (mostly social ones) (Wolf, 2005), as it focuses on the retail entrepreneurs (RE) and or their behaviour towards digitalisation, the ego-centred qualitative network analysis (ENA) is well suited to collect and visualise relationships between the ego and its network partners (alteri) in a short amount of time. Therefore, a name generator and a network map (Straus, 2010) are used as methodological instruments to visualise the network. The added value for the research interest lies in the collection of qualitative data that examines the underlying relationships between ego and alteri (Hollstein *et al.*, 2006). This means that the method provides reasons for how the ego is integrated into its network. This research approach is used in particular in health care research (e.g. integration of seniors into social networks to ensure care at home).

2.1. Research framework

Our teaching and learning project took place in winter and summer 2020, our study was conducted by h2 Magdeburg-Stendal University of Applied Sciences (Germany) after the first wave of COVID (from June to July 2020). During the track of two months 12 graduate students of h2s part-time “Digital Business Management” (DBM) and Crossmedia Master Programmes with the support of 15 students of h2 universities bachelor-level study program on social work developed a mixed-method approach of qualitative and highly explorative case studies and a quantitative questionnaire to provide detailed insights into how store-front owner-managers engaged in digitalisation and what positive and negative experiences they were confronted with. Secondly, students chose to explore the research question of the individual attributes of

a subset of OMR showing experimental behaviour for exploring how network partners would impact business models experimentation through COVID-19 in terms of digitalisation through a self-developed research framework guided by the authors.¹

Figure 1: Visualisation of the research process



(Source: Authors' calculations)

2.2. Sample generation

During the preparatory phase retailers' addresses and contacts were collected through a provided dataset of local chambers of commerce, student field trips and additional internet research, which was conducted by graduate students. Additionally, the 15 social work students were engaged in connecting to retailers via phone, email, or in-person to ask for retailers' participation, leading to a final n=53. Depending on OMR preference and methodological diversity, four research groups were formed: qualitative interviews (n=8), focus groups with other stakeholders (n=2), a quantitative survey (n=39), and a visual network analysis for an exploratory analysis of the role of network structures (n=4). For the ENA, we used purposive sampling [source] as the sample needed to include proactive experimenters with networking and digitalization. The low number of the subsample derived from availability issues and avoidance of physical contact, mostly related to the COVID pandemic, which led to the cautious behavior of potential participants.²

¹ The full research is available through the authors and visualised in figure 1.

² Generally, our main sample shows two types of retailers were specified on the basis of the data collected: Digitalisation Sceptics (DS) or non-active and those willing to experiment. DS mainly have been discouraged by previous digitalisation experiences or hearsay, would have hardly used the lockdown period for digitalisation activities made up the largest group (w. approx 85%), while the group of experimenters increased their main digital activities in order to stay in contact with their regular customers.

Table 1: Structure of the exploratory subsample

Type of retail product/ service	Gender	In business since		# of employees	prior www	digitisation project(s)	# of alteri
Fair Fashion	Female	2019	full-time	0	yes	- establishment of an online shop system - online marketing campaign via social media - first-time use of digital outdoor advertising spaces	7
Tea Store	Male	2014	full-time	1	yes	- social media marketing - newsletter for delivery and pick-up service - update of online shop and cash register software and system (GER) - integration of cashback- and payment provider - cross-marketing with a regional online-marketplace	7
paint store and manufacture	female	2017	full-time	0	no	- Web shop concept development - digital product development for digital distribution (DIY easter present offer) - digital photography Idea trigger for online video course, participation in social media and social sales platform (both US) - support by regional online-marketplace (photography)	8
wool and	female	2012	pt.	0	yes	- renovation of online	10

yarn Store			time			shop system - search engine optimization - social media marketing - digital customer advice sessions	
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(Source: Authors' calculations)

2.3. Data collection

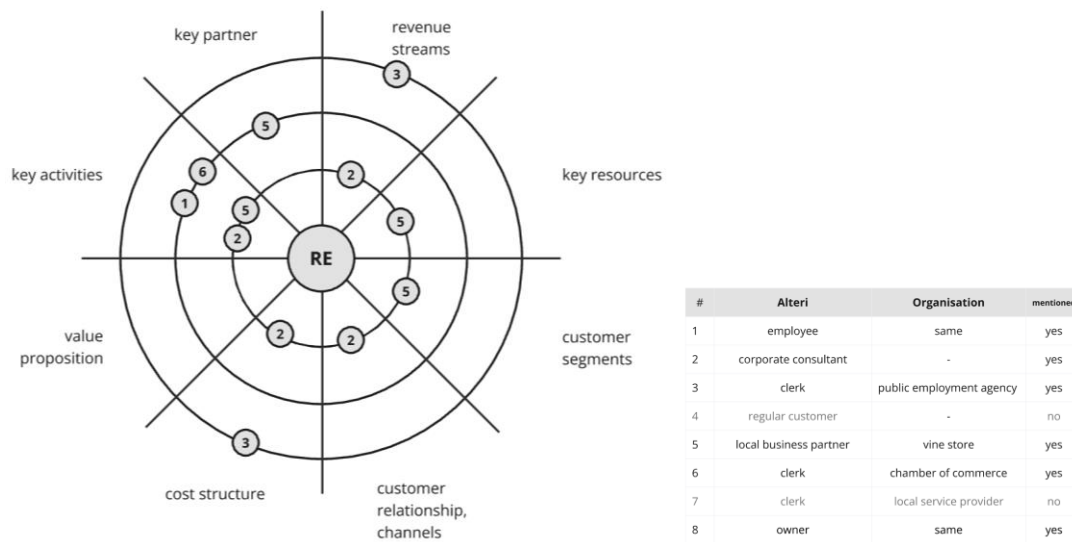
The ENA (ENA) was engaged within a subset of n=4 focussing on examining the social connections and relationships of one or more focal individuals (egos) from their own perspective. The individual networks are constructed from the viewpoint of the ego /the business owner), capturing their subjective perception of their social environment. It maps out the ego's direct connections (alters) and the relationships between those alters (von der Lippe & Gamper, 2016).

The data collection was structured as follows: 1. Interviewee self-introduction | 2. collection of network participants using a name generator (Straus, 2010) incl. information about attributes of alters (e.g. age, gender, relationship type) | 3. Generation of a visual network map (Straus 2010) through semi-structured interviews to collect on characteristics of ego-alter ties (e.g. closeness, frequency of contact) and their intensity. | 4. Conclusion.

For scope, the characteristics asked in step 3 would be based on the degree of proximity, connection, affiliation, etc. (von der Lippe & Gamper, 2016). As the “Shopping 4.0”'s research design sought to examine the patterns of connections among alters, the scope of the research was to uncover the intensity of the relationships from ego to alteri and between alteris. Therefore, students chose the category “degree of influence” to map the impact of network partners on the interviewees' digitalisation efforts. To ensure that the individual cases can be evaluated in a comparable manner within the scope of the study, the partially standardised procedure according to Kahn and Antonucci (1980) is used. The attribute “degree of influence” is set in the ordinal characteristics “low influence”, “medium influence”, and “strong influence” and embedded in concentric circles in the network map. As the distance from the ego increases, the degree of influence of the alter decreases (see the following figure).

To generate a more in-depth view of the interviewees' change of business models, students additionally chose to use an adaptation of the 9 components of the Business Models (Osterwalder *et al.*, 2015) as additional analysis sub-categories. The Business Model Canvas structures business models into nine different components in order to gain structured insight into which factors influence the business model (Osterwalder *et al.*, 2015).

Figure 2: Example of network map and name generator



(Source: Authors' calculations)

The following components have been used for further analysis: 1. Revenue sources 2. Key resources 3. Customer segments 4. Customer relationships/channels 5. Cost structure 6. Service/product offering 7. Key activities 8. Key partners. Narratives were gathered through the following initial and interview question: *What is the degree of influence of the (in step 2) mentioned network partner in terms of digitalisation regarding the components of the business model canvas?*

3. FINDINGS

Comparing the cases of retail entrepreneurs (RE) engaging in business experimentation had structurally comparable experiences found to be very marketing-oriented in introducing or expanding digital measures. Activities include setting up the shop software, maintaining data for the merchandise management system, creating online marketing campaigns and content, mostly images and blog posts, for social media, or providing digital customer advice and optimisation for search engines.

Data shows that digital business model development within our subsample is primarily influenced by knowledge in the areas of entrepreneurship, online marketing and communication as well as resource and time management and RE's willingness to communicate and collaborate. To keep up pace with these new demands of digital marketing RE needed individual attributes such as openness, persistence, flexibility, trust and an attitude geared towards networking (network orientation) as well as opportunity spotting, creative and decision-making skills.

All four cases showed a high level of individualism in RE businesses, reflecting the individual interests of their owners. Furthermore, digitalisation efforts are collectively described as time-consuming, demanding, and resource-intensive, as it is blurring the boundaries between work, core business, and digitalization activities. EL engaging in digital marketing found the follow-up costs extremely difficult to estimate, as financial and time resources and own competencies may not match the high expectations related to digitization. This may be explained by very high standards regarding ERs own businesses and the value of customer relations which may be mirrored in the expectations towards digital solutions (e.g. corporate design, product presentation, and customer communication).

However, we found that digitalisation is a task RE could not accomplish independently, but only in conjunction with various non-commercial/commercial network partners bringing in complementary expertise. ER, who already had network peers in digital marketing were more easily able to further intensify their digitalisation and customer communication efforts. Our cases also indicate that within the group of RE, there are a wide variety of qualification and consulting needs in order to implement digital customer communication in an economically and socially acceptable way.

Furthermore, our sample shows that collaboration in local innovation-driven networks and participation in supporting digitisation efforts may not produce resilience in ER as these networks did not offer the support, EL needed. The high level of expectations and individualism of challenges addressed by ER during data generation raises the question of what support regional entrepreneurship and business education programs can have for those already experimenting.

Learnings

Visualizing the individual's networks throughout the interview provides a reflexive instrument that develops narratively, i.e. creatively (Schönhut and Gamper, 2013). The use of ENA allowed students an easy and engaging entry point into the examination of how an individual's network interacts with their entrepreneurial behaviours, attitudes, and outcomes, but also other advantages in terms of applicability, engagement, integrability, and flexibility.

Advantages of applying visual network maps

Easiness of use and engagement

The interactive nature of the network map visualisation process made the data collection process more engaging for both students and respondents engaging in the production of a visual network map supporting participants to keep an overview of their relationships throughout the data collection process (Hollstein et al. 2020).

Providing flexibility in data collection

The use of ENA allowed the students a more flexible approach to data collection, accommodating both structured and unstructured methods.

Providing integrability

The use of ENA allowed the students to be integrated into traditional survey methods and sampling techniques allowing for integration in sophisticated research designs aiming at triangulation (Flick, 2011).

Limitations of applying visual network maps

Although working with network map visualisation process, limitations to be found may apply from data quality as well as from a methodological perspective:

Incomplete network picture

Ego-centred networks only capture the connections from the perspective of a single individual (ego), which may not provide a complete picture of the broader social network. This limited view can lead to an incomplete understanding of the overall network structure and dynamics.

Bias in alter selection or recall

Egos may not accurately report all their connections, potentially leading to bias in the selection of alters. Also, Egos might be inclined to report connections that they perceive as socially desirable, potentially distorting the true nature of their network (Hollstein et al., 2020). Also to visualise changes in ego networks over time is challenging, as alterations in the network

composition may not be integrated in map design (Hollstein et al. 2020). This may result in a distorted representation of the network, as some important connections might be overlooked or underreported.

Boundary specification

Defining the boundaries of an ego network can be challenging, as it's not always clear where to draw the line in terms of positioning or including or excluding certain alters (Hollstein *et al.*, 2020).

However, as the use of ENA in our case followed a very structured approach while producing a decent amount of comparable data (name generator, visual network map, interview transcript) we found that ENA comparability evolves the more structured the approach is and the more datasets are included. By providing an easy but sophisticated research method that can capture rich data (both structured and semi-structured) we argue, that these characteristics contribute to both qualitative and mixed-method research projects, that aim for scalability and comparability, eventually in longitudinal studies aiming with the scope of capturing developments over time and/ or regions. Anyhow: As Ego networks may be of different sizes it can be difficult to compare directly, as network measures may be influenced by the number of alters reported.

LIMITATIONS

The qualitative data obtained using the method of ENA are to be understood as individual case studies, showcasing the situation in the city of Magdeburg. The sample primarily represents established retail entrepreneurs, who are keen to experiment. This means that the sample is not a reflection of the population, as a whole nor of Magdeburg itself, as most of the retailers did not participate in digitalisation activities. Using case comparisons (comparative analysis), similarities and differences, in the sense of structurally identical characteristics, could be identified on a qualitative level. The data material was subjected to intensive evaluation and discussion in a research workshop. Although the analytical depth of the case understanding can be classified at a high level, the present results are not representative. However, we argue that relevant assumptions of key characteristics as well as the first hypothesis can be derived from our research.

CONCLUSION AND OUTLOOK

By centering on the individual's perspective, ENA provides valuable insights into how people's immediate social environments shape their experiences and outcomes. As such, we encourage researchers, scholars, and educators to use this highly easy and flexible tool in their own research design as well as in teaching, as it provides potential and feasibility for studying large or undefined populations compared to whole network approaches. The use of ENA may have helped respondents recall relationships more accurately, potentially leading to more comprehensive network data (Hollstein et al., 2020). In cross-regional research and study settings, the method may enable students with a variety of backgrounds and academic skills to participate in collaborative research projects as it provides low-barrier entry. The scalability makes comparisons across multiple ego networks to identify patterns or differences based on ego characteristics, which makes it a potential method for cross-regional research aiming at ecosystem comparisons.

While ENA has shown to be a valuable tool for understanding personal networks and their impacts, researchers should carefully consider these potential pitfalls when designing studies and interpreting results. Combining ego-centred approaches with other network analysis

methods or complementary data sources can help mitigate some of these limitations and provide a more comprehensive understanding of social networks and their effects.

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THE IMPACT OF SOCIOECONOMIC DETERMINANTS ON INFANT MORTALITY: AN ANALYTICAL APPROACH

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ABSTRACT

Investigating the impact of socioeconomic factors on infant mortality rates (IMRs) is of key importance to sustainable economic development. The lack of global studies is notable, with previous publications exploring these relationships only in specific regions or countries. Utilizing data from the World Bank and the World Health Organization (WHO), we fit a multiple linear regression model to examine the impact of individual variables such as the number of doctors per 1000 people, female literacy rate over 15 years, corruption index, and health expenditure per capita. Our findings reveal significant relationships between the natural logarithm of IMR and the natural logarithm of health expenditure per capita, as well as the number of doctors, suggesting that higher levels of health care expenditure and greater availability of medical workers significantly influence the level of infant mortality rates globally. This research deepens the understanding of the multifaceted determinants of IMR and highlights the importance of targeted interventions to improve health care. Consequently, policymakers and stakeholders can develop more effective strategies to promote long-term sustainable economic development and improve infant health outcomes.

Keywords: Regression, Infant mortality, Socioeconomic factors, Health care system, Sustainable development, Health expenditure.

JEL classification: I15, C20.

1. INTRODUCTION

Infant mortality, defined as the death of a child under the age of one, is one of the most significant indicators of a country's healthcare system, development, and socioeconomic conditions. Despite substantial advancements in healthcare and medical technology in recent decades, there are still notable disparities among countries and regions when it comes to infant mortality rates (IMRs). A complex interplay between socioeconomic and environmental factors occurs, which deserves a higher focus of the scientific work globally. Namely, economic development can be observed through the national healthcare system, with the health sector and economic conditions being mutually dependent. Although similar studies on the determinants of infant mortality can be found, none focus on the specific choice of factors nor analyses the global context with the latest data. We aim to fill this gap in the academic literature.

This paper aims to uncover the impact of various socioeconomic factors on infant mortality rates as a proxy variable for the quality of the national healthcare system. This is achieved through secondary cross-sectional data for 2023 obtained mainly through the World Bank and the World Health Organization (WHO) databases. A total set of 227 countries is analysed, segregated into several geographical regions. We looked at external, socioeconomic factors to see if they are significant in determining the national infant mortality rates. For instance, the increased government spending in the health sector affects health infrastructure and the overall quality of health, which could lead to a theoretical decrease in the mortality of newborns. When deliveries are performed by professional medical staff, such as adequately qualified doctors, nurses, and midwives, they contribute to better medical care, monitoring, and intervention that reduce the risk of complications and death of the baby or the mother. We also observe the impact of corruption, as it can lead to the inappropriate allocation of resources, including funds, medical supplies, and personnel that will later result in a reduction in the quality and availability of medical care, potentially contributing to increased infant mortality. We hypothesize that specific healthcare and socioeconomic metrics will have a direct impact on infant mortality rates (IMR), with clear statistical correlations between a combination of key variables and IMR on a global scale. This analysis investigates which metrics are most effective in improving IMR through rigorous statistical methods.

Through a multiple linear regression model, we observe the impact of corruption, the number of doctors per 1000 people, health expenditures per capita, and female literacy rates as independent variables on the infant mortality rates. General results confirm the theoretical expectations of lower infant mortality rates in countries with higher health expenditure per capita, as well as a higher number of available medical staff. The conducted machine learning regression also proves that GDP per capita, the available medical staff, availability of health insurance are significant determinants of IMRs as well as confirming the regional disparities in the world.

The study is structured as follows. After the brief introduction to the topic, the paper highlights the key concepts in the global literature review in Section 2. Next, the research provides a detailed exploratory data analysis followed by the methodological approach. In Section 4, the study elaborates the obtained results and provides key insights into the topic. Finally, an adequate conclusion is given.

2. LITERATURE REVIEW

Healthcare and economics are intertwined as there is no healthy economy without a healthy nation. As stated by Erdoğan *et al.* (2013), ‘health is one of the necessary elements to socially develop a society’. Global literature has discussed this topic extensively over the years, focusing on various aspects deemed important. Most research on this topic has focused on the medical part of the equation, concentrating on genetic predispositions, medical conditions, and other, risk factors (see Baraki *et al.*, 2020; Satti *et al.*, 2023; Fisher *et al.*, 2024, p. 14). However, we conducted this research to examine the influence of relevant socioeconomic determinants on the quality of health in the country, reflected through infant mortality, which in turn is proven to be in a long-term relationship with the business cycles (Ogburn and Thomas, 1922; Schady and Friedman, 2007). Subsequently, this has also been confirmed by Maruthappu *et al.* (2010).

Infant mortality can represent a major economic burden. In developing countries, this burden is borne by a large number of poor families, while in developed countries such as the United States, the burden is reflected in high health costs (Okobi *et al.*, 2023). It is worth noting that some of the potential determinants of IMRs have been previously studied, however on a smaller scale. For instance, Bexson *et al.* (2021) studied the effects of the number of doctors per 1000 citizens in Brazil. They concluded that increasing their number could only affect the underdeveloped areas of the country, in turn signaling a lower marginal utility in the developed Brazilian regions.

Less developed countries are more commonly studied in the global academic literature. For instance, Jayachandran and Jarvis (1986) found that good nutrition and midwife availability are more significant determinants of infant mortality rates than formally trained healthcare staff in 60 less-developed economies. Stockwell and Wicks (1984) found a strong inverse relationship between low-income families and the IMRs, noting that socioeconomic disparities may hinder medical advancements in developed regions such as metropolitan Ohio.

Another study (Salariak *et al.*, 2009) found that female literacy rates, welfare, and access to high-quality healthcare are major determinants of infant mortality rates. For similar findings, we suggest Ahmed *et al.* (2011) as well as Kim and Saada (2013) which provide a systematic literature review on the topic. Additionally, it is worth noting that the work of Prisco *et al.* (2015) shows that on the European level, higher GDP and female education levels are strongly associated with lower rates of infant mortality, unlike the income inequality measured through the Gini index which does not show statistical significance. This is considered opposite to the findings of Waldmann (1992) whose study highlights that high infant mortality rates are associated with income inequality.

On the contrary, Younger (2001) argues that economic growth, expressed through GDP per capita, does not consistently influence infant mortality, but rather variables like primary school enrolments and DPT vaccination rates for infants do so. Moreover, the availability of healthcare measured through the number of doctors, nurses, and hospital beds per 1000 inhabitants has no impact on the reduction of IMRs. Using a country fixed-effects models, Conley and Springer (2001) find that independent of economic development, higher public health spending significantly lowers the rates of infant mortality.

It is worth noting that machine learning (ML) is becoming increasingly popular among studies focusing on developing predictive models and unraveling non-linear relationships, especially in the field of pathology (Islam *et al.*, 2020; Dahiwade *et al.*, 2019; Jing *et al.*, 2023). Some common ML algorithms include decision trees, support vector machines (SVM), k-nearest neighbors (KNN), and random forests. For larger datasets in which interpretability of the results is not paramount, neural networks are used (Ahmed *et al.*, 2019; Cabaneros *et al.*, 2019; Jiang and Luo, 2022).

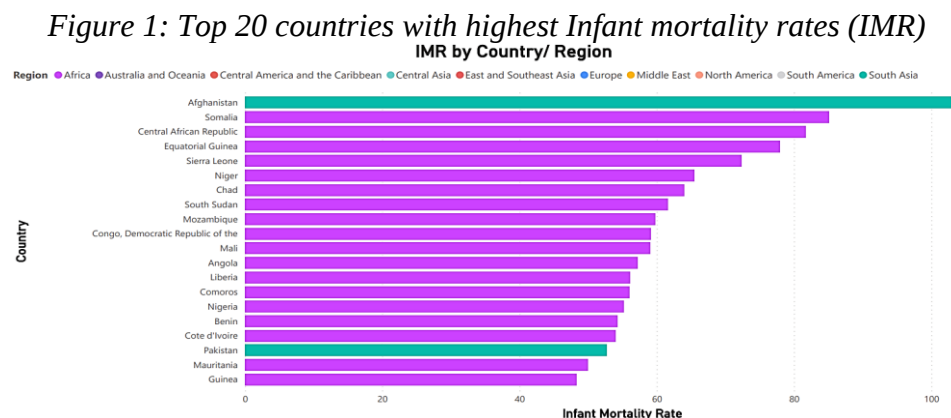
Our study addresses the gap in the literature by conducting a large-scale global study on the latest data, focusing on the staff sufficiency of the healthcare systems, health expenditures, literacy rates in females, GDP per capita, and even the country's corruption level. Additionally, Microsoft Power BI's Key Influencers ML tool was utilized to allow for identifying key factors in a supervised learning framework without extensive manual data preprocessing, making it accessible for large-scale data analysis. With this, existing literature is complemented while potentially raising questions for further broadening of the study.

3. METHODOLOGICAL APPROACH

3.1. Exploring data characteristics

Secondary cross-section data for 227 countries in 2023 was utilized and extracted from various sources, such as the World Health Organization (WHO), the World Bank, CIA (Central Intelligence Agency), and the PRB (Population Reference Bureau). The main dependent variable in our study is the infant mortality rate (IMR) measured as the number of deaths of children under the age of one, per 1,000 live births.

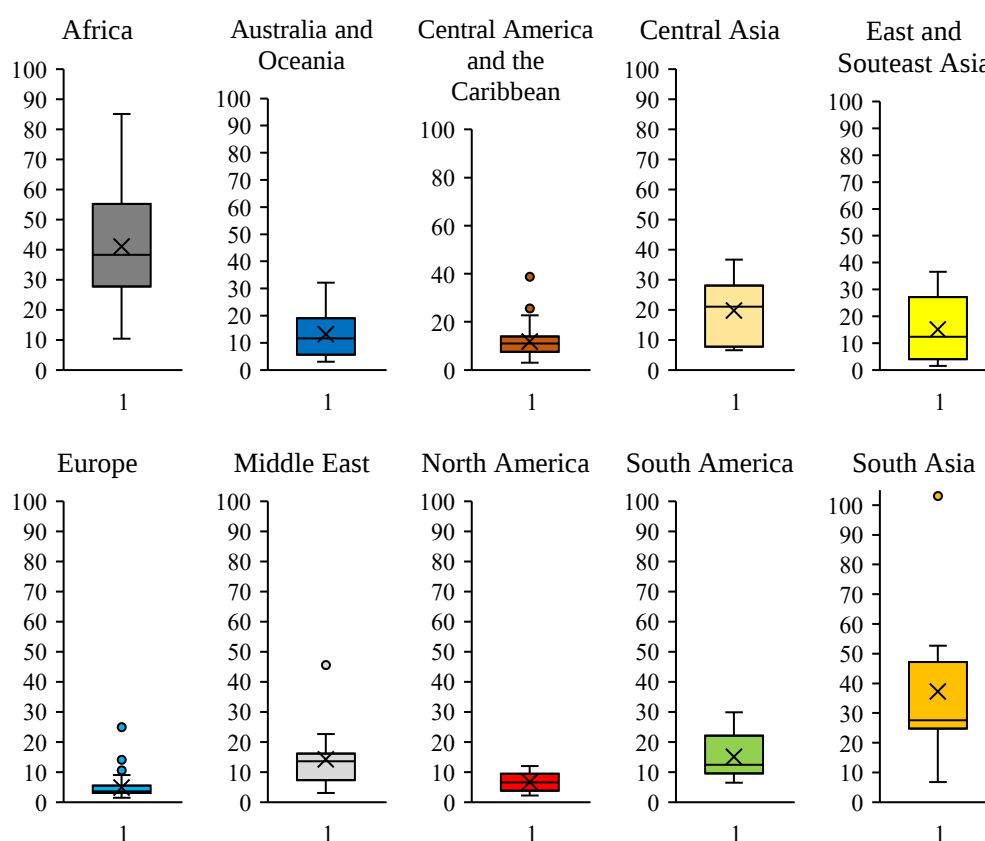
In Figure 1, we can see that the dominant regions in terms of high infant mortality are Africa and South Asia, in countries that are still underdeveloped. Afghanistan stands out with the highest death rate per 1,000 infants in 2023 or 103.1. On the other hand, the lowest death rate is found in the European countries. For instance, Singapore and Slovenia had the joint-lowest rate of 1.5 which is far below the rates found in African countries. Low IMRs are also characteristic for countries in North America and East and Southeast Asia.



(Source: World Health Organization; Authors' depiction)

The box and whisker charts show that there are huge differences in IMR across the world and by region. Africa has the highest median IMR with large IQR and outliers meaning high variability and higher IMR. On the other hand, the median IMRs of Europe, North America, Australia and Oceania are much lower with a smaller IQR, implying that the mortality rates in these areas are more stable and lower. Central America and the Caribbean, Central Asia, and East and Southeast Asia have moderate median IMRs, with their corresponding IQR and outliers to indicate the ranges and disparities within the regions. The Middle East and South Asia have higher median IMRs than the more developed regions, although not as high as Africa; South Asia also has some very high outliers. In general, these charts show the contrast of the economically developed regions with the regions where the health of infants remains a crucial problem.

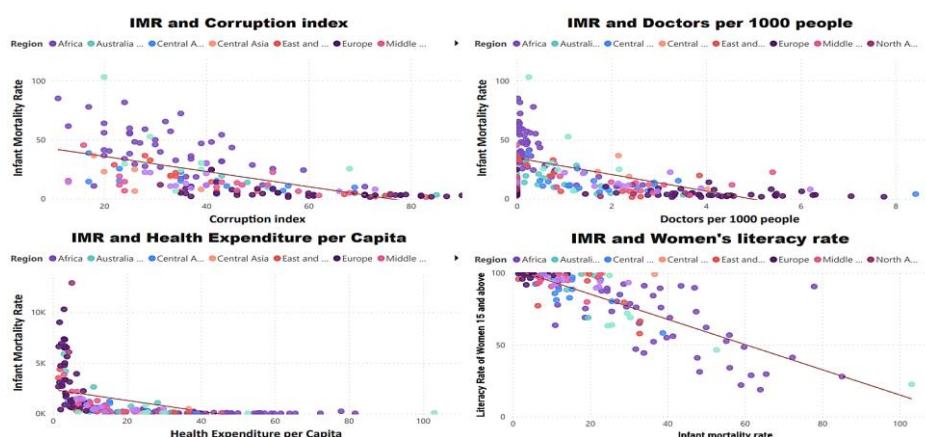
Figure 2: Boxplot of infant mortality rates (IMRs) by regions



(Source: World Health Organization; Authors' depiction)

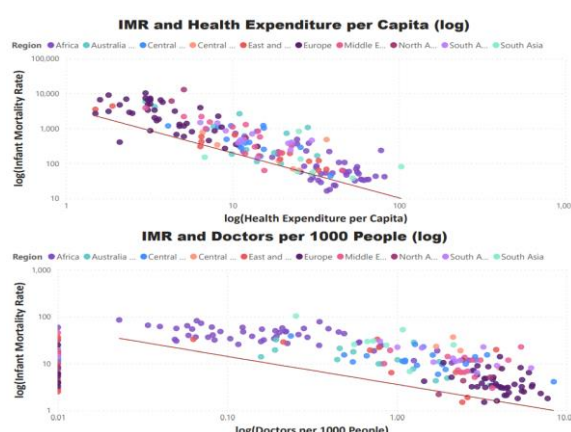
To check for the direction and the behaviour of the relationship across data points, we construct several scatter plots, with variable pairs depicted in Figure 3. There is a notable inverse relationship between the corruption index and the infant mortality rates. This is important because corruption translates through inefficient and flawed institutions, lack of ethical criteria as well as inefficient allocation of resources – mainly in the health sector. Furthermore, we have to note that a higher corruption index is desirable and means a lower corruption level for the country. Data points on the left-hand side of Figure 3a data show higher variability, as infant mortality rates are naturally more dispersed in those countries due to the influence of several other factors. Next, there is a clear inverse relationship between the IMRs and the number of doctors available, measured per 1000 inhabitants. The availability of qualified medical staff is most notable in European countries, ranging between 3 and 6 doctors per 1000 people. On the contrary, the lack of such work profiles in African countries is highly correlated with the substantially higher IMRs. A slightly non-linear curve, even though much more prominent than the one for the previous case, maybe a better fit for the relationship between IMRs and health expenditures per capita. That being said, the logarithmic form, depicted in Figure 4, is considered to pronounce the linear relationship between the variables of interest. Nevertheless, there is a strong inverse relationship which is expected in theory, given that higher investments in medical staff, infrastructure, and technological investments are indeed associated with lower rates of infant mortality. In Figure 3d, we can observe the relationship between women's literacy rate and infant mortality. That being said, educated women have better knowledge about health, hygiene, nutrition, and overall healthcare utilization. Women in less developed regions show a lower tendency to seek medical attention during pregnancy and childbirth, thus resulting in higher infant mortality rates.

Figure 1a, 3b, 3c, and 3d: Scatter plots of Infant Mortality Rate (IMR) and Corruption Index, Doctors per 1000 people, Health Expenditure per capita, and Female Literacy Rate across countries



(Source: Authors' depiction)

Figure 4a and 4b: Infant Mortality Rate and logarithms of Health Expenditure per capita, and Doctors per 1000 People



(Source: Authors' depiction)

The correlation matrix with all the variables analysed prior to the modeling phase is presented in Table 1. It is worth noting that some of the variables were selected to check the consistency of the data. This is achieved by examining the correlation between infant mortality and similar indicators such as mortality rate, birth rate, and perinatal mortality rate. From the variables that were of interest to the research, those that have a significant degree of correlation and of which there are possible mechanisms through which they would theoretically influence IMRs were selected. The variables in this research are divided into 3 groups: I) Variables that are defined by the same or similar metrics as IMR (variables 2, 3, 19 from Table 1); II) Socioeconomic and healthcare variables (metrics) that have previously mentioned theoretical grounds to influence IMR (var. 1, 4-13, 15-18, 20, 21 from Table 1); III) IMR as the primary variable of the study (var. 14 from Table 1). It is important to note that there is a large amount of data for individual regions, which is why wrong conclusions can be drawn when analysing data by region. Some control variables were also implemented. For instance, we observe a large positive correlation

(0.8) between the IMRs and maternal mortality ratio, which is theoretically expected due to the complexity of the delivery process. A significantly large positive correlation is also noted between the IMRs and birth rates (0.85) which can be self-explanatory and spur multicollinearity in the modelling process afterwards. A moderate inverse relationship is observed between the IMRs and the number of doctors per 1000 citizens (-0.65), while a slightly lower correlation is noted with the health expenditures per capita for 2021 (-0.47). A moderate inverse relationship is noted between the infant mortality rates and the country's corruption index or -0.61. Surprisingly, real GDP per capita for 2022 does not seem to exhibit any correlation with the infant mortality rates in 2023, which may indicate that non-economic factors may be more significant for the analysis itself.

Table 1: Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	1.00	-0.09	0.13	0.21	0.24	0.11	-0.03	-0.07	0.26	0.03	0.05	0.00	-0.08	-0.05	0.02	0.20	0.24	-0.05	0.10	0.09	-0.05
2	-0.09	1.00	-0.29	-0.57	-0.72	-0.04	-0.77	0.16	-0.53	0.46	-0.58	-0.27	-0.46	0.85	0.76	0.21	-0.45	-0.33	-0.81	-0.55	-0.79
3	0.13	-0.29	1.00	0.51	0.41	0.09	0.03	-0.17	0.29	0.01	0.20	0.26	0.19	-0.07	-0.01	-0.24	0.18	0.31	0.05	0.11	0.07
4	0.21	-0.57	0.51	1.00	0.61	0.03	0.47	-0.21	0.58	-0.11	0.37	0.27	0.55	-0.51	-0.49	-0.23	0.30	0.27	0.48	0.27	0.55
5	0.24	-0.72	0.41	0.61	1.00	0.08	0.56	-0.21	0.75	-0.15	0.62	0.24	-0.21	-0.65	-0.59	0.35	0.58	0.41	0.71	0.52	0.61
6	0.11	-0.04	0.09	0.03	0.08	1.00	-0.05	0.04	0.09	0.04	0.09	0.00	-0.06	0.01	0.13	0.18	0.16	0.09	0.02	0.02	0.50
7	-0.03	-0.77	0.03	0.47	0.56	-0.05	1.00	-0.06	0.45	-0.41	0.52	0.24	0.13	-0.77	-0.80	0.24	0.31	0.34	0.69	0.56	0.78
8	-0.07	0.16	-0.17	-0.21	-0.21	0.04	-0.06	1.00	-0.09	-0.32	-0.14	-0.16	0.39	0.18	0.02	-0.56	-0.21	-0.13	-0.21	-0.11	0.01
9	0.26	-0.53	0.29	0.58	0.75	0.09	0.45	-0.09	1.00	-0.02	0.76	0.18	0.01	-0.52	-0.50	0.40	0.77	0.40	0.62	0.47	0.57
10	0.03	0.46	0.01	-0.11	-0.15	0.04	-0.41	-0.32	-0.02	1.00	-0.11	0.04	-0.13	0.49	0.38	0.41	0.15	0.08	-0.20	-0.03	-0.58
11	0.05	-0.58	0.20	0.37	0.62	0.09	0.52	-0.14	0.76	-0.11	1.00	0.19	-0.09	-0.61	-0.48	0.59	0.76	0.48	0.69	0.56	0.47
12	0.00	-0.27	0.26	0.27	0.24	0.00	0.24	-0.16	0.18	0.04	0.19	1.00	-0.18	-0.27	-0.23	-0.03	0.13	0.18	0.23	0.20	0.22
13	-0.08	-0.46	0.19	0.55	-0.21	-0.06	0.13	0.39	0.01	-0.13	-0.09	-0.18	1.00	-0.12	0.06	-0.29	-0.08	0.04	0.08	0.23	-0.80
14	-0.05	0.85	-0.07	-0.51	-0.65	0.01	-0.77	0.18	-0.52	0.49	-0.61	-0.27	-0.12	1.00	0.80	-0.68	-0.47	-0.25	-0.84	-0.58	-0.80
15	0.02	0.76	-0.01	-0.49	-0.59	0.13	-0.80	0.02	-0.50	0.38	-0.48	-0.23	0.06	0.80	1.00	-0.49	-0.33	-0.23	-0.79	-0.54	-0.77
16	0.20	0.21	-0.24	-0.23	0.35	0.18	0.24	-0.56	0.40	0.41	0.59	-0.03	-0.29	-0.68	-0.49	1.00	0.40	0.37	0.59	0.29	0.68
17	0.24	-0.45	0.18	0.30	0.58	0.16	0.31	-0.21	0.77	0.15	0.76	0.13	-0.08	-0.47	-0.33	0.40	1.00	0.51	0.63	0.51	0.45
18	-0.05	-0.33	0.31	0.27	0.41	0.09	0.34	-0.13	0.40	0.08	0.48	0.18	0.04	-0.25	-0.23	0.37	0.51	1.00	0.40	0.57	0.24
19	0.10	-0.81	0.05	0.48	0.71	0.02	0.69	-0.21	0.62	-0.20	0.69	0.23	0.08	-0.84	-0.79	0.59	0.63	0.40	1.00	0.64	0.66
20	0.09	-0.55	0.11	0.27	0.52	0.02	0.56	-0.11	0.47	-0.03	0.56	0.20	0.23	-0.58	-0.54	0.29	0.51	0.57	0.64	1.00	0.56
21	-0.05	-0.79	0.07	0.55	0.61	0.50	0.78	0.01	0.57	-0.58	0.47	0.22	-0.80	-0.80	-0.77	0.68	0.45	0.24	0.66	0.56	1.00

(Source: Authors' calculations)

Note: 1 – (immigration-emigration)/1000 citizens; 2 – Birth rate; 3 – Death rate; 4 – Hospital beds/1000 citizens; 5 – Doctors/1000 citizens; 6 – Real GDP per capita (2022); 7 – Births attended by skilled staff; 8 – Low birthweights babies; 9 – Nurses and midwives/1000 citizens; 10 – Income per annum; 11 – Corruption index; 12 – Health insured population (in %); 13 – Hospital stay; 14 – Infant mortality rate; 15 – Maternal mortality deaths/1000; 16 – Natural deliveries per 1000 births; 17 - Health expenditure per capita (2021); 18 – Total health expenditure rate (2021); 19 – Life expectancy; 20 – Government expenditures on health (in %); 21 – Literacy rate in females aged above 15.

3.2. Methodology

We conduct three different regression analyses through the Eviews and Microsoft Power BI software tools. First, in order to select the independent variables that could have an impact on the mortality of newborns, a simple linear regression was performed with each of the possible factors. Subsequently, we observed the coefficient of determination (R^2) as an indicator of the explanatory power of each variable. The method used to estimate the linear regression model is the ordinary least squares (OLS) method. The linear regression model is defined as

$$Y = \beta_0 + \beta_1 X + \varepsilon$$

where Y is the dependent variable i.e., infant mortality rate in our case, X is the independent variable, while β_0 and β_1 are intercepts and slope parameters to be estimated. With ε we denote the residual variability in the model.

Second, we conducted a multiple linear regression model to find the strongest relationships between a combination of factors and the infant mortality rates. Simple transformations of

variables were applied to the most significant regression models to meet the theoretical assumptions for regression of cross-sectional data: linearity, homoscedasticity, normality (normal distribution of residuals), and independence (absence of autocorrelation in residuals). The models were selected by comparing several statistical indicators: the statistical significance of each coefficient separately, the statistical significance of the model (F-statistic), the coefficient of determination (R^2 and the adjusted R^2 for comparison between models with different numbers of variables) as well as different information criteria (i.e., Akaike, Bayesian). The general form of the models that showed the best compromise between their fit and complexity is

$$Y = \beta_0 + \beta_1 X + \beta_2 X_2 + \dots + \beta_i X_i + \varepsilon$$

or

$$Y = \beta_0 + \sum_{i=1}^k \beta_i X_i + \varepsilon$$

The slope coefficients indicate a linear relationship at a marginal change in the corresponding independent variable, all else being equal. By transforming all variables in a given model, into their logarithm form, we explore a relationship in which the effect of each variable on the outcome is proportional to its natural logarithm.

Finally, the Key Influencers tool from Microsoft Power BI software was used to capture associations between a larger number of variables that could potentially have an impact on increasing or decreasing infant mortality. Key Influencers determine which variables have the most pronounced influence on the target variable. This tool uses machine learning algorithms to analyse statistical measures like correlation, performs linear regressions, logistic regressions (for categorical, qualitative data like region in our case), decision tree analyses, and association rule learning). We specifically utilize it to solve a regression problem through a machine learning setting, thus introducing a new method of modelling besides the ones already elaborated in the global literature. The analyses help us assess theoretically proposed causal relationships between certain socioeconomic indicators and infant mortality.

4. ANALYSIS OF RESULTS

In the first step, we performed several regression analyses to examine the assumptions for modeling cross-section data as well as the explanatory power of each variable, observed through the R^2 in the models. We found that most of the associations of the independent variables with the dependent variable are heteroscedastic, that is, ten out of the total thirteen samples, with one of them being excluded. The analyses that showed heteroscedasticity included the following independent variables: state expenditures on health; birth rate; deliveries performed by skilled and qualified employees; corruption; doctors per 1000 people; health expenditure per capita; life expectancy; maternal mortality rate; and nurses per a thousand people.

Out of the conducted regression analyses (with IMR as the dependent variable), the ones containing the following independent variables exhibited homoscedasticity: hospitals per capita, natural births per thousand births, female literacy rate, and hospital beds per one thousand people. The last was considered homoscedastic due to the Breusch-Pagan-Godfrey test showing values near the critical values. We then examined the normality of the individual models, where we found that none were normal, with a small exception. The regression analysis where the maternal mortality rate was the independent variable, although de facto it had no normality at a 95% confidence level, the distribution of its residuals was characterized by only a slight leptokurcy. However, after the in-depth examination of the regression analyses, we can

still conclude that the heteroscedasticity, as well as the normality of the residuals, is not as important due to the nature and objectives of the research, especially since the results of the real data showed similarity with the transformed data in the further multivariate analyses. In addition to this, we also looked for correlation in all samples, from which we speculated the risk of multicollinearity due to certain high correlations between independent factors, which can increase errors in multifactor analysis. Hence, medium/high correlations between two independent variables that we should consider are about four, that is, the correlation between doctors per thousand people in relation to corruption, which is 0.61; the correlation of 0.58 between doctors per thousand people and state expenditures on health; doctors per one thousand people in relation to the literacy rate of women (0,6); corruption and public expenditure on health, where the correlation is quite strong with 0.75. In our analysis there were more independent variables with strong correlations, but we stuck to the four above, because they are part of our two main models, which we used to study IMR. Furthermore, we obtained the coefficient of determination (R^2) for each regression, i.e. we found out which of the independent variables explain our dependent variable the best. We found that birth rate with 72%, life expectancy rate with 70%, maternal mortality rate per thousand births with 64% and female literacy rate also with 64% statistically explain the variability of infant mortality rate.

Table 2: Simple linear regression between the IMRs and chosen factors.

<i>Variable</i>	<i>Coefficient</i>	<i>R²</i>	<i>Heteroskedasticity</i>	<i>Normality</i>	<i>Obs.</i>
Govt. Expenditure on healthcare in %	-0.2415	0.3392	Heteroskedastic	Not normal	166
Birth rate	1.7784	0.7275	Heteroskedastic	Not normal	227
Births attended by skilled staff	-0.8829	0.5933	Heteroskedastic	Not normal	176
Corruption index	-0.6420	0.3702	Heteroskedastic	Not normal	163
Doctors per 1000 citizens	-6.9900	0.4286	Heteroskedastic	Not normal	181
<i>log</i> (Govt. Expenditure on healthcare in %)	-8.6633	0.5740	Heteroskedastic	Not normal	178
Hospital beds per 1000 citizens	-4.3349	0.2616	Homoskedastic	Not normal	174
<i>log</i> (Hospitals per capita)	-5.9210	0.1195	Homoskedastic	Not normal	123
Life expectancy	-2.1425	0.7098	Heteroskedastic	Not normal	182
Maternal mortality per 1000	0.0740	0.6417	Heteroskedastic	Normal	186
Natural deliveries per 1000 births	-0.0158	0.4636	Homoskedastic	Not normal	31
Nurses and midwives per 1000 citizens	-2.2034	0.2713	Heteroskedastic	Not normal	188
Literacy rate in females aged above 15	-0.7299	0.6406	Homoskedastic	Not normal	128

(Source: Authors' calculations)

After conducting the multiple linear analysis, about 69% of the variability IMR in 112 countries is explained by the percentage of literacy among women over 15 years and the index of corruption. The linear association is represented by the coefficients of the corresponding (explanatory) variables *ceteris paribus*: for each percentage point increase in the literacy rate among women, infant mortality decreases by 0.63 and for every point of increase in the corruption index, mortality decreases by 0.36. The residuals do not have a normal distribution and according to the Durbin-Watson statistic (2.6969), there is autocorrelation in the residuals. Although the results indicate that the model is heteroscedastic, for research purposes, we consider it to be homoscedastic, as the probabilities of the Chi-square and F statistics from the conducted Breusch-Pagan-Godfrey heteroscedasticity test on this specific model are close to the critical values (0.05). In order to meet the assumptions of cross-sectional data regression, a model was estimated in which all variables were transformed with a natural logarithm. The transformation of the variables solves all the problems with the fulfillment of the criteria (Table 4). Akaike and Schwartz's (Bayesian) information criterion indicate that the newly obtained model is more suitable for use, but the reduced coefficient of determination (54.6%) indicates that the phenomenon is explained in a smaller percentage by the transformed data. However,

the non-linear relationship shown in this model is significant and provides insight into the interdependency of the variables. According to the obtained result, about 60% of the dependent variable is explained through the phenomena of the rate of doctors and healthcare expenditures per capita. The linear relationship indicates a decrease in mortality per 1000 newborns of -2.07 for each doctor per 1000 population on average, *ceteris paribus*, and a decrease of about 7 on average, *ceteris paribus* in the dependent variable for each natural logarithm unit of a dollar per capita spent on health. The variable was logarithmized due to large differences between series values. We believe that the logarithmic series is still a representative indicator of health spending in individual states. There is no autocollinearity, but the model is heteroskedastic and the distribution of residuals is not normal as per Table 4. The transformations in the final model contribute to the fulfillment of all the necessary assumptions for such a model confirmed by the heteroscedasticity, multicollinearity and normality tests (Table 4). In this model, the Infant Mortality Rate (IMR), health expenditure per capita, and the number of doctors per 1000 people were log-transformed using the natural logarithm. According to the information criteria, this model compared to all the others is by far the most suitable and according to the coefficient of determination, it is explained with the highest percentage (78.568%). All previous models were considered solely because of the economic significance of the variables and results.

Table 3: Modelling results of infant mortality rates.

	Model 1	Ln Model 2	Model 3	Ln Model 4
Intercept	89.4818*** (4.3008)	11.1806*** (0.7431)	66.7947*** (4.4031)	5.0095*** (0.2466)
Female literacy rate	-0.6310*** (0.0561)			
Corruption index	-0.3604*** (0.0858)			
ln(Female literacy rates)		-1.1226*** (0.1865)		
ln(Corruption index)		-0.9714*** (0.1767)		
Doctors per 1000 citizens			-2.0771** (0.8214)	
ln(Health expenditures per capita)			-6.9788*** (0.9178)	-0.4074*** (0.0410)
ln(doctors per 1000 citizens)				-0.1894** (0.0477)
Included Obs.	112	112	164	164
R-squared	0.6902	0.5463	0.6000	0.7857
Adjusted R-squared	0.6846	0.5380	0.5950	0.7830
S.E. of regression	11.2121	0.6262	12.2395	0.4836
SSR	13,702.62	42.7458	24,118.46	37.6545
Log likelihood	-428.1044	-104.9801	-641.9570	-112.0503
F-statistic	121.4397***	65.6194***	120.7401***	295.1107***
AIC	7.6983	1.9282	7.8653	1.4031
BSC	7.7711	2.0010	7.9920	1.4598
HQ	7.7278	1.9576	7.8884	1.4261
DW statistic	2.6969	2.1683	2.0145	1.9778

Note: *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively, based on the conducted t-test.
(Source: Authors' calculations)

Table 4: Heteroscedasticity and multicollinearity test results.

Model num.	Model 1	Ln Model 2	Model 3	Ln Model 4
Breusch-Pagan-Godfrey heteroscedasticity test				
F-stat	3.3244	2.069194	4.6819	0.259401
Prob. F	0.0397**	0.1312	0.0106**	0.7718
Obs*R-sq.	6.4391	4.096748	9.014	0.526772
Prob. Chi-Sq.(2)	0.04**	0.1289	0.011**	0.7684
Scaled explained SS	19.074	4.075332	37.481	0.64675
Prob. Chi-Sq.(2)	0.0001***	0.1303	0.0000***	0.7237
Variance Inflation Factors multicollinearity test				
Centered VIF	1.2869	1.323502	2.5625	3.277629
Centered VIF	1.2869	1.323502	2.5625	3.277629

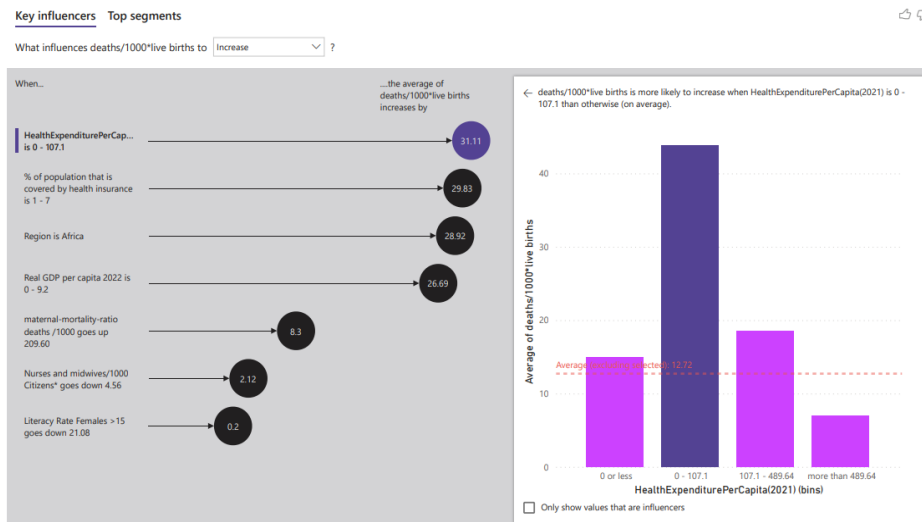
Note: *, **, and *** statistical significance at the 10%, 5%, and 1% respectively.

(Source: Authors' calculations)

From the conducted machine learning, we see that the greatest influence on the reduction of infant mortality was the level of GDP per capita (according to purchasing power parity) ranging between 21.3 and 139.1 USD. The relationship with this indicator, however, isn't very precise due to the large range it was analysed in. Furthermore, the region in which the country is located has a similar effect on the investigated indicator - if that region is Europe, on average, the indicator decreases by as much as 18.26. The percentage of health insurance among the population is another important indicator. In countries with over 90% health insurance coverage, there is an average reduction in mortality per 1000 newborns by 15.46. The number of nurses and midwives per 1000 inhabitants and the literacy of women over 15 years old were also found to be significant to a small extent. On average, they reduce IMR by 2.12 and 0.2 respectively. More significant results were obtained when the Key Influencers tool analysed the top contributors to increases in infant mortality rates. On average, mortality increases by more than 26% when there are minimal health expenditures per capita (below \$107.1), minimal percentage of the population covered by health insurance (up to 7%), when the country's region is Africa and when GDP per capita (according to purchasing power parity) is between \$0 and \$9.2 respectively.

Figure 5a and 5b: Key influencers of infant mortality rates in 2023





(Source: Authors' calculations)

The analysis of key influencers on infant mortality rates, particularly their increase and decrease, highlights significant economic implications. When observing the decrease in infant mortality rates, a higher real GDP per capita implies better economic conditions, which typically correlate with improved access to healthcare, better nutrition, and enhanced living conditions. These factors contribute to the reduction of infant mortality, as they directly impact the overall health and well-being of both mothers and infants. Additionally, the availability and quality of healthcare services, for example, the presence of skilled nurses and midwives, play a crucial role in ensuring safer childbirth and postnatal care, thus reducing IMRs.

On the other hand, the increase in infant mortality rates is often associated with low health expenditure per capita. This scenario indicates underfunded healthcare systems that struggle to provide adequate medical services and facilities (including up-to-date technological capabilities), leading to higher infant mortality. Economic constraints can also result in insufficient healthcare infrastructure, lack of essential medical supplies as well as inadequate or exclusive training for healthcare professionals, further exacerbating the situation. Furthermore, regions with low economic development, such as certain areas in Africa, are more vulnerable to higher infant mortality rates due to the compounded effects of poverty, malnutrition, limited access to healthcare, and low quality of life overall.

In the general context, the interplay between national wealth, healthcare investment, and IMRs emphasizes the critical importance of economic policies that prioritize healthcare funding. Investment in healthcare not only improves health outcomes but also promotes economic stability and growth by fostering a healthier population. Addressing economic disparities on both central and local levels, while improving healthcare infrastructure, are some of the most important strategies for reducing infant mortality rates and improving the overall public health of a nation.

5. CONCLUSION

In this study, we aimed to investigate the impact of various socioeconomic and healthcare factors on infant mortality rates (IMR) across 227 countries, hypothesizing that specific metrics would have a direct impact on IMR. This hypothesis was successfully confirmed, identifying particular key factors. Our findings indicate that several variables, including state expenditures on health, birth rate, deliveries performed by skilled staff, corruption, doctors per 1000 people, health expenditure per capita, life expectancy, maternal mortality rate, and nurses per 1000

people, exhibit heteroscedastic associations with IMR. Despite the presence of heteroscedasticity and non-normal residuals in most models, the overall explanatory power of these variables remains significant. The most significant relationships proved to be the ones between natural logarithms of the variables, which were used to stabilize the model. The regression analyses reveal that the birth rate, life expectancy, maternal mortality rate, and female literacy rate are particularly strong predictors of IMR, explaining 64-72% of its variability. In our multiple linear analysis, about 69% of the variability in IMR is explained by female literacy rates and the corruption index. Specifically, an increase in female literacy by one percentage point results in a 0.63 decrease in IMR, while a one-point increase in the corruption index decreases IMR by 0.36. The model that proved to be the most accurate ($R^2=78,57\%$) and fitting (lowest information criteria values), while meeting all theoretical assumptions for cross-sectional regression analysis, was the one in which the natural logarithm of IMR was the dependent variable and the logarithms of doctors per 1000 people and health expenditure per capita were independent variables. The last model (Ln Model 4) may have further positive implications for the efficiency of future budgets and policies regarding IMR. In other words, budgets focused on public health and policies focused on producing more doctors per 1000 citizens may be the most productive way to improve IMR. However, our study faced several limitations. First, the presence of heteroscedasticity and non-normal residuals in many models could affect the robustness of our findings. Although we transformed variables using natural logarithms to address these issues, the transformed model's reduced explanatory power (54.6%) indicates a trade-off between meeting statistical assumptions and retaining predictive strength. Second, some papers divide their studied regions by income levels, finding that some policies are more effective based on income levels (Bexson *et al.*, 2021). This is one example of how our study could be improved if we were to go in depth regarding the classification of the categorical data types. Still, findings from more recent papers align with the results from our wider-encompassing study (Kammerlander and Schulze 2023; Salariak *et al.*, 2009; Prisco *et al.*, 2015).

There are important implications for the overall success of the economy, which, among other things, is necessary for improving the healthcare system through various mechanisms. The quality of the health care system could improve if there was improvement in the most significant determinants that we mentioned above. Namely, through the aging of the population, without having an increase in the birth rate (or a decrease in the IMR), the old age dependency ratio would continue to increase, impacting the sustainability of pension funds and destabilizing the labour market. Future research should focus on refining these models by exploring alternative transformations or advanced statistical techniques to mitigate heteroscedasticity and multicollinearity. Additionally, expanding the dataset to include more countries and incorporating time-series data estimation in a panel format (Sari and Prasetyani, 2021) could provide a more comprehensive understanding of the dynamic relationships between socio-economic factors and IMR. Investigating the impact of other potential influencers, such as healthcare quality, access to education, and social policies, could further enhance the explanatory power of the proposed models.

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AI REVOLUTION IN FINANCIAL INSTITUTIONS: IMPACT, CUTTING-EDGE APPLICATIONS AND A COMPREHENSIVE BIBLIOMETRIC ANALYSIS OF EMERGING TRENDS

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EXTENDED ABSTRACT

Purpose Financial institutions are rapidly following the applications of artificial intelligence (AI) allowing them to better organize and perform job duties and understand their customers. With the application of AI, employees in financial institutions will not be burdened with the performance of operational activities and will have more time to devote themselves to their professional and personal growth and development. In this way, technology such as AI will not replace people but will be their support. This current topic is the main incentive to delve deeper into the application of AI in financial institutions through bibliometric data visualization and analysis.

Many managers have an aversion to using artificial intelligence algorithms in decision-making, despite their superior performance (Mahmud *et al.*, 2023). Banks, as the most important actors for the continuity of the financial system, should conduct evaluation and measurement of branch performance and set goals for them and portfolio managers, which is an important process for decision-making and strategic planning in the banking industry (Met *at al.*, 2023). Poor decision-making in financial institutions is likely to cause financial crises (Weng and Huang, 2021). Artificial intelligence and machine learning are helping many managers to focus on key and strategic aspects and spend less time on repetitive tasks, enabling better financial risk management (Mahalakshmi *et al.*, 2022). The artificial intelligence system enables development accompanied by better performance and optimization (Dennis *et al.*, 2023). The gradual application of artificial intelligence in corporate financial risk management results in a decent performance in recalling fraudulent firms (Lin and Gao, 2022). COVID-19 has affected the change of digitalization and technological development of financial institutions (Aziz *et al.*, 2022). Many challenges for financial services have opened up with the transition to digital freedom (Narsimha *et al.*, 2022). Detecting activities related to financial cybercrime is a major problem, as a highly restrictive algorithm can block all suspicious activities that interfere with customers' real business (Nicholls *et al.*, 2021). Customers are increasingly facing many fraudulent attacks and scams in financial banking operations, and cybercriminals have found the opportunity to use financial transactions to carry out their fraudulent activities (Narsimha *et al.*, 2022). A large volume of sensitive customer-related data circulates and accumulates in

financial institutions every day (Park *et al.*, 2021). In the financial sector, machine learning algorithms, in addition to being used in fraud detection and providing financial advice to investors, can also examine a large database in a short period (Lei *et al.*, 2022).

Design/methodology/approach The data for the bibliometric analysis has been downloaded from the Scopus database. By applying the Prisma protocol, in the first phase-identification, we searched for the terms “financial institutions”, “artificial intelligence” and “AI”. 467 documents were identified during the period 1987-2023. The language of the documents was English. In the second phase-screening, no document was excluded because non-English documents and duplicates were not identified. In the third phase-eligibility, 281 documents were excluded because only the articles were eligible and the total sample in this phase consisted of 186 articles. In the fourth phase-inclusion, we undertook a manual check of the relevance of each article based on an analysis of the abstracts 70 articles were excluded due to their irrelevance and the total sample in this phase consists of 116 articles. Furthermore, the VOSviewer software was employed for authors' co-authorship, organizations' co-authorship, and countries' co-authorship analysis, keyword co-occurrence analysis of the abstracts for the whole period and the last five years and keyword co-occurrence analysis for the last five years for the used methods, models, and software.

Findings The number of articles related to AI in financial institutions has been growing in the last three years of the analyzed period. 84% of the articles were published by co-author teams and 16% by a single author. The most cited single author is Mhlanga D. and the journal Expert Systems with Applications takes the first place in terms of the source of published articles and number of citations. From the analysis made with VOSviewer software, it can be concluded that: it does not mean that if some countries are geographically closer, the authors will write papers in co-authorship, USA is in first place both in terms of the number of citations and in terms of the number of published articles, from all the clusters the terms that occur the most for the whole period are learning, implication, tree, statistical method and risk evaluation. According to their occurrences, the terms that appear most concerning methods, models, and software in the last five years of the period are prediction model, correlation, discriminant analysis, statistical technique, classification method, and clustering.

Originality/value The analysis of abstracts and citations is of great importance in the exchange of knowledge as well as the monitoring of trends. The obtained results and conclusions can be used for further research both by academics and by all those who have an interest in researching financial institutions and artificial intelligence.

Keywords: *AI, Artificial intelligence, Financial institutions.*

JEL classification: *G21, G22, J29, O31.*

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CROWDFUNDING AS A TOOL FOR ALTERNATIVE FINANCING IN POLAND: PERSPECTIVES AND CHALLENGES

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ABSTRACT

Purpose The dynamic development of the alternative finance sector is a characteristic phenomenon of contemporary times. In the literature, the key reasons identified for this phenomenon are:

- i. Technological advancement: The development of digital technologies, including the Internet, blockchain, and artificial intelligence, has enabled the creation of innovative financial platforms and services that are more accessible and efficient compared to traditional financial institutions (Taherdoost, 2023; Lekhi, 2024).
- ii. Financial exclusion issues: Many small and medium-sized enterprises, startups, and individuals have limited access to traditional sources of financing, such as bank loans, due to stringent credit requirements. This exclusion manifests as a lack of access to traditional banking services, high costs and demands of traditional financial institutions, lack of flexibility of traditional financial services, limited geographical availability of specific financial services, low financial awareness, and a lack of trust in traditional financial institutions. Alternative finance, through technological innovations and flexible business models, offers solutions that can reduce the problem of financial exclusion and provide access to essential financial services for entities previously excluded from the traditional financial system (Carbó *et al.*, 2005).
- iii. The search for higher returns: Investors are looking for new investment opportunities that offer higher returns compared to traditional bank deposits or bonds. Alternative forms of investing, such as crowdfunding, attract investors due to potentially higher profits (Freedman and Nutting, 2015).
- iv. Changes in consumer behavior in the market: The younger generation, known as Millennials and Generation Z, prefers convenient, fast, and online financial services. Young people are more open to using modern financial technologies and are less attached to traditional banks (CAsfera.pl, 2022).
- v. Changing regulations and government policies aimed at increasing competition in the financial sector: Many governments and regulatory bodies are introducing regulations that support the development of alternative finance. These include not only regulations regarding crowdfunding but also cryptocurrencies and open banking, which promote innovation and competition in the financial sector (World Bank and Cambridge Centre for Alternative Finance, 2019).

The aforementioned conditions contribute to the rapid development of the alternative finance sector, which is becoming an increasingly important part of the global financial system. In this

context, the dynamic growth of crowdfunding (CF) as a community financing instrument is also observed. CF appears to be a kind of phenomenon. The term was first used in 2006 by the American blogger M. Sullivan, founder of Fundavlog. One of the most comprehensive definitions of CF is proposed by Mollick (2014). According to him, CF “refers to the efforts by entrepreneurial individuals and groups - cultural, social, and for-profit - to fund their ventures by drawing on relatively small contributions from a relatively large number of individuals using the internet, without standard financial intermediaries” (Mollick, 2014).

The research objective set by the authors is to determine the specifics of CF as an alternative financing tool in the Polish context. The authors focus on ten key characteristics of the analyzed instrument, including (1) community financing, (2) accessibility for small and medium-sized enterprises and startups, (3) lower entry barriers compared to traditional financial services, (4) direct interaction with investors, (5) diversity of financing models (e.g., donation-based CF, reward-based CF, royalty-based CF, equity CF, debt CF, etc.), (6) market testing, (7) marketing and promotion, (8) investment risk, (9) administrative support and legal regulations, and (10) community and engagement.

Design/methodology/approach The study employed the method of analyzing literature related to the issues of alternative finance and CF, as well as the analysis of legal acts regulating CF for instance Regulation (EU) 2020/1503 of the European Parliament and of the Council of 7 October 2020 on European crowdfunding service providers for business) and the national level (the Act of 7 July 2022 on crowdfunding for business ventures and assistance to borrowers). Additionally, an analysis was conducted on the functioning of selected crowdfunding platforms and entities authorized to provide crowdfunding services, as well as an analysis of examples of investments financed using this instrument. The article also utilized statistical data from the European Securities and Markets Authority database.

Findings The conducted research confirmed the research hypothesis, which states that the development of CF as a financial instrument in Poland is driven by technological advancements that enable the creation of innovative financial platforms, as well as by the ability of the instrument to offer greater financial flexibility (compared to traditional financing instruments), faster access to capital, and the potential to build communities around financed projects. It was shown that in Poland, compared to other EU member states (such as France, Italy, Spain, the Netherlands, and even Lithuania), CF is at an early stage of development (European Securities and Markets Authority Database, 2024). However, it has significant growth potential due to the aforementioned attributes. These features make it not only an attractive instrument for entities that face difficulties in obtaining traditional financing but also contribute to reducing financial exclusion in Poland. It was demonstrated that CF is gaining importance primarily as an alternative source of financing for small and medium-sized enterprises, startups, and various social and cultural projects.

Originality/value The legal regulations regarding CF in Poland are relatively new, and analyses of the functioning of crowdfunding platforms and investments financed through this source of funding are limited. This analysis fills that gap. The unique economic context of Poland, with its specific economic and social conditions differing from those of other EU countries, is significant in this regard. The analysis of CF in Poland takes into account the specific conditions of the country, such as the level of digitization of society, trust in new technologies, the level of financial exclusion, and the specific financial needs of small and medium-sized enterprises. Moreover, Poland is one of the fastest growing fintech markets in Europe. Analyzing CF in this context allows us to understand how innovative financial technologies impact the development of alternative sources of financing in the country. Poland is at the stage of developing various types of crowdfunding platforms, including donation-based, equity-based, and reward-based platforms. Examining the functioning of these platforms provides valuable information about their effectiveness and attractiveness to different user

groups. It is also worth noting that Poland has a strong community culture (e.g., "Solidarity" as a social movement in the 1980s, which played a key role in overthrowing communism in Poland and is one of the most well-known examples of a strong community and solidarity culture in Europe), which can promote the development of CF. Importantly, our research also considers the aspect of financial education, which is crucial for understanding and accepting alternative forms of financing by society.

Keywords: *Crowdfunding, Alternative financing, Investment.*

JEL classification: *G11, G23, G28.*

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DETERMINANTS OF CAPITAL STRUCTURE: EMPIRICAL STUDY OF THE INDUSTRIAL COMPANIES IN NORTH MACEDONIA

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ABSTRACT

This study explores the determinants of capital structure within industrial firms in North Macedonia, focusing on a decade-long panel of companies listed on the Macedonian Stock Exchange from 2012 to 2022. Using panel regression analysis, the research examines the impact of key factors—firm size, profitability, asset tangibility, growth, risk, and taxation—on the leverage decisions of these firms. The results reveal that firm size and asset tangibility are positively associated with leverage, indicating these companies' reliance on debt, especially when supported by substantial physical assets. In contrast, profitability demonstrates a negative relationship with leverage, consistent with the Pecking Order Theory, suggesting that profitable firms in this emerging market prefer internal financing. Growth, measured through sales, shows a positive correlation with leverage, though the impact varies with growth metrics. Overall, this study highlights the unique capital structure dynamics in a transitioning economy and provides valuable insights for financial managers operating in similar markets.

Keywords: *Capital structure, Leverage, Theories of capital structure, Trade-off theory, Pecking order theory.*

JEL classification: *G21, G30, G32, G33.*

1. INTRODUCTION

The decision on a company's capital structure—its balance between debt and equity financing—remains one of the most fundamental challenges in corporate finance. Since Modigliani and Miller's groundbreaking theory in 1958, known as the Irrelevance Theorem, which suggested that a firm's value is unaffected by its capital structure in a perfect market, numerous studies have sought to address the complexities of real-world factors that influence these choices. Their theory, which overlooked practical factors like taxes and bankruptcy costs, laid the foundation for further research and refinement through alternative theories, most notably the Trade-Off Theory and the Pecking Order Theory.

The Trade-Off Theory proposes that companies aim to balance the tax advantages of debt against the costs of financial distress, seeking an optimal structure where the benefits and costs of debt are equalized. Contrastingly, the Pecking Order Theory suggests firms prioritize internal over external financing to avoid signaling risks to investors, turning to debt only when internal resources are insufficient. This study builds on these theoretical frameworks by

examining the capital structure determinants within North Macedonia's industrial sector, an economy in transition from a centrally planned to a market-oriented system. Such a context offers a unique opportunity to understand capital structure dynamics in an emerging economy, where institutional and market conditions markedly differ from those in developed economies. Through an empirical analysis of firms listed on the Macedonian Stock Exchange from 2012 to 2022, this research investigates the impact of factors such as company size, profitability, asset tangibility, growth, risk, and tax considerations on leverage decisions. Findings from this study aim to deepen our understanding of financing behaviour in transitioning economies and to provide insights relevant to academics, financial managers, and policymakers involved in similar economic environments.

In part 2 of this paper, we provide a literature review, part 3 gives an overview of the data used and measurement of the variables, part 4 gives results of the analysis and part 5 concludes.

2. LITERATURE REVIEW

The decision of capital structure over the years has inspired and fascinated many researchers. There is a large scope of studies and research on this topic, both theoretical and empirical, that attempt to answer Myers's (1984) 40-year-old question: "How do companies choose their capital structure?". Many theoretical models and studies provide an answer to this question from a different point of view.

Franco Modigliani and Merton Miller are considered to have laid the foundations of capital structure theories with the publication of their research in 1958. In the Modigliani-Miller theory, also known as the *Irrelevance Theorem*, it is assumed that in a perfect market, the choice of capital structure is not relevant to the value of the company. Later, in 1963, they proposed a modification of the theory after adjusting their original assumptions to include corporate taxes. Although this theory contains many weaknesses, Modigliani and Miller's proposals are the basis for the research and development of many other theories related to this subject. The most important theories stand out: is the trade-off theory, according to which companies have a mixture of debt and equity that is considered as optimal (Kraus and Litzenberger, 1973). The impact of asymmetric information on capital structure was originally observed by Jensen and Meckling (1976). The group of the most significant theories also included the Pecking Order Theory developed by Myers and Majluf (1984) and complemented by Myers (1984), which assumes that companies follow a certain order to minimize the problem of information asymmetry. However, these findings did not provide us with an explanation for why some companies prefer debt over equity and vice versa.

In order to find an answer to the set question, a lot of theoretical and empirical research has been done on this topic recently. For example, according to Rajan and Zingales (1995), larger companies have higher leverage, and the profitability of the company has a negative impact on the leverage. Harris and Raviv (1991) state that the underlying theories in most of the research have not been empirically proven. Baker and Wurgler (2002) introduced the Market Timing Theory, according to which companies prefer debt when the stock price is overvalued, otherwise they prefer equity. In his research, Bauer (2004) considers the most important determinants of capital structure by analysing companies listed on the Prague Stock Exchange, while De Wet (2006) conducts his research on companies listed on the South African Stock Exchange. De Wet concludes that a company with a lower cost of capital can maximize its value. A different type of research was carried out by Brav (2009), who made his analysis based on data from private and public companies. He concluded that private companies are more sensitive to changes in performance that may occur when making a capital structure decision and that they prefer debt financing. In their research, Akhtari and Oliver (2009) used a sample of domestic and multinational Japanese companies. The results that were drawn showed that

multinational Japanese companies are significantly less indebted than domestic companies. The same conclusion was reached in the scientific research done by Avarmaa et al. (2008), where Baltic multinational and domestic companies were the subject of analysis, and by Chen et al. (2014), who analysed multinational and domestic companies in the People's Republic of China. Chen (2004) independently researched the capital structure of Chinese companies. The results showed that Chinese companies do not follow either the Trade-Off Theory or the Pecking Order theory, that is, they follow the so-called "new adjusted Pecking Order Theory" due to the institutional differences and financial constraints between China and other countries.

Črnigoj and Mramor (2009) studied Slovenia, revealing that firm size and profitability influenced leverage, with governance shifts impacting decisions. Thippayana (2014) examined capital structure in Thailand, finding that firm size, profitability, and financial distress costs were key determinants. Czerwonka and Jaworski (2021) found that SMEs in CEE countries prioritized internal financing, with minimal industry and country-specific effects on debt levels, supporting the Pecking Order Theory. Gostkowska-Drzewicka and Koralun-Bereźnicka (2024) highlighted regional differences in agricultural financing, with Western EU firms relying more on debt. Jaworski et al. (2019) found Poland's food manufacturing sector favored debt due to stable demand, aligning with Trade-Off and Pecking Order theories. Nazarova and Budchenko (2020) noted that Chinese firms preferred retained earnings, adapting to banking constraints. ALmuaither and Marzouk (2019) observed that UK firms prioritized internal financing, with Brexit affecting external options. Mardan et al. (2023) reported that size and growth positively influenced capital structure in Indonesia, while profitability and liquidity had negative impacts. Růčková and Škuláňová (2022) found interest rates impacted European transport and storage firms, with profitability as a key factor. Barburski and Hořda (2023) showed EU energy and mining sectors relied on debt due to asset specificity and regulation. Akinyomi and Olagunju (2013) noted that asset tangibility and size positively affected leverage in Nigerian manufacturing. Raju (2024) found liquidity reduced leverage in India's pharmaceutical and chemical sectors, while size increased it, aligning with the trade-off theory. Köksal and Orman (2014) concluded that the trade-off theory best explained capital structure choices for Turkish firms, emphasizing firm size, asset tangibility, and economic stability.

Michaelas et al. (1999) and Ozkan (2003) did their research on a group of large and medium-sized companies from Great Britain and concluded that most of the determinants that were included in the analysis have an impact on the leverage. Later Antoniou et al. (2006) set up a sample in which UK companies were again included, but in this research also as part of the sample were analysed companies from France and Germany. The conclusion that was drawn from this analysis suggests that there are differences between companies from different financial systems, i.e. for companies from Great Britain the theories of debt maturity structure that were considered are applicable, while for companies from France and Germany, the results differ and were not specified. The first research where the focus was put on underdeveloped and developing countries was made by Demirgüç-Kunt and Maksimovic (1999), Keister (2004), and Benkato et al. (2005). In 2002, Nivorozhkin published research in which for the first time economies in transition were the subject of analysis and later this trend was followed by many other experts (Gonenc, 2003; Bauer, 2004; Delcours, 2007; Kořak and Čok, 2008; Ribnikar and Kořak, 2011). Some of the studies that analyze these subjects lead to the conclusion that there are significant differences between countries that are in the post-transition period and developed countries (Mramor and Valentinčič, 2001; Filatotchev et al., 2003; Yeoh, 2007), therefore, results obtained from the analyses differ depending on the degree of economic development of the countries. In the last two decades, the interest in these countries has increased significantly and has become the main topic in several papers (Cvijanović and Redžepagić, 2011; Peev, 2001; Bena and Hanousek, 2008; Gonenc and Seifert, 2010; Teker et al., 2009). More recently, research has been carried out in the region that includes the Balkans

(Berk, 2007; Črnigoj and Mramor, 2009; Arsov and Naumoski, 2016), that argues that companies are mainly focused on applying the Pecking Order Theory.

These are just a few of the many studies that have been published on this topic over the years. There is no single theory that can answer the question of optimal capital structure and so this area will continue to be analysed and researched in the years to come. The results of this research are of great interest, mainly for financial managers who constantly strive to achieve maximization of the company's value.

3. RESEARCH METODOLOGY

3.1. Data and measurement

This research aims to determine the capital structure of industrial companies in the Republic of North Macedonia and to identify the key factors that influence these financing decisions. The study draws on data from a selected group of industrial companies listed on the Macedonian Stock Exchange, covering the period from 2012 to 2022—a span of 11 years. This data, sourced from audited financial statements, was obtained from both the official portal of the Macedonian Stock Exchange and the companies' websites.

After defining the sample and gathering relevant financial data, a statistical model was constructed to guide the empirical analysis. The study begins with descriptive statistics to summarize and interpret the key characteristics of the data. Following this, a panel regression analysis is conducted to evaluate the relationship between the dependent variable (leverage) and various independent variables, addressing the central research question regarding capital structure choices.

The analysis incorporates leverage as the dependent variable, represented in multiple forms, while the independent variables include company size, tax considerations, asset tangibility, profitability, growth, and risk. A detailed explanation of these variables and the methods used to calculate them is provided in the subsequent section.

3.2. Measuring dependent variable leverage

A dependent variable in the research is the company's leverage, which has a key role in determining the capital structure. In previous studies, by default, leverage is presented as a ratio between total liabilities and total assets, but in addition to the basic one, we can also find other variants for calculation. In this research, the dependent variable will be calculated in the following ways:

- as a ratio between total liabilities and total assets (total leverage or total liabilities-to-total assets ratio) marked as TL (total liabilities). This is the most commonly used way of calculating the leverage in this type of research;
- as a ratio between total debt and total assets (total debt-to-total assets ratio) marked as TD (total debt). Total debt means interest-bearing liabilities such as bank loans and
- as a relationship between long-term loans and total assets (long-term debt-to-total assets ratio) marked as LTD (long-term debt). This variant of the calculation is separated from the total debt/total assets indicator because it is considered that short-term loans are used by companies for everyday needs and do not affect the long-term capital structure.

3.3. Exogenous variables

Table 1 describes the exogenous variables used and their measurement.

Table 1: Exogenous variables measurement

Determinant	Symbol	Calculation	Type of determinant
LEVERAGE	TL	total liabilities/total assets	dependent
	TD	total debt/total assets	dependent
	LTD	long-term debt/total assets	dependent
SIZE	SIZE	natural log of net sales	independent
PROFITABILITY	PROF	operative profit/total assets	independent
TANGIBILITY	TANG	tangible assets/total assets	independent
GROWTH	GROWTH	natural log (sales from the current year - sales from the previous year) /sales from the previous year	independent
	INVEST	cumulative sum of investments in fixed assets in the last two years/total assets	independent
TAXES	TAX	(profit before taxes-profit after taxes)/profit after taxes	independent
RISK	RISK	standard deviation of operating profit/total assets for consecutive two years	independent

(Source: Authors' presentation)

4. EMPIRICAL DATA AND ANALYSIS

4.1. Descriptive analysis

In this paper, with the help of descriptive statistics, we can make a brief overview of the financial data of the Macedonian companies that are the subject of analysis. An initial picture of the sample used will be formed, and further, with the help of regression analysis, an attempt will be made to give an answer to the previously asked questions. The results obtained from descriptive statistics are shown in Table 2.

Table 2: Descriptive statistics

Determinant	Mean	Median	Maximum	Minimum	Standard Deviation
Total liabilities/total assets	0.4586	0.4266	1.0311	0.0657	0.2463
Total debt/total assets	0.2511	0.2237	0.9428	0.0000	0.2265
Long-term debt/total assets	0.1036	0.0483	0.5395	0.0000	0.1225
Company size	14.4446	14.2658	17.9093	8.9784	1.3973
Operational profit/total assets	0.0493	0.0389	0.3555	-0.2370	0.0979
Tangible assets/total assets	0.4489	0.4468	0.6660	0.0568	0.1242
Company's growth	0.0039	0.0024	0.2600	-0.3346	0.0473
Investments in fixed assets	0.0906	0.0729	0.3785	0.0015	0.0720
Tax	0.0820	0.0864	0.9316	-0.5438	0.1675
Risk	0.0316	0.0157	0.5153	0.0000	0.0572

(Source: Authors' calculations)

In descriptive statistics, all types of variables are included: the dependent variable – leverage presented in three variants, and the independent variables are size, profitability, materiality, growth (expressed as growth rate and investments), risk, and taxes.

The research sample comprises 10 industrial companies from the Republic of North Macedonia, covering 11 years from 2012 to 2022, resulting in a balanced dataset of 110 observations. To enable comparative analysis, the collected data has been grouped accordingly. The average leverage ratio, calculated as the total liabilities-to-total assets ratio, is 45.8%, suggesting that a substantial portion of the analysed companies rely on debt financing. The minimum leverage value is 6.5%, while the maximum is 103%, which is unusually high due to one company reporting negative share capital and significant accumulated losses over multiple periods. Excluding this outlier brings the maximum leverage to 82.6%, still indicating a high level of liabilities among these companies.

To further assess debt financing in the Macedonian industrial sector, we used the ratio of total debt to total assets as a second leverage measure, excluding trade liabilities and employee obligations. The average for this metric is lower, at 25.1%, with a minimum of 0%, indicating that some companies do not use bank loans for financing. The maximum value is 94.2%, which again is influenced by the same outlier company. Excluding this outlier reduces the maximum to 59.3%, highlighting the impact of this one company on overall results.

The third leverage variant is the ratio of long-term debt to total assets. Long-term debt includes all bank credit obligations with a payment term exceeding one-year, which companies typically use for substantial investments. On average, 10.3% of companies in the sample have long-term debt, with some having none, as indicated by a minimum value of 0. These figures suggest that Macedonian industrial companies tend to rely more on short-term loans and liabilities.

The high standard deviation (1.39) and wide range in the size variable—from a minimum of 8.9 to a maximum of 17.9—indicate that the sample includes companies of varying sizes. The average company size, measured as the natural logarithm of net sales, is 14.4, with a negative skewness, suggesting a few companies have larger-than-average sales.

Profitability is measured as the ratio of operating profit to total assets. There is a wide gap between the extreme values, with some companies reporting negative profitability due to operating losses over the period analysed. The average profitability rate is 4.9%.

Asset tangibility, which represents the share of tangible assets in a company's total assets, averages 45% in the sample. Tangibility ranges widely, with some companies having as much as 66.6% and others as low as 5.6% in tangible assets.

Growth is calculated in two ways for regression purposes: the natural logarithm of the change in net sales from the previous year and the cumulative sum of fixed asset investments relative to total assets. Macedonian companies show low average growth across both measures, with maximum values of 37.8% (for fixed asset investments) and 25.9% (for sales growth). Some companies even exhibit no growth or negative growth.

The corporate tax variable has an average and median value of 8%, close to the nominal income tax rate. Some companies, however, benefit from various tax exemptions or have no tax liability, so the effective tax rate was used for a more accurate reflection. The effective tax rate varies significantly, with a maximum of 93.1% in one company (due to a high level of unrecognized expenses in 2012) and a minimum of -54.3% (due to deductible timing differences that resulted in a negative effective tax rate for another company).

Company risk, measured as the standard deviation of return on assets (ROA), averages 3.1%, with a maximum of 51.5%. This variable provides an indicator of financial stability, suggesting a relatively low level of risk across the sample.

Overall, the analysis reveals that most Macedonian industrial companies exhibit a leverage ratio below 1, meaning only a few companies are highly debt dependent. These outliers significantly impact the overall capital structure analysis. Consequently, when examining grouped data through descriptive statistics, certain companies exert a strong influence on average results. Over the observed period, no major shifts in capital structure were noted across the companies.

4.2. Regression analysis

The research was started by setting up the basic model:

$$LEVER_{i,t} = \beta_0 + \beta_1 SIZE_{i,t} + \beta_2 PROF_{i,t} + \beta_3 TANG_{i,t} + \beta_4 GROWTH_{i,t} + \beta_5 RISK_{i,t} + \beta_6 TAX_{i,t} + \epsilon_i$$

Through this model, an answer would be given to the question of how the capital structure (represented by leverage as a dependent variable) is affected by certain determinants, i.e. the independent variables: size, profitability, tangibility, growth, risk, and income taxes in the analysed companies from Republic North Macedonia. As a useful tool throughout the analysis was used statistical software. Since the sample consists of heterogeneous companies, the pooled regression model was not applied. In the analysis, the method of OLS (ordinary least squares) was applied with several variations of the basic model. An initial assumption is that the fixed effects model is appropriate, but for greater certainty, a Hausman test was conducted.

Six regression models were set:

Model 1: $TL_{it} = \beta_0 + \beta_1 SIZE_{it} + \beta_2 PROF_{it} + \beta_3 TANG_{it} + \beta_4 INVEST_{it} + \beta_5 RISK_{it} + \beta_6 TAX_{it}$

Model 2: $TD_{it} = \beta_0 + \beta_1 SIZE_{it} + \beta_2 PROF_{it} + \beta_3 TANG_{it} + \beta_4 INVEST_{it} + \beta_5 RISK_{it} + \beta_6 TAX_{it}$

Model 3: $LTD_{it} = \beta_0 + \beta_1 SIZE_{it} + \beta_2 PROF_{it} + \beta_3 TANG_{it} + \beta_4 INVEST_{it} + \beta_5 RISK_{it} + \beta_6 TAX_{it}$

Model 4: $TL_{it} = \beta_0 + \beta_1 SIZE_{it} + \beta_2 PROF_{it} + \beta_3 TANG_{it} + \beta_4 IGROWTH_{it} + \beta_5 RISK_{it} + \beta_6 TAX_{it}$

Model 5: $TD_{it} = \beta_0 + \beta_1 SIZE_{it} + \beta_2 PROF_{it} + \beta_3 TANG_{it} + \beta_4 GROWTH_{it} + \beta_5 RISK_{it} + \beta_6 TAX_{it}$

Model 6: $TL_{it} = \beta_0 + \beta_1 SIZE_{it} + \beta_2 PROF_{it} + \beta_3 IGROWTH_{it} + \beta_4 RISK_{it} + \beta_5 TAX_{it}$

where dependent variables are TL are total liabilities, TD is total debt and LTD is long-term debt; independent variables are SIZE is size, PROF is profitability, TANG is tangibility, INVEST are investments calculated through investment in fixed assets, GROWTH is the growth rate calculated through the annual change in sales, RISK is risk and TAX is income taxes. Detailed information about the variables and the method of their calculation is given in Table 3.

Since three ways were used to express leverage (total liabilities, total debt, and total long-term debt), the set models have different dependent variables with various combinations of independent variables. In some of the models, the growth is expressed through investment in fixed assets, in others is calculated as the change in net sales, while in one model the determinant tangibility of assets is excluded.

The results obtained from the panel's regression analysis are presented in Table 3. After we had done the Hausman test, it was shown that the use of the fixed effect model was appropriate for the first five models, while the use of the random effect model would be more appropriate for the last model.

Table 3: Panel regression analysis

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
C	-1.454326* (0.182729)	-1.209605* (0.220680)	-0.647742* (0.172916)	-1.253638* (0.213271)	-1.154938* (0.263967)	-0.867687* (0.219106)
Size	0.117747* (0.012321)	0.066359* (0.014880)	0.038264* (0.011660)	0.106133* (0.013758)	0.062579* (0.017028)	0.094798* (0.014142)
	-0.637243*	0.063259	-0.147187	-0.694362*	0.046697	-0.908261*

Profitability	(0.157955)	(0.190761)	(0.149472)	(0.159042)	(0.196849)	(0.158991)
Tangibility	0.554289* (0.122670)	1.173316* (0.148147)	0.474001* (0.116082)	0.465766* (0.127745)	1.122221* (0.158111)	
Growth (investment)	-0.093866 (0.148180)	-0.261791 (0.178955)	-0.063483 (0.140222)			
Growth rate				0.295699 (0.167694)	0.082636 (0.207557)	0.549499* (0.165970)
Taxes	0.042398 (0.045689)	0.002007 (0.055178)	-0.012622 (0.043235)	0.040877 (0.045037)	-0.000104 (0.055743)	0.041499 (0.047798)
Risk	-0.009387 (0.141293)	-0.130585 (0.170638)	-0.004990 (0.133705)	-0.005960 (0.139285)	-0.136723 (0.172394)	-0.120908 0.143416
p-value (Chi-Sq)	0.0164	0.0152	0.000000	0.000000	0.000000	0.4200
Probability (F-stat)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Adjusted R ²	0.921991	0.865375	0.717556	0.924166	0.862542	0.533865
Model used	Fixed effects	Fixed effects	Fixed effects	Fixed effects	Fixed effects	Random effects
no. of observations	110	110	110	110	110	110

*Note: standard error in parentheses; *coefficients are statistically significant at 5% ($p < 0.05$)(Source: Authors' calculations)*

In summary, according to the adjusted coefficient of determination - R^2 , the most significant are the models in which as a dependent variable is leverage calculated as the ratio between total liabilities and total assets. In two of the models, the adjusted R^2 reaches a significantly high level, which shows that up to 92% of the variability is explained by the influence of the determinants included in the analysis.

5. RESULTS AND DISCUSSION

There is a positive and statistically significant relationship between the size and the leverage in all models. This positive relationship is consistent with most of the previous research. Banks are more open to lending more money to large companies because they see them as more stable and to companies with diversified portfolios that have higher transparency for potential and current investors, which can lead to a decrease in information and agency costs. In all the set models, size was found to be a statistically significant variable.

In four out of six models, profitability is found to be negatively related to leverage, which is somewhat of an expected result for this determinant. An explanation for this result can be found in the Pecking Order Theory. That is, profitable companies first choose internal sources and then if those are not sufficient to cover the operational and investment needs of the company, the company would turn to external financing through borrowing. In most cases, profitable companies use part of the realized profits and retained earnings to finance investments, so their need for external sources is limited, resulting in a low level of indebtedness. In the conducted research, there is a divided opinion about this determinant. In some of the researches a positive relationship was established in accordance with the trade-off theory (Frank and Goyal, 2009;

Jensen, 1986; Jõeveer, 2013), while certain authors, as in our case, found a negative relationship explained by the pecking order theory (Rajan and Zingales, 1995; Titman and Wessels, 1988; Nivorozhkin, 2004; Črnigoj and Mramor, 2009; Kędzior, 2012; Arsov and Naumoski, 2016). According to the theoretical point of view, a positive relationship is expected between tangibility and leverage. The results obtained in this research show the same: a positive and statistically significant relationship was established between leverage and tangible assets in our sample. After all, in this research, this variable has the highest degree of consistency compared to all the other determinants. This positive relationship can be explained through the trade-off theory and agency theory. As seen by lenders, tangible assets can be potential collateral in case the companies need to finance their activities using debt. Collateral offers greater security to lenders and contributes to the reduction of bankruptcy and agency costs i.e. financial distress costs. In our country, despite the high level of liquidity, banks are exclusively cautious when lending and are not prone to taking risks, so the obtained result can be explained to some extent by the banks' policies regarding the ratio of requested collateral compared to the loan exposure of a certain company. But, according to the research conducted in developing countries, this relationship has been shown to be negative. It is believed that this is because of underdeveloped secondary markets, which leads to uncertainty in determining the market value of assets, or that it is simply possible that companies with higher levels of tangible assets have a small need for additional external capital.

When it comes to growth, it has been theoretically shown that in developed countries the growth rate is negatively correlated with the leverage, while in developing countries this relationship is positive because companies that often make investments tend to use debt to finance their projects. But the completed analysis does not fully correspond to this, because the results obtained differ based on how the growth is expressed. Two approaches were used to calculate the growth rate: through the change in net sales and through realized capital investments. In our country, growth, seen as the annual increase of sales shows a positive and somewhat significant relationship, but capital investments turned out to be insignificant.

The impact of corporate taxes or specifically in this case income tax was found to be insignificant and no notable relationship with the level of indebtedness was established. The implementation of corporate taxes was crucial for establishing the first theories of capital structure, where the authors of the theories pay special attention to the benefits that companies have from the existence of a tax shield. In the research so far, there is a divided opinion, and the results obtained differ. In the analysis that we conducted on the selected sample, in some of the set models it was shown that the relationship is positive, while in some there is a negative relationship between leverage and corporate taxes. Anyhow, the influence of this determinant is not statistically significant for any of the defined models.

The results showed that there is an inverse and weak relationship between risk and leverage in all models and that this variable is statistically insignificant. The inverse relationship confirms the previously given opinion that companies with higher risk have a lower level of leverage because this can lead to a situation where the company falls into a greater financial crisis. Investors, banks, and other financial institutions usually do not tend to finance risky companies, which is in accordance with the results obtained. The results are consistent with other studies conducted for the countries covering the region (Črnigoj and Mramor, 2009; Arsov and Naumoski, 2016), but there are also studies where this relationship has been shown to be positive (Harris and Raviv, 1990; Huang and Song, 2002).

6. CONCLUSIONS

This study aimed to examine the determinants of capital structure in North Macedonia's industrial sector, focusing on ten companies listed on the Macedonian Stock Exchange over the

period from 2012 to 2022. The analysis explored key factors such as company size, profitability, asset tangibility, growth, risk, and taxes to understand their impact on leverage decisions within a transitional economy.

The findings indicate that the capital structures of industrial firms in North Macedonia are predominantly equity-based, with lower levels of debt, consistent with patterns observed in many developing economies. Additionally, companies tend to rely more on short-term debt, with limited reliance on long-term liabilities. This inclination aligns with the cautious lending environment in North Macedonia, where financial institutions typically favor short-term lending. Six determinants—size, profitability, tangibility, growth rate, taxes, and risk—were assessed using panel regression analysis, with leverage represented by total liabilities, total debt, and long-term debt.

Company size showed a positive relationship with leverage, suggesting that larger firms, due to their perceived stability and transparency, find it easier to secure debt financing. The study also found a significant negative relationship between profitability and leverage, as profitable firms tend to prioritize internal financing, in line with the Pecking Order Theory. This trend implies that profitable firms in North Macedonia rely on retained earnings to meet their capital needs, turning to debt only when internal resources are insufficient.

Asset tangibility was positively correlated with leverage, highlighting that tangible assets serve as collateral and reduce financial distress costs, making companies with substantial physical assets more attractive to lenders. The study observed a positive relationship between leverage and sales growth, as companies experiencing growth in revenues tend to increase borrowing to meet rising operational demands. However, growth measured by capital investment showed a negative relationship with leverage, a finding that warrants further investigation, as it diverges from typical expectations in a developing economic context.

The influence of income tax on leverage was insignificant, while higher risk had a negative impact on leverage. This result reflects the cautious approach of lenders and investors, who generally prefer not to finance higher-risk companies, thus limiting leverage in such firms.

These conclusions align with established capital structure theories. Larger companies with high asset tangibility exhibit a preference for debt, consistent with both the Trade-Off Theory and the Pecking Order Theory. Profitability's inverse relationship with leverage further supports the Pecking Order Theory, where internal funds are prioritized over external financing.

In conclusion, North Macedonian industrial firms do not appear to follow a fixed optimal capital structure but instead adhere to a financing hierarchy: they use internal funds first, then turn to debt financing, and finally consider equity issuance when necessary. This pattern reflects limited market development and reliance on bank loans in the absence of corporate bond issuance. Further research with a broader, more diverse sample across industries is recommended to gain deeper insights into the capital structure behavior of firms in this transitional economy.

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A SYSTEMATIC LITERATURE REVIEW OF GREEN FINANCE AND GREEN ECONOMY TRANSITION IN ECONOMY AND BUSINESS-RELATED STUDIES

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ABSTRACT

The main objective of this study is a systematisation of relevant published scientific papers on green finance and green transition economy published in the renowned scientific databases Scopus and Web of Science. For this purpose, PRISMA guidelines have been applied. Scientific databases were surveyed with the keywords "green finance" and "green transition", with an emphasis on economy and business-related studies. Areas of application of green finance and literature related to green transition are identified and presented, and in this way, trends over the years, publication year, types of documents, and, most importantly, research gaps are illuminated to provide guidelines for future work.

Keywords: Green finance, Green transition, Systematic literature review, PRISMA.

JEL classification: E44, Q01, Q56.

1. INTRODUCTION

At a time of increasingly significant climate changes, the depletion of natural resources, the destruction of the environment, and the loss of biological diversity, the demand for green finance, which represents a powerful tool for achieving an environmentally friendly and sustainable economy, is continuously growing. "Green finance" is a concept deriving from the green economy concept, which is not novel and dates back to the late 1980s. It is based on environmental economics knowledge, and it defines the green economy as "a clean economy that depends on green development" (Al-Taai, 2021). This means it utilizes resources and energy sources optimally, and it promotes and supports fair production, in a harmonizing and preserving way for the environment and nature. There is an ever-increasing number of studies that recommend both the private and public sectors accept and reinforce the concept of the green economy in the future for the sake of "sustainable development, job creation, and poverty alleviation", in both developed and developing countries (Houssam *et al.*, 2023).

According to Zhao *et al.* (2023), "green finance refers to financial instruments that provide environmental benefits". Green finance is financing or investing in projects that have an economic benefit and promote a sustainable environment (Ozili, 2021). To develop green finance, all subjects of the private and public sectors must be involved in developing and

implementing sustainable environmental projects (Martin, 2023). Green finance comprises "the financing of public and private green investments; the financing of public policies that encourage the implementation of environmental and environmental-damage mitigation or adaptation projects and initiatives and components of the financial system that deal specifically with green investments" Lindenberg (2014). Green finance plays a central role in green transitions, in both developed and developing countries (Wang *et al.*, 2021). Green finance facilitates the green transition, i.e. the transition towards a sustainable economy that establishes a balance between economic, social, and environmental circumstances. The green transition will make economies more ecologically sustainable, "but also make them more resistant to future shocks" (OECD, 2024).

The main objective of the paper is to identify, present, and analyse relevant published scientific economy and business-related studies from the scientific databases dealing with green finance and green transition by using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The main contribution of this paper is reflected in the systematization of relevant scientific full-text papers dealing with the mentioned research area and their detailed analysis and findings in narrative form.

The scientific contribution of this research is reflected in the promotion of green finance and green transition as a topical issue with an emphasis on researchers dealing with the economy and business. This research could be of interest to a wider audience, i.e. among researchers in any scientific field. The literature review presented later on in this paper significantly contributes to the scientific literature and is a springboard for future work and research on a topic that is crucial for today's sustainable economic development. Moreover, this is the first study to present a comprehensive systematic literature review and analysis of the so far published papers in this research area, thus making an important contribution to future research and work on the green economy, especially in the field of business and management as well as economy, econometrics, and finance.

The rest of the paper is structured in the following manner. After the introduction, a theoretical background of green finance and green transition is given. Section 3 presents the research design and methodology. Research results are presented in section 4, while the last section provides a discussion and a conclusion.

2. THEORETICAL BACKGROUND

2.1. Green finance

The concept of the green economy was first introduced in 1989 in the so-called *Blueprint for a Green Economy report*, which was put together by a team of economists and analysts trying to encourage practical policy measures for 'greening' modern economies and paving their way towards more sustainable development (Pearce *et al.*, 1989). The terms "Green economy", "circular economy" and "bioeconomy" have emerged as "popular narratives in macro-level sustainability discussions in policy, scientific research, and business" in the past decade (D'amato and Korhonen, 2021). These narratives address, with different approaches, the topical challenges of meeting economic, social, and environmental goals at the same time in the global context. The green economy is also defined as a "catalyser for sustainable development" in these three dimensions - economic, social, and environmental (Chaaben *et al.*, 2022). A more common definition of the green economy is its characterization as "low in carbon emissions, resource-efficient, and socially inclusive" (UNEP, 2011). Al-Taai (2021) defines it as "the nucleus of sustainable development" and the key pillar for growth, development (and especially economic development) and prosperity.

Green finance, on the other hand, is a more specific concept that is a part of the green economy, but it includes financing of new green projects that enhance environmental benefits. These

novel financial instruments and new policies, such as “green bonds, green banks, carbon market instruments, fiscal policy, green central banking, financial technologies, community-based green funds”, etc., are nowadays collectively known as “green finance” (Sachs *et al.*, 2019). However, even today, a commonly accepted and well-established definition of green finance does not exist (Berrou *et al.*, 2019). Khan *et al.* (2022) defined and quantified green finance as “climate mitigation finance”.

It is widely accepted among scholars that green finance is vital in financing renewable and green energy projects that could decrease carbon emissions and thus, its negative health effects, in developing climate-resilient infrastructure for cities and supporting and enhancing environmental sustainability (Taghizadeh-Hesary and Yoshino, 2019).

Even though the interest in the concept of green finance is quite large, the literature on green finance is still rather modest. Some of the most interesting findings regarding green finance are presented as follows. Ozili (2022) found that green finance can indeed make a big impact on the environment, society, and climate change mitigation, however, he also recognized many challenges ahead for green finance, such as “the lack of awareness about green finance, inconsistent definitions of green finance, lack of policy coordination for green financing, inconsistent policies, and lack of profitable incentives to investors and financial institutions who are willing to invest in climate change mitigation”.

The findings of the study of Akomea-Frimpong *et al.* (2022) reveal that “green securities, green investments, climate finance, carbon finance, green insurance, green credit, and green infrastructural bonds are the key green finance products mostly used by banks”.

There are even empirical studies (such as the one of Meo and Abd Karim, 2022), whose findings imply that green finance is the “best financial strategy” for decreasing CO₂ emissions. Khan *et al.* (2022) empirically proved that green finance “delivers as anticipated” in Asia.

2.2. Green transition

In the past few decades, rising environmental issues such as “global warming, climate change, ozone layer depletion, respiratory diseases, deforestation, and desertification” have been recognized and treated as both national and global challenges (Zhang *et al.*, 2023). Therefore, understanding green transitions is of key importance, especially at a time when all the available and currently dominant solutions “contribute to unsustainable development” (Haukkala, 2018). The term “green transition” refers to the process of transition to a green and sustainable economy, i.e. to “a fundamental transformation towards more sustainable modes of production and consumption” (Söderholm, 2020). The term “Green Transition” “refers to the EU’s efforts to become a carbon neutral continent by 2050” (Kekkonen *et al.*, 2023), thus including a wider application of renewable energy, reduction of greenhouse gas emissions, and promotion of the sustainable process of transportation and agriculture.

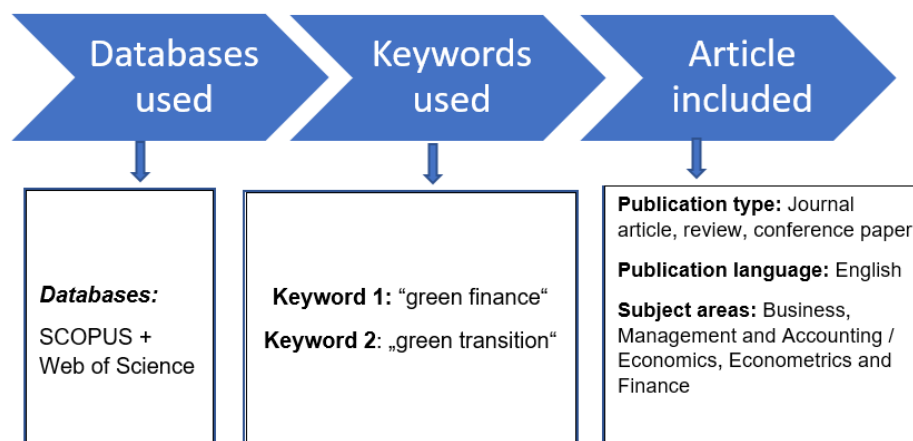
The successful green transition process needs adequate fiscal, monetary, and financial market policies that would support the process and provide the needed funds since the currently existing funds for this purpose are not sufficient (Braga and Ernst, 2023). Green transition processes take time. For instance, Europe’s green transition is a “long-term project guided by the political resolution to make Europe’s economy climate neutral by 2050” (Pietras, 2023). Kemp and Never (2017) addressed some of the green transition issues, tackling a few actions governments in developing economies could undertake to “phase in green technologies given the priorities for development, imperfect institutions for policy-making and implementation, weakly developed innovation systems, and problems of lock-in”. To implement a successful and quality green transition, policymakers have to come up with an innovative policy mix that would encourage a higher quantity of green finance projects, but with very good quality as well (Lamperti *et al.*, 2019).

It is no wonder that the concepts of green finance and green transition receive such increased interest, especially after the adoption of the 2030 Agenda for Sustainable Development in 2015 by the UN, as a potential way to address sustainability challenges. Moreover, green finance and green transition are directly and indirectly related to various SDGs (Sustainable Development Goals) (Taghizadeh-Hesary and Yoshino, 2019). Thereafter, a surge in interest in the topic of green economy occurred and the scholarly literature on the topic is expanding. Recent bibliometric studies found that the green/ sustainable economy gained greater academic attention and interest from scholars since 2016, with Asia and Europe leaders in green economy studies (Zhu *et al.*, 2023). However, as shown in section 3, the investigation of green finance and green transition combined (i.e. green finance products and services that support the green transition) is rather neglected by scholars, researchers, and academic members in the field of Business, Management and Accounting as well as Economics, Econometrics and Finance.

3. RESEARCH APPROACH

This paper implements the PRISMA-guided systematic review of green finance and green transition in economy and business-related studies. Based on the key phrases "green finance" and "green transition", relevant works related to business and economy were identified from the scientific databases Scopus and Web of Science, as shown in Figure 1. Moreover, there were stringent criteria used in this systematic review. First, the publication type was one of the inclusion criteria, i.e. only journal articles, reviews, and conference papers were included in the process. Second, the publication language of all included papers is English, and third, the selected surveyed papers are written in the research fields of Business, Management, and Accounting as well as Economics, Econometrics, and Finance.

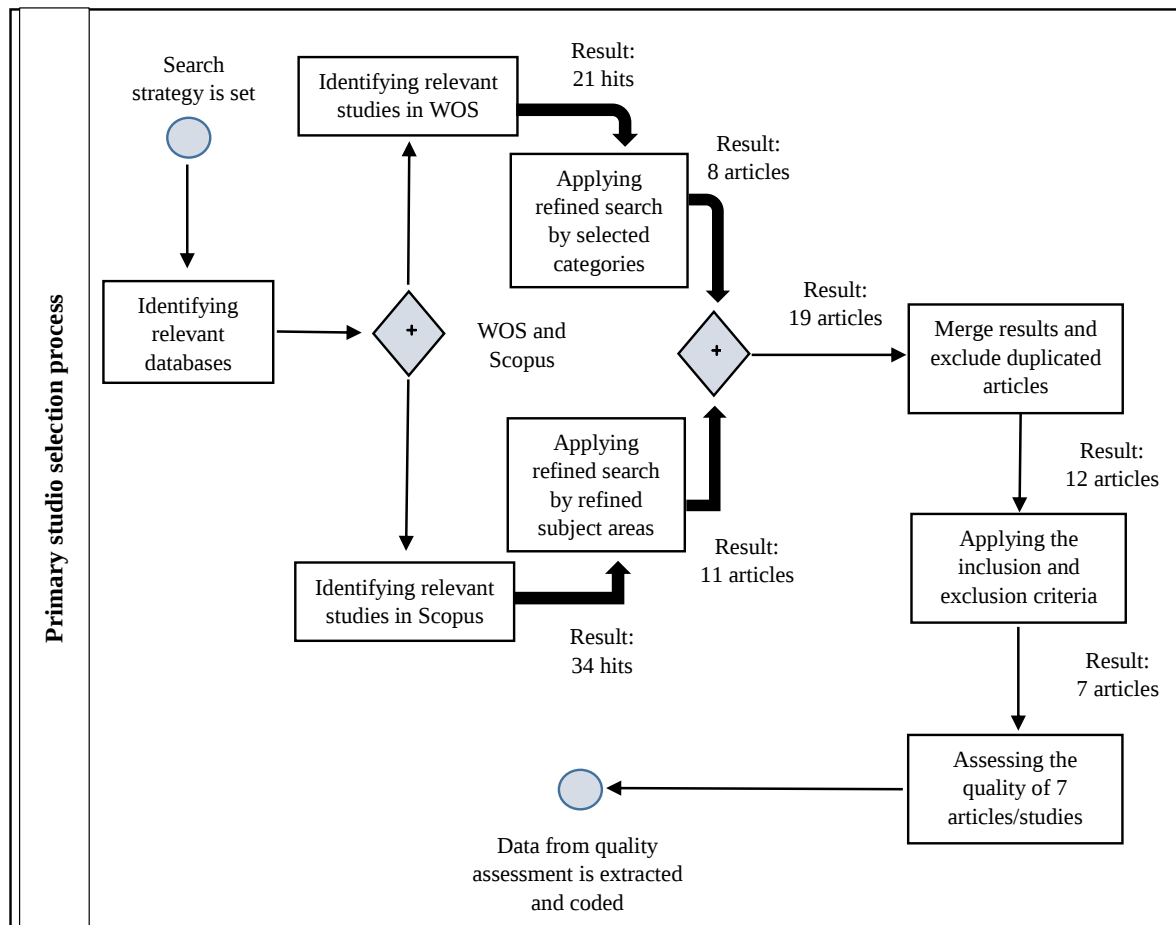
Figure 1: Procedure of the review study



(Source: Authors' work)

The whole selection procedure of the included papers is presented in Figure 2. Namely, in the first step, each of the Scopus and Web of Science databases was surveyed with the key phrases "green finance" AND "green transition", which led to 34 papers in Scopus and 21 papers in the Web of Science database. After applying the refining criteria and selecting defined research areas, types of publications, language of publication, as well as full-text availability, a total of 7 papers for quality assessment were left out.

Figure 2: The selection process flowchart



(Source: Authors' work)

4. RESEARCH RESULTS

As discussed in the introduction, this paper is related to the systematization of relevant scientific papers on green finance and green transition economy and studies related to business published in globally renowned scientific databases. In the continuation, the relevant papers, available as full-text papers from the mentioned scientific databases, are analysed in detail in a narrative form. For the sake of transparency, the presentation of the same is also given in a table form, in Table 1.

Table 1: List of analysed papers

Author/s and year of publication	Title of the paper	Analysed country/region
Zhao, Wang and Dong (2023)	“The role of green finance in eradicating energy poverty: ways to realize green economic recovery in the post-COVID-19 era”	China
Chi and Yang (2023)	“Green finance and green transition by enterprises: An exploration of market-oriented governance mechanisms”	China

Martin (2023)	“Green Finance: Regulation and Instruments”	Serbia
Zhao, Zhao, Dong (2023)	“Green growth contribution to carbon neutrality”	China
Kandrács (2023)	“Financing a Sustainable Economy in Hungary, Opportunities and Challenges: Decarbonisation, Green Transition, Sustainable Finance, Central Bank”	Hungary
Angelov (2022)	“Assessment of Challenges and Risks for the Banking Sector in the Transition to a Green Economy through a Sample Survey”	Bulgaria
Versal and Sholoiko (2022)	“Green bonds of supranational financial institutions: On the road to sustainable development”	selected countries of Africa, Asia, Europe, America

(Source: Authors' work)

Zhao et al. (2023) analysed whether green finance can solve energy poverty. The research was conducted for the period 2004–2018 in China by using an empirical econometric model. Energy poverty can be eradicated using green finance only in regions with low energy poverty and mitigated in areas with high and low green finance. Green finance directly helps eradicate energy poverty and indirectly reduces it by introducing innovations and technological changes. **Chi and Yang (2023)** analysed the impact of green finance on Chinese enterprises between 2009 and 2019. The authors concluded that green finance could stimulate the green transition of enterprises through the provision of market-oriented management, especially in areas where state environmental management is more prominent. In conclusion, the hypothesis "Green finance significantly drives green transition by enterprises." which the authors set was confirmed.

The green transition towards sustainable economic growth is made possible by green finance (**Martin, 2023**). In addition to green bonds, the author points out some other common green financial instruments in Serbia. Recently, market values of green instruments have increased significantly in Serbia. It is necessary to encourage the development of new green instruments for solving problems related to climate change.

The effects of the green transition on CO₂ emissions are analysed by **Zhao et al. (2023)** by using 2004–2018 data in China. The research results indicate that green transitions gradually reduce but have different effects on CO₂ emissions. In the eastern region, they increase emissions, and in the central and western decrease. The green transition has a direct impact on the reduction of CO₂ emissions, while green financing has an intermediary effect.

A green transition is not possible without significant investment and financing. In Hungary, the central bank, Magyar Nemzeti Bank, effectively helps finance green and sustainable investments, to contribute to the transition to an ecologically sustainable economy (**Kandrács, 2023**). To protect the environment and mitigate climate change in the Hungarian economy, decarbonization is essential, which will improve the macroeconomic structure and reduce energy imports.

Through a survey conducted in the period 2021/2022, Angelov (2022) tried to determine the attitudes of employees of banking institutions about the changes in banks during the green transition in Bulgaria. Research results indicate that employees are familiar with green finance and green banking. They are also familiar with mechanisms of state support for green investments and generally accepted standards of green finance.

Green bonds and green projects carried out by the World Bank and the European Bank for Reconstruction and Development were analyzed in **Versal and Sholoiko (2022)**. Financial (for the period 2008–2021) and non-financial (for the period 1992–2018) data were collected for selected countries of Africa, Asia, Europe, and America. A positive trend was observed in the issuance of these financial instruments, particularly focused on RES and energy efficiency.

Table 2: The research subject and period in analysed articles

Author/s and year of publication	Subject of research	Time frame
Zhao, Wang and Dong (2023)	green finance in eradicating energy poverty	2004–2018
Chi and Yang (2023)	green finance impact on enterprises	2009–2019
Martin (2023)	green finance instruments regulation	2021
Zhao, Zhao, Dong (2023)	green transition and CO2 emissions	2004–2018
Kandrás (2023)	financing a sustainable economy	2008–2021
Angelov (2022)	attitudes of employees of banking institutions about the changes in banks during the transition to a green economy	2021/2022
Versal and Sholoiko (2022)	green bonds and green projects	2008–2021, 1992–2018

(Source: Authors' work)

A summary of all the findings and a discussion regarding them is provided in the next section.

5. DISCUSSION

This paper deals with a PRISMA-guided systematic review of green finance and green transition in economy and business-related studies. Based on the keywords "green finance" and "green transition", relevant papers related to business and economics are identified from the scientific databases. A total of 7 relevant papers, available as full-text papers, were analysed qualitatively. The results of this analysis are provided as follows. Out of all the analysed articles, two were published in 2022, and the remaining in 2023, which indicates that green finance and green transition have become a world concern in the past few years of the 21st century. Five articles were published in journals, one as a book chapter and one as a conference paper. Three of the surveyed studies focus on China (Zhao *et al.*, 2023; Chi and Yang, 2023; Zhao *et al.*, 2023), one study on Hungary (Kandrás, 2023), one on Bulgaria (Angelov, 2022), one on Serbia (Martin, 2023)) and one include multiple world economies (Versal and Sholoiko, 2022). Three surveyed papers concern the impact of green finance and the transition to an ecologically sustainable economy (Zhao *et al.*, 2023; Zhao *et al.*, 2023; Kandrás, 2023). Two

studies deal with green financial instruments (Martin, 2023; Versal and Sholoiko, 2022). One study involves the impact of green finance on enterprises (Chi and Yang, 2023)) and one on employees of banking institutions (Angelov, 2022). The systematization of articles according to the research subject and period is given in Table 2.

6. CONCLUSION

The scientific contribution of this paper is reflected in the promotion of green finance and green transition as a topical issue with an emphasis on researchers dealing with the economy and business. The same research could be of interest to a wider audience, i.e. among researchers in any scientific field. This literature review would significantly contribute to the scientific literature and is a springboard for future work and research on a topic that is crucial for today's sustainable economic development. The subject at hand is very contemporary and thus, it could be beneficial to policymakers, NGOs, scholars, academic members, and the wider audience.

The main limitation of this paper mirrors the selection of the two most renowned and popular scientific databases, excluding and not counting potential papers that might be relevant to this research topic, but are published in journals indexed elsewhere. This could have affected the correctness of the analysis. Moreover, another limitation is that this study included only available full-text papers, which leaves the possibility for non-available papers to be relevant to this subject but not included in the review. Therefore, the authors plan to expand this research in future work and undergo a more detailed meta-analysis, data comparison, and methodology introduction of similar literature, including more empirical studies. This would help reveal regions and factors of green transition globally. Moreover, in future work, more scientific databases are planned to be included in the literature review (besides the Scopus and Web of Science databases), to obtain a stronger theoretical background as well as stronger research findings.

As far as the authors' knowledge goes, this article is the first to present a comprehensive systematic literature review and analysis of the so far published papers in this research area. Future research is expected to investigate the position of Croatia in terms of green finance and green transition in the EU frame which strives for a climate-neutral and sustainable economy. Notwithstanding, a future analysis of the impact of digital technology on the green economy is expected, as well as the implications of artificial intelligence, business innovations, and digital business transformations on the sustainable growth and development of economies globally.

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ANALYZING THE DYNAMICS BETWEEN MACROECONOMIC VARIABLES AND THE MACEDONIAN STOCK EXCHANGE INDEX

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ABSTRACT

This paper presents an empirical analysis of the dynamic relationships between the Macedonian Stock Exchange Index and a set of macroeconomic variables including Gross Domestic Product (GDP), central bank bills interest rate, interest rates on deposits, inflation, and crude oil prices. Utilizing the Autoregressive Distributed Lag (ARDL) approach, we examine the short-term and long-term impacts of these variables on the stock market from Q1 2009 to Q3 2023. Our ARDL Bounds Test results confirm the presence of a cointegrated relationship, indicating that the stock market and macroeconomic variables are mutually influenced over the long term. In the long run, increases in GDP positively impact the Macedonian stock exchange market, while rising central bank interest rates exert a negative effect on the MBI10 index. While, in the short term, only changes in oil prices and the stock index itself are found to have significant impacts on the MBI-10, with the error correction term indicating a swift adjustment to equilibrium after short-term shocks. This study contributes to the literature by providing nuanced insights into the macroeconomic determinants of stock market performance in North Macedonia, offering implications for policymakers and investors regarding the critical factors influencing market dynamics. The findings underscore the importance of economic growth for stock market vitality, the critical role of monetary policy, and the sensitivity of the stock market to oil price volatility, emphasizing the need for strategic economic policies to foster a stable and growth-conducive market environment.

Keywords: Macedonian Stock Exchange Index, Macroeconomic Variables, ARDL Model.

JEL classification: G10, E44, C22.

1. INTRODUCTION

Financial institutions contribute to the national economy by accumulating capital funds to meet the financial needs of different productive and business sectors (Gupta, 1982). Financial markets are broadly classified into money markets and capital markets. Transactions in short-term debt instruments or marketable securities are done in the money market, whereas long-term securities (bonds and stocks) are traded in the capital market (Kovács and Kajtor-Wieland, 2017). According to Ehrmann *et al.* (2011), the money market is the financial market for short-term borrowing and lending and provides short-term liquid funding for the financial system, whereas the capital market is the financial market for long-term borrowing and lending and provides long-term liquid funding for the financial system, including government bonds, institutional bonds, and stocks. The stock market is a major component of the securities market (Boehme and Colak, 2012). A stock market is the center of a network of transactions where buyers and sellers of securities meet at a specified price (Bologa and Cavallo, 2002). Stock markets play a pivotal role in facilitating economic development by efficiently allocating capital among investment opportunities, enabling companies to secure funds for expansion, and encouraging savings through portfolio diversification, thus fostering economic growth (Adam *et al.*, 2016). The role of these markets is important in the way that they mobilize the domestic resources of the economy and channel them to productive investment (Comincioli, 1995).

There is a widespread acknowledgment among analysts, scholars, and policymakers that the advancement of financial markets, particularly stock markets, is crucial for promoting economic growth. This emphasis on stock market development aligns with the guidance provided by international and regional organizations, highlighting the importance of integrating such markets into a country's financial system. The performance of a nation's stock market is believed to reflect that country's economy. Since the previous few eras, the reputation of the stock market around the world unlocked different pathways of investigation into the financial progress and stock market growth. While the importance of stock market development is widely recognized, there is no universal consensus on the specific determinants that drive it. Therefore, identifying key factors influencing stock market development is of paramount importance. Many factors can be a signal to stock market participants to expect a higher or lower return when investing in the stock market and one of these factors is macroeconomic variables, (Talla, 2013). Numerous researchers in this area showed that share prices are determined based on macroeconomic influences such as industrial production, interest rate, consumer price index, inflation rate, exchange rate, money supply, etc. (Mukherjee and Naka, 1995; Pilinkus and Boguslauskas, 2009; Eita, 2012; Kabir *et al.*, 2014; Soti, 2015; Majeed and Masih, 2016; Khatri, 2019; Devkota and Dhungana, 2019; Verma and Bansal, 2021). Stock analysts usually believe that economic factors have an enormous effect on stock market prices. Understanding the interplay between macroeconomic factors and stock market performance is essential, given that macroeconomic variables significantly influence stock market behaviour and returns.

In North Macedonia, stock markets are relatively underdeveloped compared to their counterparts in other regions. Challenges such as the dominance of the banking sector, limited trading volume due to a small number of listed companies, and market volatility due to speculation hinder stock market development. However, these challenges can be addressed through reforms aimed at improving banking services, enhancing legal frameworks, and incentivizing private companies to go public. The relationship between stock markets and macroeconomic variables remains a topic of debate.

To address this gap in the literature, this study aims to analyse the development of stock markets in Macedonia and its relationship with key macroeconomic variables such as GDP,

interest rate, inflation, and crude oil prices. By employing an autoregressive distributed lag (ARDL) model, the study seeks to understand the relationship between stock market prices and major macroeconomic variables. It can further help policymakers and investors to keep an eye on the stock market. The remaining part of the paper is organized into three sections. Section 2 reviews the literature relevant to the present study. Data, methods, and results are discussed in Section 3 and Section 4 presents the concluding remarks.

2. REVIEW OF THE EMPIRICAL LITERATURE

Mukherjee and Naka (1995) conducted a seminal investigation into the relationship between the Tokyo Stock Exchange index and various macroeconomic variables. Employing vector error correction models, they identified long-term associations between the stock market index and factors such as call money rates, inflation rates, exchange rates, and industrial production. Similarly, Muradoglu *et al.* (2000) examined causal relationships among inflation rates, interest rates, industrial production, exchange rates, and stock returns across nineteen emerging markets. Their findings underscored the significant role of country-specific factors in determining stock market returns, emphasizing the importance of conducting country-level analyses over-generalized panel data approaches for informed policy formulation.

Extending the scope of macroeconomic influence studies, Ben Naceur *et al.* (2007) analysed stock market development in the Middle East and North Africa (MENA) region. Utilizing panel data analysis, they found that savings rates, domestic credit to the private sector, stock market liquidity, and inflation significantly influenced stock market development. In contrast, income levels and investment did not exhibit statistically significant impacts. Humpe and Macmillan (2009) provided a comparative analysis of how macroeconomic variables influence stock market movements in the United States and Japan. Their findings indicated that U.S. stock prices were positively related to industrial production but negatively correlated with interest rates and the consumer price index. Conversely, Japanese stock prices exhibited a negative association with both industrial production and money supply.

Investigating the interplay between oil prices and stock markets, Bjørnland (2009) focused on Norway, an oil-exporting country. By applying a Vector Autoregression (VAR) model that included the stock market index, industrial production, inflation rate, and oil prices, the study found that increases in oil prices led to a rise in stock market prices. This suggests that in oil-exporting countries, higher oil prices can positively impact stock market performance due to increased revenues from oil exports. Investigating short-term dynamics, Pilinkus and Boguslauskas (2009) explored the relationships between macroeconomic variables and the stock market index in Lithuania. Their results suggested that increases in GDP and money supply were associated with rises in the stock market index, whereas higher unemployment rates, exchange rates, and interest rates were linked to declines in index values. Similarly, Filis (2010) examined the relationships between macroeconomic variables, the stock market, and oil prices in Greece from 1996 to 2008. The study revealed that oil prices had a significant negative impact on the Greek stock market in the long run. Additionally, industrial production positively influenced the stock market, while inflation exerted a negative effect. Hussain *et al.* (2012) investigated the impact of various macroeconomic variables on Indian stock prices through multiple regression analysis. Their findings indicated that oil and gold prices had a significant negative influence on stock prices. In contrast, factors such as the balance of trade, GDP, industrial production, interest rates, foreign exchange reserves, and money supply positively affected stock prices. In the context of African markets, Eita (2012) analysed the macroeconomic determinants of stock market prices in Namibia using a vector error correction model. The study concluded that economic activity, interest rates, inflation, money supply, and exchange rates significantly influenced Namibian stock prices. Specifically, exchange rates,

income levels, and inflation demonstrated a positive relationship with stock prices. Focusing on the ASEAN region, Miseman *et al.* (2013) assessed the influence of macroeconomic factors—including interest rates, broad money supply, domestic output, and inflation—on stock prices in Malaysia, Indonesia, Thailand, Singapore, and the Philippines. Their findings revealed that these macroeconomic variables significantly affected stock prices across the region.

In the context of economic crises, Bellalah *et al.* (2013) studied the relationship between stock exchange prices and macroeconomic variables such as interest rates, money supply, and oil prices in the USA, Japan, and China. Their research focused on the period during the global economic crisis and provided valuable insights into how these variables influenced stock prices differently across these distinct economies during times of financial instability. Investigating European markets, Degiannakis *et al.* (2014) examined the impact of oil price shocks on European stock markets using a structural vector autoregressive model. The study suggested that increases in oil prices significantly affected the demand side of the economy, ultimately leading to a negative impact on stock markets. Turning to Nepal, Soti (2015) explored the long-run relationship between the Nepalese stock market and macroeconomic variables by utilizing the Autoregressive Distributed Lag (ARDL) model. The study concluded that, despite some short-term fluctuations, there existed a long-run relationship between the NEPSE index and variables such as the consumer price index, money supply, and interest rates. Building upon this, Devkota and Dhungana (2019) employed the ARDL bounds testing approach to confirm further the long-run association between macroeconomic variables and stock market performance in Nepal.

Collectively, these studies underscore the significant influence of macroeconomic factors on stock prices across various economies, both developed and emerging. Accordingly, the present study aims to investigate the impact of changes in macroeconomic variables on Macedonian stock market prices, thereby providing crucial insights for policymakers and investors.

3. DATA, METHODOLOGY AND RESULTS

An empirical study is based on a data set covering the quarterly period from 2009Q1 to 2023Q3. The stock market prices are shown through the Macedonian Stock Exchange Index – MBI10, consisting of the ten most liquid shares on the Macedonian stock exchange. The data for the value of the MBI10 index is obtained from the Macedonian stock exchange database. Macroeconomic determinants on the MBI10 index are CB bills (reference) interest rates, interest rates on deposits, which are obtained for the Central Bank database, the State Statistical office as a source for data for GDP and inflation, and data for oil prices from West Texas Intermediate crude oil prices per barrel (Pilinkus, 2010; Eita, 2012; Giri and Joshi, 2017; Karakostas 2023). Before testing the model and determining the influence on the variables, Table 1 presents some basic descriptive statistics. Note that the values in the descriptive statistics table reflect the statistics of the raw data but in further analyses, some of the variables are going to be used by taking their natural logarithm.

The descriptive statistics indicate a wide range of values for the MBI10 index, with a minimum value of 1 575 index points and a maximum of 6 278 index points. The average value is 3 171 index points with a standard deviation of 1 519 points, suggesting notable variability in the data relative to the mean. The average GDP is 148 207 million denars, with significant variability ranging from 92 764 million denars to 217 461 million denars. Its standard deviation of 31 359 million denar underscores fluctuations in economic output. Inflation, with a mean of 0.23% and a standard deviation of 0.63%, remains relatively low but exhibits notable variability, with rates ranging from -1.75% (deflation) to 2.77%. Central bank bills interest rates show moderate means of 3.69% with standard deviations suggesting stability in lending environments. The

interest rates on deposits demonstrate an average of 1.47% with a standard deviation of 0.58%, indicating a range from 0.53% to 2.78%, reflecting the interest environment for depositors within the period studied. The volatility of oil prices, ranging from \$18.38 to \$125.45 with a mean of \$76.86 and a standard deviation of \$25.22, also highlights significant external economic factors.

Table 1: Descriptive statistic

Variables	Mean	Standard Deviation	Minimum	Maximum
Macedonian Stock Exchange Index (MBI10)	3 171	1 519	1 575	6 278
Gross domestic product (GDP) (in million denars)	148 207	31 359	92 764	217 461
Inflation (in %)	0.23	0.63	-1.75	2.77
Central bank bills interest rate (CBB_IR) (in %)	3.69	1.85	1.25	9.00
Interest rate on deposits (IR_D) (in %)	1.47	0.58	0.53	2.78
Oil prices (in dollars per barrel)	76.86	25.22	18.38	125.45

(Source: Authors' compilation)

According to suggestions from the literature review and the characteristics of our financial system, the study employs an autoregressive distributed lag (ARDL) model because of its flexibility in handling variables that are integrated at different orders, such as $I(0)$ or $I(1)$. This makes it particularly suitable for our analysis, where some macroeconomic determinants may exhibit varying levels of stationarity. Peseran and Shin (1999) first proposed this autoregressive distributed lag method, which has indeed gained wide application in empirical research. This approach was further elaborated by Peseran *et al.* (2001) using it to examine the existence of a long-run cointegrating relationship between variables. Cointegration represents the existence of a stationary linear combination between non-stationary variables, (Engle and Granger, 1987). This implies that despite the stochastic movement of the variables, a stable long-term relationship can be identified between them. Compared with other techniques of determining the cointegration relationship such as Granger's cointegration method, (Engle and Granger, 1987), Johansen's cointegration method, or Johansen's cointegration technique, (Johansen and Juselius, 1990), the autoregressive model approach is preferred, if there is a different order of integration between the variables, $I(0)$ and/or $I(1)$, as long as no variable is integrated from the second order. Hence, the first step of the time series analysis is examining the stationarity of the variables. According to Gujarati (2003), a series can be considered stationary if its mean and variance are constant over time. In order to determine the integrative characteristics of the time series, the Augmented Dickey–Fuller (ADF) and the Phillips–Perron (PP) unit root tests, which were developed by Dickey and Fuller (1979), Phillips and Perron (1988), respectively, are used in this study. The unit root test results are shown in Table 2. Note that the null hypothesis for the ADF and the PP tests is that the variable has a unit root (nonstationary) while the alternative hypothesis suggests stationarity. Combining two different unit root tests enables us to examine both the null hypotheses of the nonstationary. According to the test results, some of the variables are stationary at a level while some others become stationary after the first difference, so the ARDL Bounds test can powerfully analyze the short-run and long-run relationships between the stock market and its macroeconomic determinants.

Table 2: Augmented Dickey–Fuller (ADF) Unit Root Test

	Variables	MBI10	GDP	Inflation	CBB_IR	IR_D	Oil prices
In level							
	t-statistics	-0.11	0.12	-5.78	-5.25	-2.54	-2.39
	Test critical values 10% level	-2.59	-2.61	-2.60	-2.60	-2.61	-2.61
First difference	t-statistics	-7.07	-16.16			-8.60	-8.24
	Test critical values 10% level	-2.59	-2.60			-2.60	-2.60
	Stationarity	I (1)	I (1)	I (0)	I (0)	I (1)	I (1)

(Source: Authors' calculations)

Table 3: Phillips–Perron (PP) Unit Root Test

	Variables	MBI10	GDP	Inflation	CBB_IR	IR_D	Oil prices
In level							
	t-statistics	-0.21	-1.34	-5.78	-1.86	-2.45	-2.51
	Test critical values 10% level	-2.61	-2.61	-2.61	-2.61	-2.61	-2.61
First difference	t-statistics	-7.13	-24.35		-5.21	-8.61	-8.23
	Test critical values 10% level	-2.60	-2.60		-2.60	-2.60	-2.60
	Stationarity	I (1)	I (1)	I (0)	I (1)	I (1)	I (1)

(Source: Authors' calculations)

Furthermore, the required autoregressive distributed lag model has the following form:

$$\ln(MBI10) = a_1 \ln(MBI10) + a_2 \ln(GDP) + a_3(L)CBBIR + a_4(L)INF + a_5(L)IR_D + a_6(L)\ln(OilP) + \mu_t$$

Where μ_t is the error term that contains the remaining variables affecting the dependent variable, and they are not included in the independent variables, and $a_j(L)$ are time delays defined as:

$$a_1(L) = a_{11}L + \dots + a_{1p}L^p,$$

$$a_j(L) = 1 + a_{j1}L + \dots + a_{jp}L^p, \quad j \geq 2,$$

Firstly, to identify the existence of a co-integration relationship, the autoregressive distributed lag model is based on the Wald-test (F-statistic), the critical values of the F-test are given by Peseran *et al.* (2001). The lower critical value assumes that all variables are integrated of order zero I(0), so there is no cointegration relationship between the variables involved. Whereas the upper critical value assumes that all variables are integrated of the first order I (1), so that there is cointegration between the variables. Hence, when the resulting F-test value is greater than the upper critical value, the null hypothesis is rejected (H0), and the variables in the model are cointegrated. Conversely, if the resulting F-test value is below the lower critical value, then the

null hypothesis cannot be rejected (H_0), and when the value is between the lower and upper critical value, the conclusion is unsupported, the existence of a cointegration (long-term) relationship between the variables cannot be determined with certainty.

Namely, if we determine that there is cointegration between the variables, this model will further allow us to estimate coefficients related to this long-term equilibrium, as well as estimate the short-term coefficients and the error correction term, the rate at which variables adjust to long-run equilibrium.

Hence, to determine the number of time lags for each of the variables, the Akaike information criterion is used. Thus, in this regression equation, the Akaike information criterion suggests the following model ARDL (3,1,0,0,3,0).

The performed test gives us the coefficient of the F-statistic 4.05, when compared with the defined limits indicating that there is a co-integration between the dependent and independent variables at a significance level of 1%, table 4.

Table 4: Cointegration Test (F-Bounds Test)

Test statistics	Value	Significance level	I(0)	I(1)
F-statistics	4.05	10 %	2.08	3
K	5	5 %	2.39	3.38
		1 %	3.06	4.15

(Source: Authors' calculations)

Furthermore, we move on to the estimation of the long-term test with constant and no trend (Long Run Form, Case 3: Unrestricted Constant and No Trend), which gives us the long-term coefficients of each of the variables, which are shown in the following table 5.

Table 5: Estimation of the long-term test with constant and no trend

Dependent variable LMBI10	
	Independent variable
LGDP	4.381*
CBB IR	-0.138*
IR D	0.413
INFLATION	-0.066
LOIL PRICES	-0.893
*, ** and *** mean rejection of the null hypothesis that the coefficient is not statistically different from zero at the 10, 5, and 1% level of significance	

(Source: Authors' calculations)

The estimation results reveal that the long-term coefficient for GDP is statistically significant, demonstrating a robust positive impact on the stock market index. This finding underscores the vital role of economic growth in driving stock market performance, as increases in GDP signal economic expansion, higher corporate earnings, and greater consumer spending, all of which contribute to rising stock prices. Furthermore, the analysis highlights the influence of the central bank interest rate, which exhibits a typically inverse relationship with the stock market index. Higher CBB interest rates increase borrowing costs for businesses and consumers, potentially curbing investment and spending, thereby exerting downward pressure on stock prices. Conversely, lower interest rates reduce borrowing costs, fostering investment and spending, and positively impacting stock prices. The coefficient before the interest rate on deposits shows no significant long-term impact suggesting a nuanced relationship between deposit rates and stock market performance that may require further exploration to fully understand its dynamics within the Macedonian financial system. Inflation, and oil prices,

represented by their respective coefficients, indicate a negative influence on the LMBI10, albeit not reaching traditional levels of statistical significance. Furthermore, through this model, we will try to examine the short-term relationships between the dependent and independent variables, as well as the dynamic adjustment coefficient, which shows the speed with which the short-term deviation is corrected to the long-term balance. The obtained results are presented in Table 6.

Table 6: Estimation of short-term relationships and dynamic adjustment coefficient

Dependent variable LMBI10	
	Independent variable
ΔLMBI10_{-2}	-0.420***
$\Delta\text{LOIL_PRICES}_{-1}$	-0.182**
$\Delta\text{LOIL_PRICES}_{-2}$	-0.143*
ECT_{-1}	-0.070***
R^2	43.10%
*, * * and *** mean rejection of the null hypothesis that the coefficient is not statistically different from zero at the 10, 5, and 1% level of significance	

(Source: Authors' calculations)

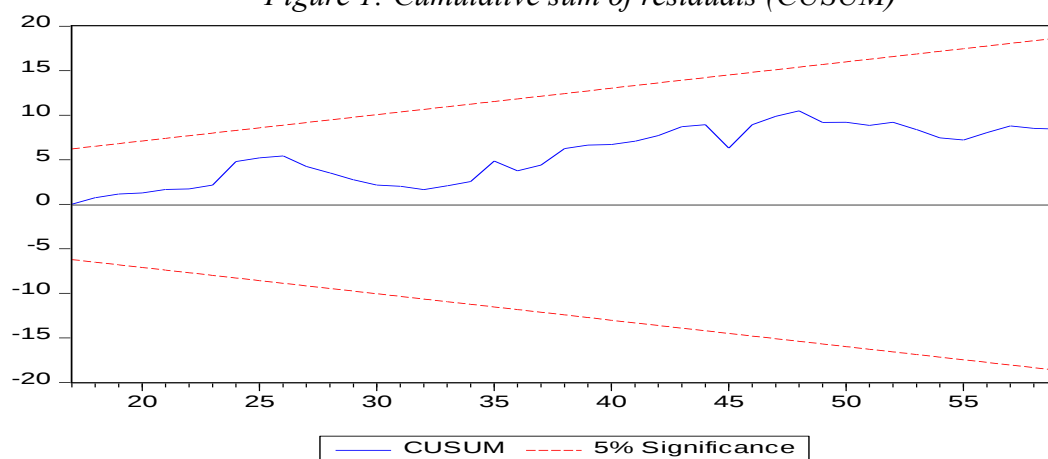
From the obtained results of the error correction method (ECM), we can conclude that in the short term, the value of the MBI10 index from the two periods back negatively affects the current level of the MBI10 index. The oil prices from one and two periods back have a negative effect on the value of the MBI10 index. The statistically significant negative coefficient of -0.420 suggests that a decline in the MBI10 index two periods ago tends to be followed by an increase in the current period. This counterintuitive finding could be reflective of a corrective mechanism in the market where, after a period of decline, prices adjust upwards towards their mean or long-term trend. This phenomenon is often related to "mean reversion" in financial markets, where prices tend to move back toward the mean or average levels over time after periods of volatility. This could indicate that after experiencing declines, the market may see opportunities for buying undervalued stocks, leading to increased buying activity that drives prices up. Investors might perceive the declines as temporary and see value in entering the market at lower prices, anticipating future gains as the market corrects itself. The negative coefficients for the lagged changes in oil prices (-0.182 and -0.143, respectively) indicate that recent increases in oil prices adversely affect the stock market in the short term. In an energy-importing country like North Macedonia, higher oil prices can increase production and transportation costs, leading to higher inflation and reduced disposable income for consumers. This can dampen economic activity and corporate earnings, leading to lower stock prices. The lagged effects suggest that the market may take time to fully absorb and react to changes in oil prices, reflecting the transmission lag between oil price changes and their economic impact. Despite the statistical significance and the expected negative sign of the error correction term ($\text{ECT}(-1)$), its coefficient is notably low in magnitude. This low value indicates a slow speed of adjustment of the stock market index back to its long-run equilibrium after experiencing short-term shocks. In other words, when deviations occur, it takes a considerable amount of time for the index to revert to its equilibrium state. This sluggish adjustment process could be due to market inefficiencies, structural rigidities, or behavioral factors among investors that impede rapid correction. The prolonged impact of shocks suggests that short-term disturbances have lasting effects on the stock market, which has important implications for investors and policymakers alike. Additionally, the dynamic adjustment coefficient (the error correction term) has the expected negative sign at the 1% significance level. To ensure the robustness of

our ARDL model, we conducted several diagnostic tests. The Breusch-Pagan-Godfrey heteroskedasticity test indicated no evidence of heteroskedasticity in our model's residuals, confirming that the variance of the residuals is constant and supporting the reliability of our coefficient estimates (Breusch and Pagan, 1979; Godfrey, 1978). The Breusch-Godfrey Serial LM test for autocorrelation suggested that there is no autocorrelation detected in the residuals (Breusch, 1978; Godfrey, 1978). The Ramsey RESET test for model specification implied that our model is correctly specified, with no signs of omitted variables or incorrect functional form (Ramsey, 1969). These results reinforce the adequacy of our model in capturing the relationships between the dependent and independent variables. Regarding the normality of residuals, the Jarque-Bera test led us to conclude that the residuals are approximately normally distributed (Jarque and Bera, 1980). Finally, plots of the cumulative sum of recursive residuals (CUSUM) confirm that the estimated parameters are within the critical bounds and stable over the sample period (Pesaran, 1997; Pesaran and Shin, 1999).

Table 7: Summary of Diagnostic Test Results

Test	Test Statistic	Degrees of Freedom	P-value
Heteroskedasticity Test			
- Breusch-Pagan-Godfrey F-statistic	1.704781	(12, 43)	0.0995
- Obs*R-squared	18.05327	12	0.1141
Autocorrelation Test			
- Breusch-Godfrey LM F-statistic	1.484024	(1, 42)	0.2299
- Obs*R-squared	1.9111.911169	1	0.1660.1668
Model Specification Test			
- Ramsey RESET F-statistic	0.790884	(1, 42)	0.3789
Normality of Residuals Test			
- Jarque-Bera Statistic	5.96430		0.0507

Figure 1: Cumulative sum of residuals (CUSUM)



(Source: Authors' Compilation)

4. CONCLUSION

This study embarked on a detailed exploration of the interplay between key macroeconomic variables and the Macedonian Stock Exchange Index (MBI-10) over the period from Q1 2009 to Q3 2023. Utilizing the autoregressive distributed lag (ARDL) model, we uncovered significant insights into how economic factors influence stock market performance in both the short and long term. Our findings underscore the complex dynamics at play and offer critical perspectives for investors, policymakers, and economists alike.

In the long term, the positive impact of GDP on the stock market index (LMBI10) underscores the fundamental importance of sustained economic growth in driving stock market performance (Soti, 2015; Devkota and Dhungana, 2019). This relationship highlights the need for policies that promote economic expansion, as higher GDP growth translates into higher corporate earnings and increased consumer spending, which collectively enhance stock market valuations. Additionally, the inverse relationship between the CBB interest rate and the stock market index emphasizes the critical role of monetary policy in shaping market dynamics (Humpe and Macmillan, 2009; Mukherjee and Naka, 1995). Elevated interest rates can constrain investment and spending, thereby exerting downward pressure on stock prices, while reduced interest rates can foster a more favorable environment for market growth.

The short-term analysis, augmented by the error correction model (ECM), highlighted the market's sensitivity to past performance and external shocks, such as oil price fluctuations. Particularly, the negative effect of past declines in the MBI-10 index underscores a momentum effect where past performance significantly impacts future market dynamics (Pilinkus and Boguslauskas, 2009). Furthermore, the negative short-term impacts of oil price increases on the stock market index underscore the Macedonian economy's vulnerability to external commodity price shocks, reflecting the broader challenges faced by energy-importing countries (Filis, 2010; Degiannakis *et al.*, 2014). The significance of the error correction term in our short-term analyses emphasizes the market's efficiency in adjusting to deviations from long-term equilibrium, underscoring the inherent resilience and corrective mechanisms within the Macedonian stock market (Soti, 2015; Devkota and Dhungana, 2019).

Our study offers several implications for policymakers and market participants. Firstly, the pivotal role of GDP and monetary policy (reference interest rate) in supporting the stock market suggests that policies aimed at sustaining or stimulating economic growth could be beneficial for market performance. Specifically, measures that promote economic expansion and consumer spending, while maintaining favorable borrowing conditions, are likely to enhance corporate earnings and boost stock prices. Secondly, the inverse relationship between the CBB interest rate and the stock market highlights the importance of carefully calibrated monetary policies. Lowering interest rates can stimulate investment and consumption, thereby positively influencing stock market performance, whereas higher rates may need to be balanced against potential adverse effects on market dynamics. Thirdly, the sensitivity of the stock market to oil price shocks calls for enhanced energy policy frameworks and diversification strategies to mitigate adverse impacts. By addressing these factors, policymakers can better support sustainable market growth and resilience.

For future research, delving into microeconomic determinants such as corporate governance, financial performance indicators, and sectoral analyses could enrich our understanding of the Macedonian stock market's dynamics. Additionally, exploring the potential lagged effects of macroeconomic variables and integrating global economic indicators could provide a more holistic view of the factors influencing the MBI-10. This approach not only lays a foundation for further research but also offers practical insights for enhancing the resilience and growth of the Macedonian stock market.

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INVESTIGATING THE IMPACT OF EU ETS ALLOWANCES ON THE CAPITAL MARKET – THE CASE OF GERMAN COMPANIES

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ABSTRACT

To achieve the international targets for limiting carbon emissions the Emissions Trading System of the European Union (EU ETS) was implemented. Considering the crucial role of this system in the process of decarbonization of the economy, it is essential to investigate whether and to what extent there is an impact on the capital market. To investigate this, the dataset of 38 German companies from 2013 until 2020 is used. The data set consists of paid allowances, free allowances, stock prices, return on assets (ROA) ratio, and dividend payouts. The study uses three econometric methods for panels including the pooled ordinary least squares, the fixed effects model, and the random effects model. In addition, the F-test and Hausman tests are used, to determine which method is more appropriate. The results show that the ordinary least square (OLS) model and fixed effect model are most suitable for the stock price estimation and confirm the negative impact of free allowances on stock prices. A random effect is considered for the ROA and dividend estimation, confirming the negative impact of free allowances on the ROA ratio and the positive on the dividend distributions.

Keywords: EU ETS, Stock price, Dividends, Return on assets, Allowances.

JEL classification: G11, G15.

1. INTRODUCTION

Due to the increased awareness of the possible consequences of climate change, international communities and organizations proposed setting international targets to limit the global average temperature. Accordingly, with the adoption of the Paris Agreement in 2015, a target of below 2°C, or around 1.5°C, above pre-industrial levels were accepted. This agreement assumes that the signatory countries must take certain actions to limit the total emissions in the air in order to achieve these targets. Although ambitions to tackle climate change have increased, some reports (see the Intergovernmental Panel on Climate Change (IPCC) Summary for Policymakers, 2018) suggest that the temperature may exceed 1.5°C until 2040, even for the very low greenhouse gas emissions scenario. This implies that in the next period, the activities of policymakers will increase and cause significant changes in economic processes.

As carbon dioxide emissions (CO₂) are considered the main driver of climate change (see Ritchie and Roser, 2020), countries started introducing measures and mechanisms to reduce them. Accordingly, in 2005, the European Commission (EC) implemented the “European Union Emissions Trading System” (EU ETS). The system is considered the first successfully

implemented “cap and trade” scheme covering around 40 percent of all EU emissions. Since its implementation in 2005, the system has gone through four phases of development. Currently, it operates in all EU country members including Iceland, Liechtenstein, and Norway. The functioning of the system is very simple. Companies covered by the system are granted free allowances or buy allowances through auctions. Unlike the allowances that are available through auction, certain sectors that have a higher risk of carbon leakage or moving the production outside the union are granted free allowances. These are sectors related to industrial production and heating because they have the highest risk of carbon leakage in other countries with more flexible legislation. In case companies need more allowances, they go to the market and buy allowances from those companies that have more than needed. Theoretically, this means that the companies that buy allowances are still carbon-intensive and have not reduced their emissions, unlike those companies that sell allowances and have managed to reduce their emissions. Buying and selling allowances on a net basis in the economy should not make a difference in terms of the number of emissions, as excess emissions are netted by the number of reduced emissions by different companies.

Since actions need to be scaled up to mitigate climate change, the cap is expected to be gradually adjusted downward. The reduction of emissions implies changing the work operations and processes, which will consequently have an impact on the results and performance of the companies. It is also expected that the capital market will redirect funds to finance economic entities with a sustainable business perspective and environmentally responsible behaviour.

Taking into account the relevance and importance of the topic, it is crucial to investigate the impact of EU ETS on the financial markets. Many studies have explored this topic primarily focusing on the impact on the stock prices. This paper makes a valuable contribution by selecting key financial indicators to examine the potential relationship between the two markets. It also uses data from the third phase, when the transition from grandfathering to auctions occurred (European Commission, 2021), a period when the relationship between the two markets would be most pronounced. Confirming that there is a significant impact from EU ETS on the capital market, would indicate that the capital market makes a distinction between companies that successfully reduce emissions and companies that fail to reduce or even increase the carbon intensity. This would further mean that the capital market can be used as a successful tool to decarbonize the economy.

To achieve the research objective, this paper uses data from (1) the EU ETS system, i.e. data on free and paid allowances, and (2) data from the capital market including data on average share prices weighted by volume, dividends paid to shareholders about the total amount of net income and return on assets (ROA). The data refer to German companies, since the German economy is the largest carbon emitter in Europe (Eurostat, 2023). The econometric techniques to investigate the possible relationships between the selected variables consist of pooled ordinary least squares, the fixed effects model, and the random effects model.

2. LITERATURE REVIEW

2.1. Development of the EU ETS

EU ETS went through four phases of development (European Commission, 2021). The first phase, from 2005 until 2007, was more of an experimental period in which the market was being set up. This phase covered emissions from selected industries including the energy-intensive and production industries. Countries were supposed to prepare a plan and determine the quantity of allowances that they would allocate on the market. Due to the determination of allowances on a national basis which were also granted for free, there were more allowances

than emissions on the market. The price of the allowances was very volatile and not market-created, while the limits set by the countries were considered as unambitious.

Even though the second phase (2008-2012) was supposed to significantly adjust the allowances downward (around 6.5 percent lower than the 2005 level) and to set more ambitious limits, the number of allowances once again exceeded the emissions which pushed the price down. The European Commission introduced the Market Stability Reserve (MRS) to absorb the surplus of allowances and to straighten the price signal (Nissen *et al.*, 2022).

In the third phase (2013-2020) the cap was once again significantly reduced to at least 20 percent below the 1990 levels or 21 percent below the 2005 levels, while the allowances were reduced by a linear factor of 1.74 percent. To straighten the price signal and to enable the functioning of the market, the default method of free allocation of allowances was replaced with the auctioning method. With some sectors being riskier than others in terms of carbon leakage, free allocation was still allowed to prevent shifting production outside the EU where the legislation is more flexible. This method is planned to be completely excluded from the system until 2027.

In the current, fourth phase (2021-2030), the EC scaled up its climate ambitions and committed to new targets of reaching climate neutrality by 2050. The emissions are supposed to be reduced by 55 percent until 2030 compared with the 1990 levels, or 61 percent compared with 2005 levels. Accordingly, the EC proposed an annual reduction of 4.2 percent and a one-off reduction of 117 million allowances from the system (European Commission, 2021).

From 2005 to 2021, the EU ETS showed satisfactory results in reducing the verified emissions mostly due to the decarbonization trend, reduced use of non-renewable resources, or increased use of renewable sources (see Nissen *et al.*, 2022). This shows that the system is an important instrument in decarbonization and since the targets gradually increase, many changes are expected in the corporate sector. Apart from the impact on reducing emissions, the question arises whether the data so far indicate an influence of the EU ETS on the capital market.

2.2. The impact of EU ETS on the capital market

Since the EU Emissions Trading System (EU ETS) is considered a crucial mechanism to reduce carbon emissions and is expected to drive many changes in investors' decisions, a substantial number of studies focus on examining the possible impact it may have on the capital market. The relevant literature provides important empirical evidence regarding the impact of the EU ETS system on the capital market and corporate performance, which can be presented in three categories.

First, the authors present results that EU ETS can negatively impact the capital market. Millischer *et al.*, (2022) analysed over 300 European companies in the period from 2013 to 2021 and found a significant negative statistical relationship between the carbon price and stock returns, meaning that higher cost of paid allowances is associated with weaker shares during periods of rising carbon prices. Bushnell *et al.* (2013) analysed 552 stocks from the EUROSTOXX index and contributed to the literature with empirical evidence that in the case of carbon or energy-intensive industries, decreasing the price of allowances has a negative impact on the stock returns.

Some authors found the positive impact of European Carbon Allowance (EUA) on stock prices and companies' performance. Oestreich and Tsiakas (2012) analysed the effect of the European Union Emissions Trading Scheme on German stock returns. The results suggest that companies that were granted free allowances in the first years of the scheme's implementation had significantly better performance compared with companies that did not receive free allowances, which can be explained by the higher cash flows due to the free allocation of carbon emission allowances, and due to the exposure to the higher carbon risk thus higher returns. Da Silva *et*

al. (2015) analyse the impact of the European Union Emission Trading System (EU ETS) on firms' stock market returns of Spanish industries and confirm the presence of a positive impact on electricity, cement, and oil sectors, and a negative impact on the iron sectors and steel. Smale *et al.*, (2006) investigated the impact of CO₂ emissions on corporate profits and market prices of a few energy-intensive sectors and found that most of them would be expected to profit. García *et al.* (2020) used data from six European Union members including Austria, France, Germany, Italy, Netherlands, and Spain, and found statistically significant and positive long-run effects from EU allowance prices on the European power sector stock market in the third Phase. Chan *et al.* (2013), Veith *et al.* (2009), and Mo *et al.* (2012) also present empirical evidence for the existence of positive relationships between price changes in the EU system and stock returns of the European power sector.

The third category provides a non-existent or very small impact on the companies' performance. The results of Qiu *et al.*, (2023), show that the long-term connection between the carbon market and the stock market and between the carbon market and renewable energy is almost zero or non-existent, while in the short term, a positive connection is found, which is believed to be further enhanced by the Covid-19 crisis. Demailly and Quirion (2008) analysed the impact of EU ETS on production and profitability and found that the losses in competitiveness are small for the iron and steel industry. Anger and Oberndorfer, (2008) investigated the role of the EU ETS in corporate revenues and employment in Germany and found that it did not have a significant impact on corporate performance and employment.

This paper investigates the impact of EU ETS allowances on the capital market in the case of German companies, since Germany accounts for one-quarter of the EU's total CO₂ emissions from fossil fuel combustion for energy use (Eurostat, 2023). The contribution of this paper is that it examines the impact of the EUA on the capital market through the stock prices, dividends disbursements, and ROA ratio.

3. DATABASE AND METHODOLOGY

To examine the relationships between the variables, this paper uses annual data for 38 German-listed companies. The data are for the period from 2013 to 2020, that is, for the third phase of the EU ETS development. Data on allowances are taken from the database used in the paper Millischer *et al.* (2022). The database used in this paper includes time series for average share prices weighted by volume, the dividend payout ratio (DPR), and the ROA ratio per company, all provided by Thomson Reuters. Table 1 provides general information about the variables.

Table 1: Descriptive statistics

Indicators	Stock Price	ROA	Dividends	Free Allowances	Paid Allowances
Mean	2.32	0.51	170.02	2,118,320.26	508,502.07
Median	1.92	0.26	-	187,833.50	46,129.00
Maximum	30.21	6.19	6,125.00	42,591,924.00	13,658,327.00
Minimum	-	(10.65)	-	(3,370,651.00)	(11,756,372.00)
Observations	304	304	304	304	304

(Source: Authors' calculation)

We used panel data analysis, fixed effect model, and random effect model. In addition to these models, we implemented the F-test and Hausman test to determine which model is more appropriate (see Baltagi, 2008 and Hsiao, 2003).

From the research questions, the following hypotheses were formulated:

H1: Free allowances have a negative impact on stock prices, while a positive impact on return on assets and dividend disbursement in the case of the selected German companies.

H2: Paid allowances have a negative impact on stock prices, return on assets, and dividend disbursements in the case of the selected German companies.

If the estimations suggest (1) that there is a positive impact of free allowances on stock price, return on assets, and dividends, it would mean that due to the free distribution of allowances, companies do not face additional costs, and are not incentivized to lower the carbon emission, leading to better cash flow results; (2) if there is a negative impact, it would mean that the increase in free allowances causes a lower market value of the companies, meaning that the capital market recognize the importance of decarbonization, a is penalizing the companies that do not have a green perspective; this would additionally mean that the EU ETS is an important tool for decarbonization, that may further speed up the process to meet international targets; (3) if there is an absence of a relationship between the variables, it would mean that the EU ETS system has no impact on the capital market.

In the case of paid allowances if there is (1) a positive impact on the selected variables that would suggest that the number of paid allowances does not have a negative impact on profit, stock price, and dividends and, thus are not very important to the company's financial results, meaning that EU ETS is still not effective in terms of enhancing decarbonization; (2) negative relationship would suggest that as paid allowances (or in other words, the carbon intensiveness) increase, the companies face more costs and are being "punished" by the capital market by lowering their market value; (3) if there is an absence of a relationship between the variables, it would again mean that EU ETS has no impact on the capital market.

Pooled OLS is employed since it assumes that there is no significant company nor significant temporal effect, i.e. all intercepts and coefficients are assumed to be the same. Since the panel data set has more companies than years, we include dummy variables for each time period to absorb the time effect. The F-test is used to determine if the pooled ordinary least squares is the best estimation model for this database. The null hypothesis of the test assumes that all coefficients are equal to zero, so if accepted, it will confirm that the OLS model is the best choice of econometric model to test the hypothesis.

Fixed or random models are used when observing the same sample of the companies and the Hausman test is used to decide which model is more suitable. The random effects model is a better choice under the null hypothesis, while the alternative hypothesis assumes that the fixed effects model is preferred. If the p-value is significant, a fixed effects model should be used.

Table 2: Cross-sectional dependence test results

Cross-sectional dependence test for panel data			
Null hypothesis: Cross-sectional independence			
Pearson CD Normal	Statistic	Prob.	Cross-dependence
Stock price estimation	3.81909	0.000	There is cross-dependence
ROA estimation	1.359771	0.174	No cross-dependence
Dividend estimation	0.506684	0.6124	No cross-dependence

(Source: Authors' calculation)

As a first step, we employ a cross-sectional dependence test. It will determine if the residuals from the cross-sectional units are correlated. Since the N dimension is larger than the T dimension, Pesaran CD test was conducted. The test results show significant cross-sectional dependence in the first estimation. The existence of cross-section dependency among the units in the first estimation suggests that the investors may be taking into account the effect of the other companies' stock prices in the country when making decisions. This dependence is in line with economic logic, so it might suggest that the model is effectively reflecting certain

fundamental economic relationships. In the case of ROA and dividends, there is no cross-sectional dependence.

In addition, Breusch-Pagan test for heteroskedasticity is employed. The p-values for the three estimations are higher than 0.05, indicating that we fail to reject the null hypothesis. This suggests that there is no significant evidence of heteroskedasticity in the model.

4. RESULTS AND ANALYSIS

Table 3 shows the results of the pooled OLS models. According to the results, the number of paid allowances is not significant and positively related to the stock prices. This relation is not according to expectations and suggests that if the number of paid allowances increases, the stock price is expected to also increase. This suggests that an increase in the paid allowances or the carbon intensiveness of the companies is not being “punished” by the capital market through lower market value. Positive relationships between these two markets can also be found in Da Silva *et al.* (2015), Veith *et al.* (2009), Mo *et al.* (2012). On the other hand, the first estimation also indicates that free allowances are statistically significant and inversely correlated with stock prices. This means that as the number of free allowances increases, stock prices tend to decrease. This relationship might be influenced by market expectations of future costs, since the EU reduces the number of free allowances, companies will need to purchase the allowances, which could increase operational expenses. Moreover, this suggests that the capital market is becoming an important tool for decarbonization.

Table 3. Results from the pooled OLS model

Variable	Expected sign	Coefficient	Std. Error	Prob.
<i>Stock price</i>				
ROA		0.421	0.092	0.000
DIVIDEND		0.352	0.078	0.000
FREE	-	(0.148)	0.052	0.005
PAID	-	0.059	0.043	0.176
C		0.061	0.463	0.896
R-squared		27%		
F-statistic		8.754		
Prob(F-statistic)		0.000		
<i>ROA</i>				
STOCK		0.426	0.093	0.000
DIVIDEND		(0.643)	0.056	0.000
FREE	+	0.102	0.053	0.059
PAID	-	(0.091)	0.043	0.036
C		2.689	0.376	0.000
R-squared		64%		
F-statistic		43.260		
Prob(F-statistic)		0.000		
<i>Dividend</i>				
ROA		(0.897)	0.078	0.000
STOCK		0.497	0.110	0.000
PAID	-	(0.161)	0.049	0.001
FREE	+	0.262	0.058	0.000
C		3.343	0.431	0.000
R-squared		67%		
F-statistic		48.732		

(Source: Authors' calculation)

The results of the second equation show that the free allowances are positively, but statistically insignificant, related to the return on assets (ROA). This is in line with our expectations since the free allocation of allowances is expected to be associated with better performance due to higher cash flows and exposure to the higher carbon risk and higher returns, as found in Oestreich and Tsiakas (2012). Paid allowances are inversely related to the ROA ratio, aligning with our expectations. These findings indicate that an increase in paid allowances can lead to

a decrease in the ROA ratio. This may be due to market preferences for products and services from companies that demonstrate corporate environmental responsibility, as well as the higher costs of purchasing these allowances.

The last equation shows that the results are in line with our expectations since there is negative impact of paid allowances and positive of free allowances on the dividend distribution.

The results from the F-test statistics show that the model as a whole is significant because the F statistics is greater than the critical value.

Table 4 shows the results from the fixed, random models and the Hausman test for stock price equations. The fixed model shows an R-squared of 69 percent, which is satisfactorily high. The results show statistically significant negative impact of free allowances on the stock price. The random model shows a value of the R-squared of only 3% and insignificant relations between the variables. The results of the Hausman tests show that the null hypothesis is rejected and fixed effects should be used. Accepting the fixed effects as a more appropriate model suggests that there are factors that can affect stock prices but do not necessarily vary over time for the companies, so the effects of those factors are contained, and the model focuses only on the influence of the allowances.

Table 4: Results from the fixed and random effect models and the Hausman test for stock prices

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Stock (Fixed)				
PAID_ALLOWANCES	-0.051	0.052	-0.983	0.327
FREE_ALLOWANCES	-0.36	0.116	-3.108	0.002
C	5.567	1.661	3.352	0.001
R-squared	69%			
Stock (Random)				
PAID_ALLOWANCES	-0.02	0.034	-0.575	0.566
FREE_ALLOWANCES	-0.081	0.043	-1.867	0.063
C	1.843	0.433	4.262	0
R-squared	3%			
Correlated Random Effects - Hausman Test				
Cross-section random		7.7	2	0.021

(Source: Authors' calculation)

Table 5 shows the results from the fixed, random models and the Hausman test for the ROA equations. The fixed model shows R-squared of 56 percent, which is satisfactory high, however there is no significant relationship between the variables. The random model shows a value of the R-squared of only 8% and significant negative relationship between the free allowances and return on assets. The Hausman test, show that we cannot reject the null hypothesis since the p-value is greater than the significance level, so we should use the random effects model. In this case, the model assumes that the unobserved company characteristics are random, so it analyzes how both within-company changes and between-company differences in allowances influence the ROA ratio.

Table 5: Results from the fixed and random effect models and the Hausman test for ROA ratio

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ROA (Fixed)				
PAID_ALLOWANCES	0.071	0.141	0.509	0.612
FREE_ALLOWANCES	0.328	0.323	1.016	0.312
C	-4.855	4.504	-1.078	0.283
R-squared	56%			
ROA (Random)				
PAID_ALLOWANCES	0.024	0.067	0.359	0.72
FREE_ALLOWANCES	-0.175	0.074	-2.371	0.019
C	1.665	0.555	2.998	0.003
R-squared	8%			
Correlated Random Effects - Hausman Test				
Cross-section random		2.612	2	0.271

(Source: Authors' calculation)

Table 6 shows the results from the fixed, random models and the Hausman test for the Dividend distributions. The fixed model shows an R-squared of 68 percent, which is satisfactory high, however there is no significant relationship between the variables. The random model shows a value of the R-squared of only 4% and a significant positive relationship between the free allowances and dividends. The Hausman test shows that the p-value is greater than 0.05, thus we should use the random effect model. This model assumes the same as for the ROA random effects equation, that is the model considers both the variation within each company over time and the variation between different companies.

The overall results suggest free allowances have a negative and significant impact on the stock prices. This is confirmed by both the pooled OLS model and the fixed effect. The pooled OLS model for ROA and dividends do not account for the unobserved heterogeneity, hence the random effects model is considered more appropriate. In this case, free allowances have negative impact on the ROA ratio, but positive on the dividends.

Table 6: Results from the fixed and random effect models and the Hausman test for dividends

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Dividends (Fixed)				
PAID_ALLOWANCES	-0.137	0.167	-0.818	0.415
FREE_ALLOWANCES	-0.416	0.5	-0.833	0.407
C	11.774	6.332	1.859	0.066
R-squared	68%			
Dividends (Random)				
PAID_ALLOWANCES	-0.178	0.098	-1.818	0.072
FREE_ALLOWANCES	0.256	0.116	2.216	0.029
C	4.221	0.869	4.858	0
R-squared	4%			
Correlated Random Effects - Hausman Test				
Cross-section random		2.136	2	0.344

(Source: Authors' calculation)

This paper has certain limitations, which are mostly due to the sample, i.e., not all companies in Germany that participate in carbon emissions are covered. Also, the sample is limited only to the third phase of development of the EU ETS system. Regarding future related research, it is suggested to expand the sample to other countries, primarily Italy, Poland, and France as these countries have the highest share of total carbon emissions in Europe. The analysis can benefit from including other variables or analysing the impact on selected variables per industry too.

5. CONCLUSION

Climate change is a major global challenge. As policymakers are becoming more aware of the consequences that can arise from climate change, they put it in the spotlight when creating policies and systemic solutions for sustainable growth and development. The international ambitions for preventing climate change resulted in a successful implementation of the EU ETS scheme which aims to directly limit carbon emissions.

Since CO₂ emissions are the main driver of pollution, and Germany is the main emitter of the EU's total CO₂ emissions from fossil fuel combustion for energy use, this research paper selected 38 German companies to investigate the possible impact EU ETS may have on the capital market. To test the proposed hypotheses, three methods are implemented, including the pooled ordinary least square model, and fixed and random effects models. The F-test is used to select between OLS model and the fixed effect model, while the Hausman specification is used to make a selection among fixed or random effect model.

The results from the OLS model and fixed effects are aligned and suitable for the stock price estimation and the negative statistically significant coefficient for the free allowances is in line with our expectations. The model suggests that free allowances have a negative impact on stock prices. This may be linked to future costs associated with purchasing allowances rather than receiving them for free, as well as potential costs due to regulatory changes. On the other hand, the results for the ROA and dividends estimations suggest that the OLS model does not account for heterogeneity, hence the random effects are more suitable. They suggest that free allowances hurt ROA and a positive on dividends.

This paper has certain limitations and proposes that future analysis should extend the sample to other countries, primarily to Italy, Poland, and France (as these countries have the highest share of total carbon emissions in Europe), to add additional variables, and to make an analysis per industry.

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IS IT IMPORTANT TO KNOW PUBLIC SECTOR ASSETS AND LIABILITIES? THE NEXUS BETWEEN PUBLIC SECTOR BALANCE SHEET AND CORRUPTION

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ABSTRACT

This paper underscores the importance of the public sector balance sheet. Typically, fiscal policies are analysed without considering the stock of public sector assets and liabilities, focusing instead on flows such as the state budget, fiscal balance, and GDP. However, a primary objective of these flows should be to achieve specific outcomes in the stock of assets and liabilities. For instance, investments from the state budget should increase the stock of physical capital. Our central argument is that the absence of public sector balance sheets contributes to pervasive corruption and a broader disregard for public property. Using the IMF's Public Sector Balance Sheet database, we demonstrate that the presence of a public sector balance sheet is positively associated with less corruption.

Keywords: Public sector balance sheet, Corruption, Flow, Stock variables.

JEL classification: H83.

1. INTRODUCTION

An analysis of a company typically begins with examining its balance sheet, which shows the stock of the company's assets and liabilities. Afterward, other reports are reviewed to understand the details of its operations and health. In this way, the analysis is based on stock variables, while variables that show flows are used to understand what has happened over certain periods and how it has affected the stock of assets, liabilities, and the company's equity. In contrast, traditional public finance analysis primarily focuses on flow variables, such as the budget, fiscal balance, and gross domestic product (GDP), while public debt is one of the few stock variables that is used in the analysis. Moreover, the consolidated balance sheet of the public sector is usually missing and there is no information about the stock of assets and liabilities, so the analysis is mostly focused only on the budget transactions and their impact on GDP, without consideration of how these transactions will impact the assets and liabilities of the public sector, and its difference which is the net-worth.

The International Monetary Fund's (IMF) Government Finance Statistics (GFS) analytical framework in 2001 introduced the complete public sector balance sheets (International Monetary Fund, 2014). The key point is that the balance sheet at the beginning of the year reflects the state of the public sector's assets and liabilities. Throughout the year, the government engages in various activities, some through the state budget, which includes

transactions generating revenue or expenses, ultimately affecting the public sector's assets and liabilities. Additionally, changes in the stock of assets and liabilities are not always the result of transactions; they can also arise from other factors, such as gains or losses due to holding assets or changes in the volume of assets. Therefore, the balance sheet at the end of the year should capture all changes in the stock of assets and liabilities – and in essence, it should represent the result of the actions and decisions.

IMF created a comprehensive database of the public sector balance sheet in countries around the world. However, the number of countries worldwide that systematically compile a public sector balance sheet remains low.

The relevant literature underscores the critical importance of a consolidated public sector balance sheet for accurately assessing a state's net worth and its fiscal and financial capacity (Gruber and Kamin, 2012; Bova *et al.*, 2013; Seiferling and Shamsuddin, 2015; Hadzi-Vaskov and Ricci, 2016; Henao-Arbelaiz and Sobrinho, 2017; and Yousefi, 2019). Without detailed information on assets like state-owned property and natural resources, a state's financial position can be misrepresented, leading to flawed assessments of its economic health. A comprehensive balance sheet provides clarity on public sector assets and liabilities, crucial for understanding economic dynamics and enhancing macroeconomic resilience. It identifies potential revenue sources, such as non-financial assets like land, roads, and buildings, and supports fiscal transparency by tracking changes in asset values unrelated to transactions. Understanding the relationship between net debt and financial assets is essential, as it affects government bond yields and overall economic stability.

In this paper, we argue that the absence of public sector balance sheets contributes to corrupt practices and a disregard for public property. One of the primary purposes of the state budget, as a flow variable, is to enhance the stock of physical capital, among other objectives. Without measuring the outcomes of flow variables, misconduct can go unchecked. For instance, it is easier to undervalue land sales when the value of the country's land resources is not properly assessed and disclosed. Similarly, there is a greater risk that the value of public buildings will not be preserved without proper valuation and monitoring. Thus, comprehensive balance sheets in the public sector can promote greater transparency and accountability, leading to better governance and ultimately benefiting the public.

We use multiple regression analysis to examine the correlation between the decision to maintain a balance sheet and levels of corruption. Our analysis is based on data from the IMF's Public Sector Balance Sheet (PSBS) database, focusing on 30 countries with available data for the most recent year (2016). This paper contributes to the literature by providing empirical evidence that a country's decision to systematically produce a public sector balance sheet is associated with its corruption.

The remainder of this paper is organized as follows: The next section discusses the key reasons for maintaining a public sector balance sheet, as highlighted in the literature. Section 3 provides an overview of the IMF's Government Finance Statistics (GFS) analytical framework and Section 4 highlights details from the IMF's PSBS database. Section 5 outlines the methodology and data used, while Section 6 presents the empirical results. The final section concludes the paper.

2. LITERATURE REVIEW

The determinants of corruption have been extensively examined in the literature, highlighting economic, political, and social factors as key influences. Economic factors such as low levels of income and high income inequality are frequently cited as significant contributors to corruption, as they create conditions where individuals and public officials may seek illicit

means to achieve financial stability (Treisman, 2000). Similarly, a lack of economic development and weak market institutions are associated with increased corruption, as these environments often lack sufficient regulatory frameworks to ensure accountability (Mauro, 1995).

Political factors are also important to understanding corruption. Weak democratic institutions limited political stability, and restricted media freedom can reduce transparency and undermine accountability, thereby creating opportunities for corrupt practices (Persson, Rothstein, & Teorell, 2013). Furthermore, social and cultural norms play a pivotal role; societies that tolerate nepotism and favoritism tend to exhibit higher levels of corruption (Rose-Ackerman, 1999). Strong governance, including effective legal systems and the rule of law, is consistently linked with lower levels of corruption, underscoring the importance of institutional quality (North, 1990). These studies provide a comprehensive framework for understanding the multifaceted nature of corruption, forming a foundation for targeted anti-corruption policies.

The nexus between public sector balance sheet and corruption has not been examined yet in the literature. The relevant literature highlights only reasons for the importance of having a consolidated public sector balance sheet. Buiter (1983) points out that the lack of information on state-owned real estate and natural resources can lead to a distorted view of a state's net worth, as well as its current and future fiscal and financial capabilities. Allen *et al.* (2002) introduce an analytical framework for understanding crises in developing economies, which is based on stock variables from the consolidated public sector balance sheet and its subsectors. Yousefi (2019) proposes a set of measures for assessing the quality of the balance sheet, arguing that its quality is a crucial determinant of a state's macroeconomic resilience.

The literature also emphasizes the importance of specific asset categories in the public sector balance sheet. Bova *et al.* (2013) highlight the role of non-financial assets, suggesting that revenues from land, roads, and buildings could be potential sources of future government income. Seiferling and Shamsuddin (2015) emphasize the role of financial assets in ensuring fiscal transparency and accounting for changes in asset values that are not due to transactions. Gruber and Kamin (2012), Hadzi-Vaskov and Ricci (2016), and Henao-Arbelaiz and Sobrinho (2017) demonstrate the impact of net debt on financial assets and government bond yields.

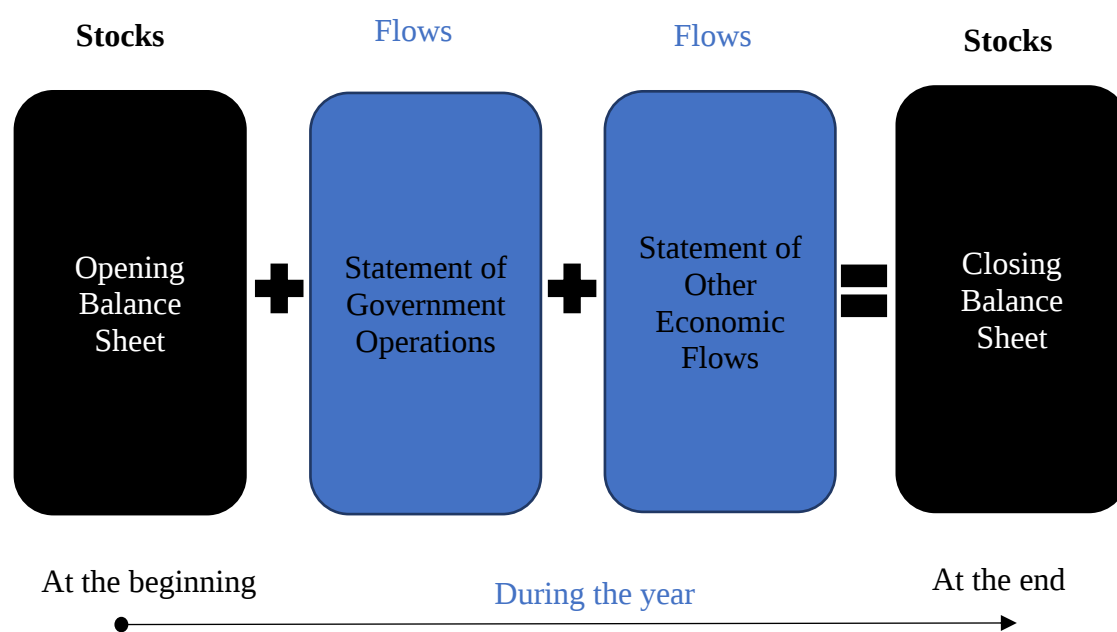
3. ANALYTICAL FRAMEWORK

The IMF's Government Finance Statistics (GFS) analytical framework from 1986 does not include public sector balance sheets. It only reports on the stock positions of certain debt liabilities and records government activities on a cash basis. This approach has the advantage of focusing government attention on liquidity constraints, which were in that period seen as the most urgent priority. However, as governments have become less constrained by liquidity and better able to separate the timing of fiscal actions from when payments are made, cash transactions alone no longer sufficiently capture the timing of activities or their economic impact. In response, the GFS analytical framework introduced in 2001 (and updated in 2014) is based on an accrual accounting system and incorporates comprehensive public sector balance sheets. The use of accrual-based statements and integrated balance sheets offers a more effective basis for monitoring the efficient allocation and use of all government resources.

The core GFS analytical framework (2001 and 2014) contains four financial statements: Statement of Operations; Statement of Other Economic Flows; Balance Sheet; and Statement of Sources and Uses of Cash (International Monetary Fund, 2014). The first three statements can be combined to show that all changes in stock positions result from flows. The fourth statement (Statement of Sources and Uses of Cash) provides key information on liquidity.

Figure 1 illustrates that the balance sheet at the beginning of the year shows the state of the public sector's assets and liabilities. During the year, two key reports are essential for presenting the flows within the (fiscal) year: Statement of Operations and Statement of Other Economic Flows. The first is the report on government operations, which includes all transactions related to revenues and expenditures, net investments in non-financial assets, net acquisition of financial assets, and net incurrence of liabilities. Essentially, this represents the state budget, or more precisely, its final account. The second report covers other economic flows, which represent changes in the state of assets and liabilities not resulting from transactions but from other factors. These can include: (1) holding gains and losses, which reflect changes in the value of assets and liabilities due to price changes, including changes in exchange rates; and (2) other changes in the volume of assets, which can occur due to the discovery of new asset stocks or liabilities (e.g., mineral resources), depletion or destruction of assets, or reclassification of assets or liabilities (International Monetary Fund, 2014). It is crucial to note that all changes in the state of the public sector's assets and liabilities by the end of the year result from transactions or other economic flows, meaning all changes in the balance sheet positions are due to flows.

Figure 1: Government finance statistics analytical framework



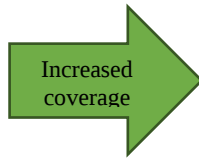
(Source: Based on the International Monetary Fund, 2014, p.68)

The scope of the balance sheet can vary. Figure 2, on the left side, shows the balance sheet of the General Government, which includes all institutional units at the central and local levels primarily engaged in non-market activities. The same figure, on the right side, shows the balance sheet of the public sector, which has a broader scope, including public enterprises and those involved in market and quasi-fiscal activities.

Figure 2: The balance sheet framework

General Government Balance Sheet

Assets	Liabilities
Financial Assets	Debt
Nonfinancial Assets	Non debt



Public Sector Balance Sheet

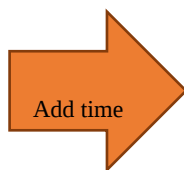
Assets	Liabilities
Financial Assets	Debt
Nonfinancial Assets	Non debt
Public Corporation Assets	Public Corporation Liabilities

(Source: Based on Koshima et al., 2021)

Figure 3: Intertemporal public sector balance sheet

Public Sector Balance Sheet

Assets	Liabilities
Financial Assets	Debt
Nonfinancial Assets	Non debt
Public Corporation Assets	Public Corporation Liabilities



Past
Future

Intertemporal PSBS

Assets	Liabilities
Financial Assets	Debt
Nonfinancial Assets	Non debt
Public Corporation Assets	Public Corporation Liabilities
Future Revenues	Future Spending

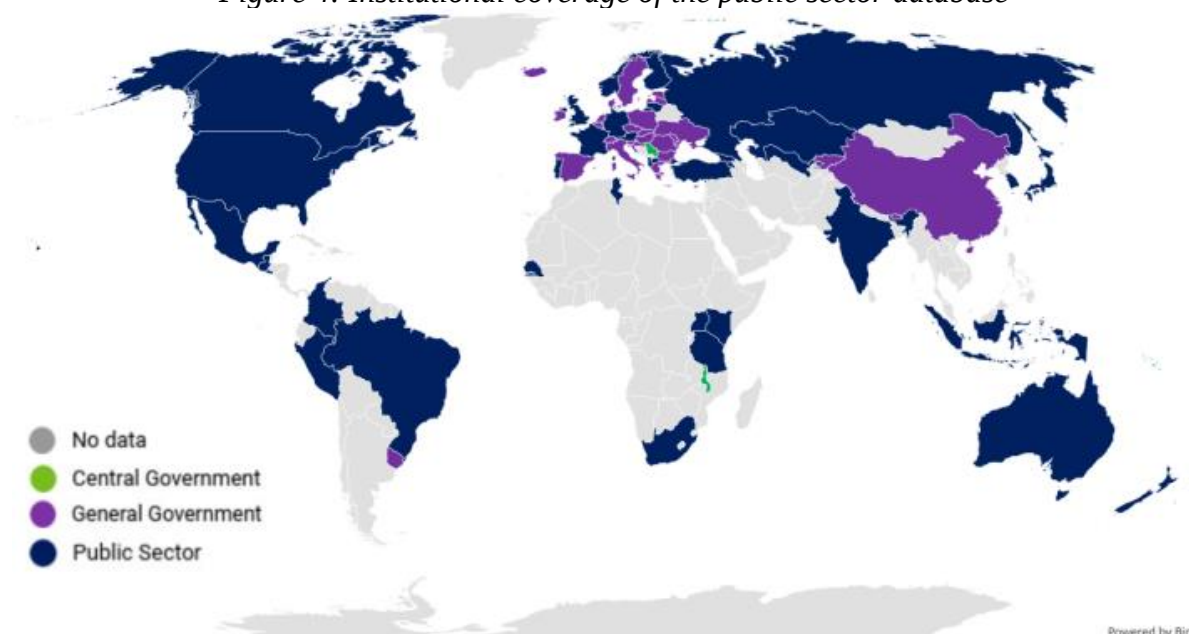
(Source: Based on Koshima et al., 2021)

Koshima *et al.* (2021) introduce an intertemporal public sector balance sheet. It adds a time dimension to the framework, by combining the static balance sheet with the costs of future fiscal policy (Figure 3). It calculates the net present value of future expenditure and revenue (over a long period) and compares this number with liabilities and assets in the static public sector balance sheet. In this way the framework transitioned from being an accounting balance sheet in the traditional sense to an economic intertemporal balance sheet for the purposes of public financial management.

4. IMF'S PUBLIC SECTOR BALANCE SHEET DATABASE

The number of countries that have public sector balance sheets is not clear. According to Alves *et al.* (2020), only a few countries in the world currently undertake the compilation of public sector balance sheets. However, the best information about it is provided IMF's public sector balance sheet database (Public Sector Balance Sheet (PSBS) - PSBS Home - IMF Data). It provides estimates of these balance sheets for a broad sample of 39 countries (that covers 63 percent of the global economy), that were compiled on a best-efforts basis using the conceptual framework of the IMF's Government Finance Statistics Manual 2014. Data for the central and general government generally are sourced from the IMF's Government Finance Statistics (GFS) database, while the data gaps are complemented by other data reported by statistical authorities at the national level or to other international organizations, or by IMF staff estimates. The IMF's database is also populated with lower institutional coverage: general government or central government estimates. The central government is available for 74 countries and territories, and the general government for 66. More about the database can be found in Alves *et al.* (2020). Figure 4 presents the highest level of government available in the dataset.

Figure 4: Institutional coverage of the public sector database



(Source: Alves *et al.*, 2020)

Table 1: Data availability in the IMF's database

Data availability	Countries
For all years in the period 2000-2016	Australia, Canada, Finland, Japan, Norway and United Kingdom
At least two years in the period 2000-2016	El Salvador, France, Georgia, Germany, India, Indonesia, Kazakhstan, Korea, New Zealand, South Africa, Sweden, United States.
Only one year in the period 2000-2016	Albania, Armenia, Austria, Brazil, Colombia, Gambia, Guatemala, Kenya,

	Lithuania, Malta, Mexico, North Macedonia, Peru, Portugal, Russia, Senegal, Tanzania, Tunisia, Turkey, Uganda, Uzbekistan.
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The public sector balance sheet database covers the period from 2000 to 2016. However, Table 1 shows that, of the 39 countries included, only 6 have public sector balance sheet (PSBS) available for every year in this period. Meanwhile, 12 countries have had PSBS for at least two years. The majority of countries, 22 out of 39, have PSBS for only one year, compiled by the IMF as part of the Fiscal Transparency Evaluation.¹ Therefore, this limited data availability cannot be seen as a sustained effort by these countries to compile a balance sheet.

5. METHOD AND DATA

We use multiple regression analysis to explore how the decision to have a public sector balance sheet is associated with the corruption perception in the set of available countries in the IMF's Public Sector Balance Sheet (PSBS) database:

$$CP_i = \beta_0 + \beta_1 \log(GDP_i) + \beta_2 PSBS_i + \beta_3 NW_i + \varepsilon_i$$

where CP_i is corruption perception score in 2016, GDP_i is GDP per capita, $PSBS_i$ is an indicator for the presence of the public sector balance sheet, and NW_i is net worth of the country in 2016. We chose 2016 because for this year there are data for most countries in the PSBS database.

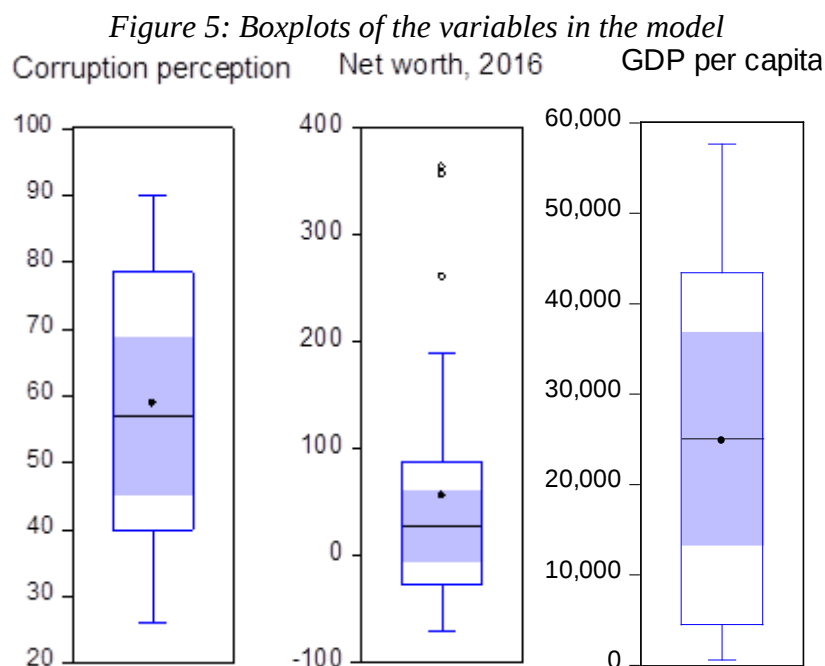
Corruption perception data are gathered from the Corruption Perception Index developed by Transparency International. This index provides a score to each country by its perceived levels of public sector corruption on a scale from 0 (highly corrupt) to 100 (very clean), as determined by expert assessments and opinion surveys. The left-hand box plot in Figure 5 illustrates that corruption perception scores among the sample countries range from 26 in Gambia to 90 in New Zealand. Additionally, 50% of the countries have scores between 40 and 79.

The presence of public sector balance sheet is based on IMF's PSBS database about countries' decision to have a public sector balance sheet. The PSBS database collects data on 39 economies about their engagement with public sector balance sheets. We use these data to create a dummy variable about whether country created a public sector balance sheet and calculated net-worth in it. Formally, this variable is equal to one if the country had data for the public sector net worth for more than one year in the period between 2000 and 2016, and zero otherwise. So, in essence, this variable is indicator for the systematic efforts of the country to produce PSBS. We expect countries that systematically use PSBS to have better score (less corruption).

Net-worth of the country in the 2016 is also gathered from IMF's Public Sector Balance Sheet (PSBS) database. As a control variable, we include the log of the GDP per capita of the country and the log of the human capital. The first variable describes the potential differences in corruption perception that may appear because of economic development whereas the second variable helps us control for the potential impact of formal knowledge on corruption. The

¹ For example, Macedonian Ministry of Finance requested Fiscal Transparency Evaluation in 2018, and IMF team produced PSBS for 2016.

central boxplot in figure 5 illustrates that net-worth among the sample countries range from -70.1% of GDP in United Kingdom to 189.8% in Australia. There are three countries considered outliers: Norway, Uzbekistan, and Kazakhstan. These outliers were removed from the data used for the regression model.



The GDP per capita data comes from the World Bank’s World Development Indicators. The GDP per capita is measured in constant 2015 US dollars. The right-hand boxplot in Figure 5 illustrates that GDP per capita among the sample countries ranges from 606.3 dollars in Gambia to 57,658.7 in the USA. We expect countries with higher GDP per capita to also have higher corruption perception scores (lower corruption).

The fact that the data for corruption perception, GDP per capita, and net worth are cross-sectional for 2016, while the PSBS indicator is calculated using data from 2000 to 2016, helps reduce potential endogeneity issues. Specifically, this approach minimizes concerns that a country's decision to have a balance sheet is influenced by its corruption perception (i.e., less corrupt economies may be more likely to implement a balance sheet, and, conversely, having a balance sheet might lead to lower corruption).

6. EMPIRICAL RESULTS

Table 2 presents the results of our analysis. The first column shows the results of a baseline model with only the log of GDP per capita as the predictor variable. The log of GDP per capita is a significant and positive predictor of corruption perception, which aligns with expectations. Higher country income is associated with stronger anti-corruption practices and lower levels of corruption.

In the second column, we add the PSBS indicator variable as a predictor to the baseline model. The results show that systematically producing PSBS is significantly and positively associated with corruption perception. Countries that maintained PSBS for more than one year, on average, had a corruption perception score that was 10 points higher, which means less corruption.

In the third column, we include net worth as an additional predictor. Here, we observe that net worth is not a significant predictor of corruption perception. However, the significance of our primary independent variable of interest, the net worth dummy, remains unchanged.

Table 2: Corruption Perception and Public Sector Balance Sheet Regression Results

	<i>Dependent variable:</i>		
	Corruption perception		
	(1)	(2)	(3)
Log (GDP per capita)	13.292*** (1.652)	11.694*** (1.659)	11.696*** (1.695)
PBSB indicator		10.655** (4.490)	10.519** (4.888)
Net-worth			0.003 (0.032)
Constant	-67.815*** (15.891)	-59.292*** (15.032)	-59.299** (15.354)
Observations	30	30	30
Adjusted R ²	0.721	0.774	0.774

Note: * p<0.1 ** p<0.05 *** p<0.01.

7. CONCLUSION

Despite the introduction of comprehensive public sector balance sheets in the IMF's Government Finance Statistics in 2001, the number of countries compiling these balance sheets remains low. This paper argues that the absence of public sector balance sheets contributes to corruption and a lack of accountability for public property. The rationale is straightforward: it is easier to misappropriate a country's assets when they are not systematically measured and valued. Our empirical analysis, based on the IMF's Public Sector Balance Sheet database and a sample of 30 countries, indicates a significant positive correlation between the existence of a public sector balance sheet and lower levels of corruption, on a scale from 100 (very clean) to 0 (highly corrupt).

In South-East Europe, including N. Macedonia, public financial management systems are not yet systematically producing public sector balance sheets. According to the International Monetary Fund (2014), several steps can facilitate the collection of public sector balance sheets, ranked by complexity: (1) adopting accrual-based reporting in accounting systems; (2) implementing the classification structures of the Statement of Operations or Statement of Sources and Uses of Cash and adjusting cash-based statistics to address known deficiencies, such as incorporating information on revenue or expense arrears; (3) compiling balance sheet information on financial assets and liabilities to estimate other economic flows related to these financial instruments; (4) gathering comprehensive data on the stock positions of non-financial assets and valuing them at current market prices; and (5) implementing a fully-developed accrual accounting system that enables complete and robust public sector balance sheets.

Lastly, it is important to note that balance sheets may not capture all aspects of the government's financial position and should be supplemented with additional data, particularly regarding contingent liabilities and public-private partnerships.

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THE ADVANTAGES OF LONG-TERM INVESTING IN OPEN INVESTMENT FUNDS VERSUS BANK DEPOSITS IN EMERGING ECONOMIES

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ABSTRACT

Purpose The capital market, in every country, as well as in the Republic of North Macedonia, has an impact on economic growth and development. Citizens are the main pillar of saving and investing in all fields of economy and finance. Open investment funds in our country, although young, act as direct intermediaries and participants in the capital market (Arsova, 2021).

However taking into account that the participation of citizens' investment in open investment funds is relatively low, compared with the more developed countries of Western Europe (Usmanovich, 2018), they are also low compared to investing in bank deposits (Cvetkoski, 2014). Whether our profits differ very much from our choice of investment between open investment funds and banking deposit, and whether should we consider it before investing in long-term investment (Halland *et al.*, 2016).

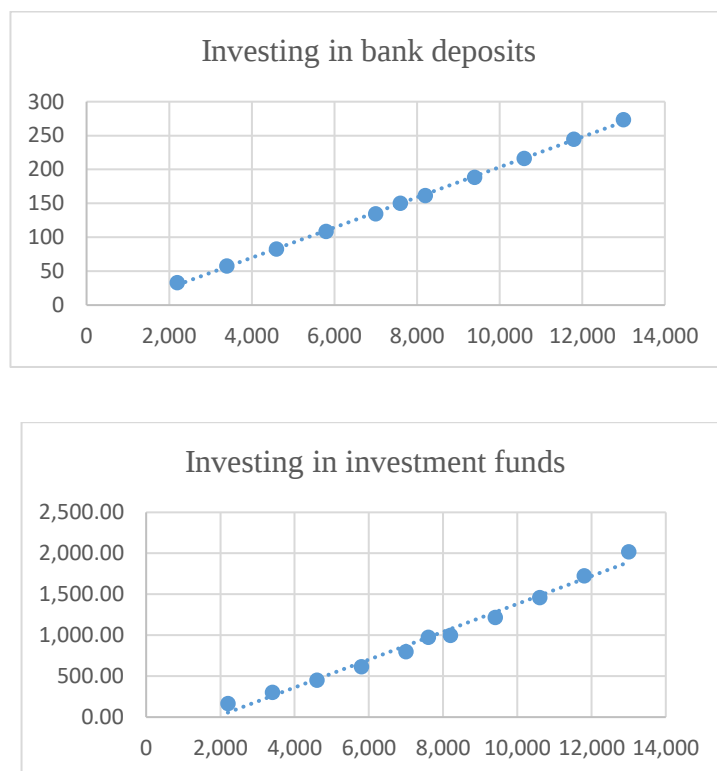
Design/methodology/approach Data were collected from the financial market in North Macedonia, especially from the Central Bank annual reports from the last 10 years (NBRM, 2023). The method of regression analysis is used to determine whether and how much investment from our choice affects those returns between two options of investments in bank deposit or open investment funds. Also, through the scatter diagrams and regression lines we are going to determine if the relation is directly positive or inverse, with the increase in spending on investment in the bank and the investment fund, in cases with increasing the investment deadline. Also, the coefficients of determination will be additionally calculated (Ristevski and Tevdoski, 2016).

Findings Although we know that by nature these 2 parameters (investment and returns) are in positive proportion, it has been scientifically analyzed that in long-term there is a direct-positive functional straight-line relationship between these 2 parameters, but also through the scatter diagram and the regression line, our study in this paper showed that given the amount of investment in a bank and an investment fund, the difference in yield is large and grows with increasing investment and the term. Because the final result of the equation seems to be directly positive, additionally we have calculated the coefficient of determination, to finally confirm the significant regression relationship.

Practical implementation – This study shows that in emerging economies like North Macedonia, it is very important to analyze and make it known to different investors that there are other opportunities for investment, respectively redirecting their free funds to other investment channels, such as Investment Funds, which bring significantly higher returns, in comparison with bank deposits

Originality/value The originality of my paper lies in the direct analysis and examination of data reports given annually by the National Bank of North Macedonia for the past 10 years.

Figure 1: Line scatter diagram of the Investment and Return Regression for 10 years.



(Source: Author's calculations using National Bank annual data reports)

Keywords: Capital Market, Investment Fund, Banking Sector, Investment, Yield, Straight Line Regression, Financial Market.

JEL classification: JEL E52, JEL 43, JEL G21, JEL D14.

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