LABOUR MARKET IN TERMS OF THE FOURTH INDUSTRIAL REVOLUTION

Borche Trenovski, PhD[1]
Marija Trpkova-Nestorovska, PhD[2]
Gunter Merdzan[3]
Kristijan Kozheski[4]

Abstract:

Recently, many studies and analysis confirmed that the world is at the beginning of a powerful process of transformation that will radically change our lives, ways of working and communicating.The Fourth Industrial Revolution is expected to improve the computerization of manufacturing industry and focuses on equipping the production with high technology. Three main goals of Industry 4.0 could be highlighted as: (1) Reduction of the human factor in manufacturing thus eliminating human errors. (2) Achieving high level of manufacturing flexibility and creating conditions for designing products that meet the specific requirements of the consumer. (3) Intensification of the production process.This paper aims to present the main trends in this field, to explain the benefits of technology and digitalization for the global economy as well as to elaborate the importance of preparing different segments of society for effects from the Fourth Industrial Revolution onto the global labor market.

This study obtains a panel data of six countries (France, Germany, Italy, Spain, UK and USA) for period between 1985 to 2017. The results have shown thatinformation and communications technology and multifactor productivity are variables whohave significant and positive impact on labor productivity while the variable average hours worked per person employed has a negative impact. Additional analysis of the demographic and socio-economic trends shows that the labor market will experience radical changes in the future.

Key words: *Fourth Industrial Revolution, labor market, ICT, MFP*

JEL Classification: *J23, O33, J2*

[1]Ss. Cyril and Methodius University in Skopje, Faculty of Economics – Skopje, Blvd. GoceDelchev 9V, 1000 Skopje, Republic of North Macedonia, Borce.Trenovski@eccf.ukim.edu.mk
[2]Ss. Cyril and Methodius University in Skopje, Faculty of Economics – Skopje, Blvd. GoceDelchev 9V, 1000 Skopje, Republic of North Macedonia, marijat@eccf.ukim.edu.mk
[3]Ss. Cyril and Methodius University in Skopje, Faculty of Economics – Skopje, Blvd. GoceDelchev 9V, 1000 Skopje, Republic of North Macedonia, gjunter.merdzan@eccf.ukim.edu.mk
[4]Ss. Cyril and Methodius University in Skopje, Faculty of Economics – Skopje, Blvd. GoceDelchev 9V, 1000 Skopje, Republic of North Macedonia, kristjan.kozeski@eccf.ukim.edu.mk

1. Introduction

A series of industrial revolutions took place after the 18th century. This process began by transforming the muscle into mechanical power that lead to an increase in human production through the cognitive power caused by the Fourth Industrial Revolution today.

The First Industrial Revolution lasted from 1760 until 1840 was led by the mechanical production through the construction of railroads and steam engines. Serial production supported by electricity and the assembly line in the late 19th and early 20th century started the Second Industrial Revolution. Third Industrial Revolution began in the 1960s and it was characterized as computer or digital revolution which was developed through semiconductors, computer networks and the Internet.

Fourth Industrial Revolution, according to Klaus Schwab, was different from the previous revolutions in three aspects: speed, width and depth and the system effect. It took 120 years for the spindle that was the symbol of the First Industrial Revolution to spread outside Europe, while the internet,in period less than 10 years, manage to spread throughout the whole world. There are still 1.3 billion people who do not have access to electricity, or only 17% of people are fully experiencing the Second Industrial Revolution. The same applies for the Third Industrial Revolution; half of the world population, mostly the developing countries, do not have internet access (Schwab and Davis, 2018). The Fourth Industrial Revolution is not connected only with smart machines and systems, it has a larger range. There are simultaneous leaps in various areas; from sequencing of entire genomes, nanotechnology, renewable energies to quantum techniques. The basic difference of this revolution from the previous three would be the possibility of merging of these technologies and their interaction in the physical, digital and biological areas.

The scope and the width of the technological revolution that is in the process of development will cause economic, social and cultural changes with incredible proportions; that is, according to the founder of the World Economic Forum, Klaus Schwab: “The changes are so profound that from the perspective of human history there has never been a time of greater hope, or greater danger.” The Fourth Industrial Revolution will have wide and different impacts on the economy, and it will be very difficult to distinguish one effect from another. That is, most of the macroeconomic variables – GDP, investments, consumption, employment, trade, inflation, etc. - will be affected by the technological revolution”. Yet, the focus of this paper is discovering and quantifying the potential effects of information and communications technology (ICT) investments and total factor productivity (ormultifactor productivity - MFP) on growth (in terms of productivity as its own determinant in the long run) and the employment.

It is necessary to observe the potential effects of the Fourth Industrial Revolution along with recent economic trends and other factors contributing to growth. A few years before the Great Recession began, the global economy grew at rates of 5%, and if that growth has continued it would have taken 14-15 years for the global GDP to double and millions of people to be saved from poverty. The expectations that after the Great Recession the global economy would return to the previous path of strong growth have not been fulfilled. The global economy appears to be stuck with growth of 3-3.5% which is lower than the average post-war growth rate (Schwab, 2016).

Economists Larry Summers and Nobel laureate Paul Krugman have returned to the claim of several economists, especially Alvin Hansen’s statement during the Great Depression about "the decline of the century" and "constant stagnation." The "constant stagnation" describes an unsurpassed situation in which although the interest rates are close to zero, the steady decline on the demand side continues.

If proven, the assumption assumes even greater declines in global GDP growth. If we imagine a final situation in which global GDP growth drops to 2%, doubling of the global GDP will take 34 years (Schwab, 2016).

There are several reasons for the slowing of the global economy growth (wrong distribution of the income, indebtedness, demographic changes etc.). For the research of this paper it is crucial to see the changes in the labor productivity that are connected with the investments in ICT.

The labor productivity has stagnated in the last 10 years despite the achieved exponential growth of the new ICT and investments in the innovations. According to the report "The Conference Board Productivity Brief" of the research company "The Conference Board", on a global scale, compared with the growth of the output per employee in 2017 for 2%, in 2018 it has grown for 1.9% and it is projected to be returned on 2% growth in 2019. The latest assesment continues the downward trend in global labour productivity from an average annual growth rate of 2.9% in 2000-2007 to 2.3% in 2010-2017. Also, the results of the analysis of the global labor productivity made from the same research company, confirm that effects of the productivity from the the long-awaited digital transformation are still too small to achieve permanent impact on macroeconomic level (The Conference Board, 2019). According to the data of the Bureau of Labor Statistics, the labor productivity has increased in the period from 1947-1983 for 2.8%, from 2000-2007 for 2.7% and in 2007-2018 for 1.3%.

The largest part of this decline is connected with the total factor productivity which is largely used as indicator of the income of the productivity connected with the technology and innovations. The Nobel Prize winner Robert Solow explains the long-run economic growth by looking at the capital accumulation, population growth and increases in productivity or technological progress. Later, Edward Denison splits the technological progress on its components and proves that education and technological progress in narrow sense are the most important factors for economic growth (Fiti, et al., 2008). On a global scale, the growth of total factor production, which takes into account capital investment and workforce skills and thus provides a better picture of the overall efficiency of the manufacturing process that combines capital, labor and technological progress, has declined by -0.1% in 2018, while in 2017 it increased slightly by 0.2%. The stagnation of the total factor productionfrom theprevious decade that continues in 2018 is a matter of concern, especially when it comes to the medium-term outlook of the growth. This means that modest productivity growth is still the result of the accumulation of physical capital rather than the benefits of expanded efficiency or innovation (The Conference Board, 2019).

The purpose of thispaper is to examine the effects of the annual changes in the investments in ICT, MFP and the average hours worked per person employed on the annual changes in the labor productivity by taking an example from the six countries (France, Germany, Italy, Spain, Great Britain and USA) in the period from 1985-2017. Given the reviewed literature, we hypothesize the positive impact of investment in ICT, MFP and the negative impact of average hours worked per person employed on the labor productivity.

The paper is structured as following: after the introduction we have consulted the relevant theoretical and empirical literature where the theoretical background of the relation between the labor productivity growth and investments in ICT and other macroeconomic variables is explained,and papers that apply a variety of different macroeconomic variables and methodologies to US economy and more developed EU countries are also consulted.We continue with our analyses using the panel regression method to examine the impact of ICT investments, changes in MFP and average hours worked per person employed on labor productivity growth. Finally, we draw some conclusions about the process of the Fourth Industrial Revolution and the investments in new technologies that affect labor productivity in developed economies.

2. Literature review

Technologies have undoubtedly contributed to improvement of the living standard and prosperity globally. They also continue to generate numerous negative impacts. More digital platforms are contributing for the wealth accumulation in the hands of a smaller group of people, and this is causing the workers to feel more insecure and vulnerable; techniques used in natural gas extraction continue to damage the environment and by transferring costs to marginalized affected parties the owners are becoming even richer. According to (Hicks and Devaraj, 2015, 2017), in the United States since 1990, approximately 83% of manufacturing job are lost are due to capital investments in equipment, and long-term changes in manufacturing sector employment are most linked to US factory productivity.

Most of these externalities have evolved gradually over the last 30 years, but as the Fourth Industrial Revolution progresses and changes occur much more rapidly, we will be faced with even more diverse, more complex and destructive effects of the new technologies. Well-known economists (Brynjolfsson and McAfee, 2014) have popularized the emergence of a "big separation" of the labour and the technology-driven productivity. Keeley (2015) blames technology as responsible for increased inequality because 80% of the reduced labor force contribution to national income creation in OECD countries is attributed to technological development and the public's perception that policies favor economic growth is increasingly reinforced before social cohesion and human well-being.

The slowing of the productivity between the matured economies in the last decade was dramatic, that is, the output rates by hour were halved from the average annual growth rate from 2.3% from 2000-2007 on 1.2% in the period from 2010 -2017. The productivity growth rate has further decreased on 0.8% in 2008 with chances for improvement of 1.1% in 2019. Given the longer-term outlook, the decline in productivity growth rates in mature economies seems to have reached the bottom in the recent years.However, after a significant improvement in MFP growth in 2017, mature economies in 2018 returned to levels below the average growth rate in 2010-2017 (The Conference Board, 2019). Van Ark, et al., (2003) in their paper highlighted the main reasons for lower productivity growth in Europe in the 90's than in the United States. The results indicated that that the productivity in USA increased faster than in the EU because in the United States, besides producing ICT, these technologies were used more successfully in other industries, while the EU was lagging behind in that respect. Most European economies showed significantly lower levels of investments in ICT goods and software than the United States. As mentioned above as USA’s productivity growth accelerated, the EU has been slowing down since the mid-1990s. It also contradicts the fact that MFP in the US declined slightly faster in the USA than the average of other mature economies, pointing to the greater importance of the efficiency and innovation investments during this period.

H. Hall and Sena (2017) discuss about the lower concentration of research and development in Europe, they focus on discussing the changes in the industrial sector and stated the small ICT production sector as the main reason. There is a similar interest in policies for the implementation of different variants of investment in the structure of the workforce skills. Given the results of significant previous research, it becomes clear that investments in ICT are often accompanied with undertaken innovations and in cooperation with other non-ICT investments.

Akande, et al., (2017) examined the impact of ICT investment on labor productivity in 19 OECD countries. Despite the different social and economic structures, all 19 countries showed a positive impact of ICT investment on productivity. The variables, the share of total labor compensation in GDP and the strength of trade unions showed a positive but insignificant impact on productivity. On the other hand, the variable of the average annual working hours per one employee is shown to have a negative impact on labor productivity. Dimelis and Papaioannou(2011) analyzed 42 countries and provided solid evidence of a significant impact of ICT on reducing inefficiencies in the country and on increasing of the labor productivity.

Considering the previous studies and the particular importance of this issue, our paper conducted a panel regression to analyze the impacts of ICT investments, MFP growth, and average hours worked per person employed on labor productivity growth of the six developed countries for which high-quality time series are available. As we have seen above, there is a significant decline in labor productivity and ICT investments in OECD countries, and therefore there is a need to investigate the relationship between the macroeconomic variables. Existing empirical literature extensively discusses the reasons why a certain percentage of output growth was not explained by inputs, while little attention has been paid to the paradox of labor productivity. Abramovitz, (1956) and Solow (1957) argue that more than 40% of outputs was not explained by inputs which is contrary to the mainstream economics. They rather found ICT as a source of innovative capabilities and knowledge as competitive driver explaining the paradox. We believe that this study will be very useful and a basis for future research.

3. Data, methodology and analysis

In order to analyze the factors that have effect on the labour productivity panel regression model is used in this research. Data are collected for six countries (France, Germany, Italy, Spain, UK and USA) for period 1985-2017 (thirty three periods) and total number of 198 observations. Data were collected from OECD Productivity Statistics. The dependent variable, Labour productivity (LP) is measured as measured as growth in GDP per hour worked, (annual change in %), and the explanatory variables used in the model are: Information and communication technologies capital (annual change in %) (ICTC), Average hours worked per person employed (annual change in %) (AHW) and multifactor productivity (annual change in %) (MFP).Variables explained in OECD database:

- LP - Labour productivity growth is a key dimension of economic performance and an essential driver of changes in living standards. Growth in gross domestic product (GDP) per capita can be broken down into growth in labour productivity, measured as growth in GDP per hour worked, and changes in the extent of labour utilization, measured as changes in hours worked per capita. High labour productivity growth can reflect greater use of capital, and/or a decrease in the employment of low-productivity workers, or general efficiency gains and innovation.
- ICTC - Estimates of ICT capital services in the OECD Productivity Database can be broken down into three types of assets: computer hardware, telecommunications equipment and computer software and databases. Countries use different approaches to deflate ICT investment series; where constant quality price changes are particularly important but difficult to measure. To ensure comparability of ICT capital services across countries, the OECD

capital services measures are based on a common computation method for all countries and a set of harmonized ICT investment deflators.

- AHW - Average hours worked per person employed - For productivity analysis, the underlying concept for labour input is total hours worked by all persons engaged in production. These reflect regular hours worked by full-time and part-time workers, paid and unpaid overtime, hours worked in additional jobs, and time not worked because of public holidays, annual paid leave, strikes and labour disputes and other reasons.
- MFP - Growth in multifactor productivity (MFP) is measured as a residual, i.e. that part of GDP growth that cannot be explained by growth in labour and capital inputs. Traditionally, MFP growth is seen as capturing technological progress but, in practice, this interpretation needs some caution. First, some part of technological change is embodied in capital input, e.g. improvements in design and quality between two vintages of the same capital asset, and so its effects on GDP growth are attributed to the respective factor. MFP only picks up disembodied technical change, e.g. network effects or spillovers from production factors, the effects of better management practices, brand names, organizational change and general knowledge. Second, data and resource constraints hamper a precise measurement of labour and capital input, affecting MFP. Moreover, MFP also captures other factors such as adjustment costs, economies of scale and effects from imperfect competition.

All included variables are tested with panel unit root test in order to confirm or deny their stationarity. The results are presented in Table 1.

Table 1. Panel unit root tests

Variable	p-values			
	Levin, Lin and Chu t*	Im, Pesaran and Shin W-stat	ADF-Fisher Chi-square	PP-Fisher Chi-square
Level				
LP	***0.0000	***0.0001	***0.0007	***0.0000
ICTC	**0.0133	**0.0416	*0.0909	0.2107
AHW	***0.0000	***0.0001	***0.0000	***0.0000
MFP	***0.0000	***0.0001	***0.0000	***0.0000
First difference				
LP	***0.0000	***0.0001	***0.0000	***0.0000
ICTC	***0.0000	***0.0001	***0.0000	***0.0000
AHW	***0.0000	***0.0001	***0.0000	***0.0000
MFP	***0.0000	***0.0001	***0.0000	***0.0000

*Null hypothesis is rejected at 0.1; **Null hypothesis is rejected at 0.05; ***Null hypothesis is rejected at 0.01;Source: Authors calculations.

The panel unit root tests are composed of: Levin, Lin and Chu test where the null hypothesis states that there is common unit root process in the panel variable and Im, Pesaran and Shin W-stat, ADF-Fisher Chi square and PP-Fisher Chi-square where the null hypothesis is formulated as existence of individual unit root process. The tests are performed with specification of individual intercept. As is evident of from the presented results, variables are stationary in their level, where for LP, AHW and MFP the null hypothesis for presence of unit root is rejected at 0.01, while for variable ICTS it is rejected at 0.1 and 0.05 for different tests.

Before the model was estimated, Hausman for Endogeneity or Hausman Specification Test was performed which in panel data regression is used to specify if the fixed effects model or random effects model is supposed to be used. The null hypothesis appoints for random effects model, while the alternative hypothesis specifies that fixed effects model is to be used. The results of the Hausman test in this analysis indicate Chi-Square Statistic of 5.171 with p-value of 0.1597, indicating that the null hypothesis is accepted and model with random effects is used.

The random effects approach proposes different intercept terms for each entity and again these intercepts are constant over time, with the relationships between the explanatory and explained variables assumed to be the same both cross-sectionally and temporally. The difference is that under the random effects model, the intercepts for each cross-sectional unit are assumed to arise from a common intercept α(which is the same for all cross-sectional units and over time), plus a random variable $\epsilon_i$that varies cross-sectionally but is constant over time. Variable ϵ_i measures the random deviation of each entity's intercept term from the 'global' intercept termα. Random effects panel model is presented in the following equation:

$$y_{it} = \alpha + \beta x_{it} + \omega_{it}, \quad \omega_{it} = \epsilon_i + \upsilon_{it}$$

where x_{it} is $1 \times k$ vector of explanatory variables, but unlike the fixed effects model, there are no dummy variables to capture the heterogeneity (variation) in the cross-sectional dimension. Instead, this occurs via the ϵ_i terms. Note that this framework requires the assumptions that the new cross-sectional error term,ϵ_i, has zero mean, is independent of the individual observation error term (υ_{it}), has constant variance σ_ϵ^2 and is independent of the explanatory variables x_{it}(Brooks, 2014).

Panel regression model with random effects for the analyzed data is given in the following equation:

$$LP_{it} = \alpha + \beta_1 ICTCS_{it} + \beta_2 AHW_{it} + \beta_3 MFP_{it} + (\mu_i + \epsilon_{it})$$

where the LP_{it} is the dependent variable, $ICTCS_{it}$, AHW_{it} and MFP_{it} are explanatory variables, μ_i is the unobserved random effect that varies across countries but not over time, and ϵ_{it} is an individual (idiosyncratic) error term, $i = 1, \ldots, N$; $t = 1, \ldots, T_i$.

Results of the random effects panel estimation are presented in table 2.

Table 2. Results of the random effects panel regression

Explanatory variables	Coefficient	t-statistic	Probability
ICTC	0.018085	3.013983	***0.0029
AHW	-0.323684	-8.490199	***0.0000
MP	0.998269	35.50252	***0.0000
α	0.409395	5.411892	***0.0000
R^2	0.887129		

Effects specification		
	SD	Rho
Cross-section random μ_i	0.046894	0.0125
Idiosyncratic random ϵ_{it}	0.416330	0.9875

Source: Authors calculations.

The findings prove that all three explanatory variable have statistically significant effect on the labor productivity. Information and communication technologies capital has positive impact onto the productivity, and similar effect is found with multifactor productivity. Average hours worked per person employed has negative coefficient with accounts for inverse relationship with the labour productivity.

The Solow-Swan model argued that an increase in capital accumulation and labor force will increase the economic growth rate, but only temporarily because of diminishing returns and once the steady-state is reached and the resources in a country are used up, the economic growth can only be increased through innovation and improvements in technology. We also tried to measure the impact of the change in total factor productivity on labor productivity growth. The rise of MFP is often attributed entirely to technological progress, but it also includes any permanent improvement in the efficiency with which factors od production are combined over time. The Solow residual is the unexplained change in output growth after calculating the effect od capital accumulation. Productivity paradox referred to a decline in the productivity growth in the United States in the 1970s and 80s despite the huge investments and rapid development in the Information Technology (Akande, et al., 2017).

We found that the growth of average hours worked per person employed has a negative impact on productivity growth. The law of diminishing returns expresses a very basic relation. As more of an input such as labour is added to a fixed amount of land, machinery, and other inputs, the labour has less and less of the other factors to work with. The land gets more crowded, the machinery is overworked, and the marginal product of labour declines.

4. Conclusion

According to the results of the analysis, the paper investigates the effects of ICT investments and their annual changes on the impact of labour productivity growth in six developed countries (France, Germany, Italy, Spain, UK, and the USA) in the period 1985-2017. Despite the different social and economic structures, all six countries show a positive response to labour productivity growth driven by investment in ICT.

The theoretical background of the problem and the empirical literature consulted have made the hypotheses presented obviously. The series of hypotheses we have outlined at the beginning of the paper are in the area of acceptance. All three explanatory variables have a significant impact on labour productivity growth. Investments in ICT as a target variable in our analysis show a positive impact on labour productivity growth. The growth of MFP, which is an indicator of the residual, that is, the share of GDP growth that cannot be explained by the growth of labour and capital inputs, also shows similar effects on labor productivity growth. On the other hand, the growth of the average hours worked per person employed show negative impacts on the growth of labour productivity. In conclusion, we can say that the model is relevant to the hypotheses presented earlier, showing that ICT investments affect labour productivity at a significant level with a strong positive impact.

This study, as we have already highlighted, presents the effects that ICT investments have on labour productivity growth at the level of national economies. They can be used by policymakers to assess potential labour productivity growth taking into account investments in ICT or other technological change, network effects and overflow effects of other factors of production, effects of better managerial skills, organizational changes, etc. Identified trends in labour productivity growth can be helpful in the process of selecting and favoring certain technological or organizational changes in individual sectors. Labour productivity has an impact on socio-economic development not only at the national level but also at the organizational and individual levels. Improvements in labour productivity nationally support economic growth, international competitiveness, GDP, and as a result stimulate educational, social and environmental programs.

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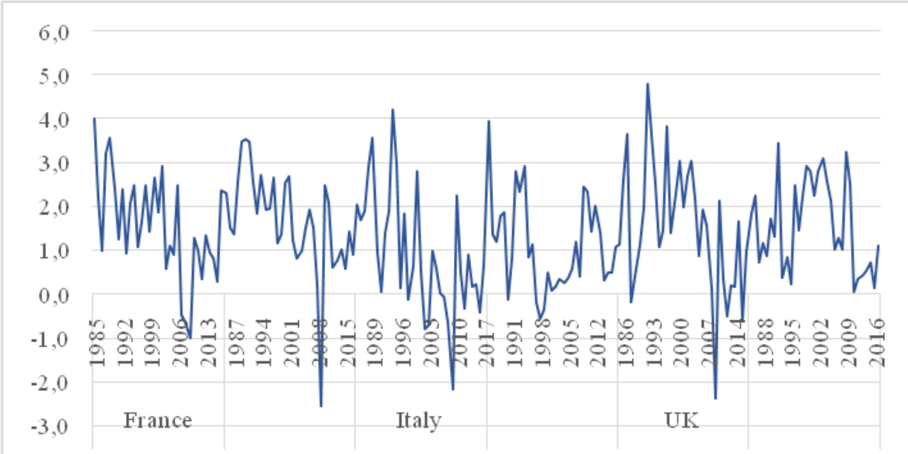
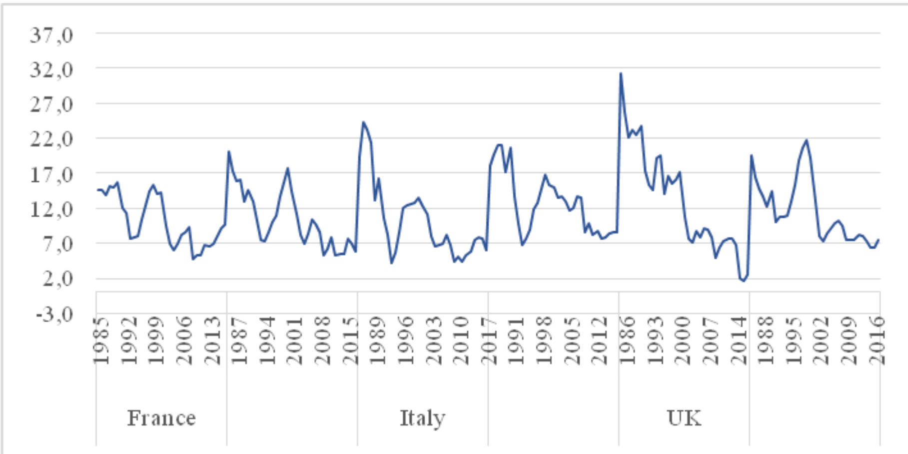
Appendix (Charts)

Figure 1. Labour productivity, annual growth rate (%)



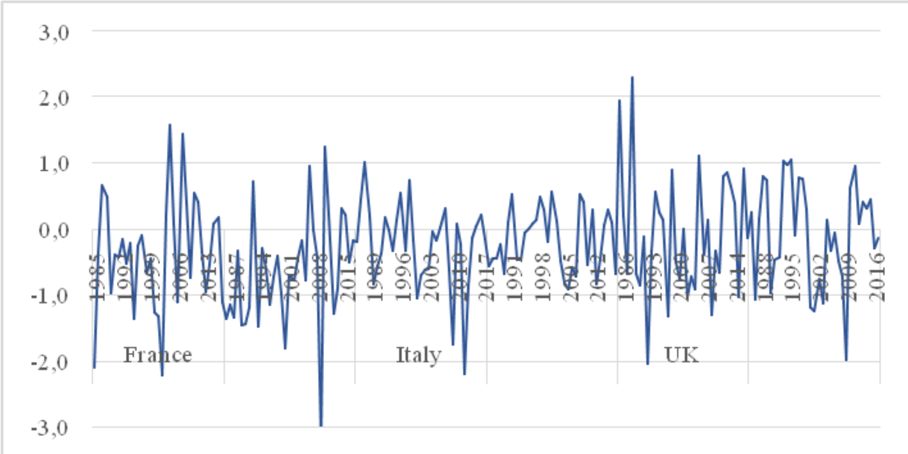
Source: OECD Productivity Statistics

Figure 2. ICT capital, annual growth/change (%)



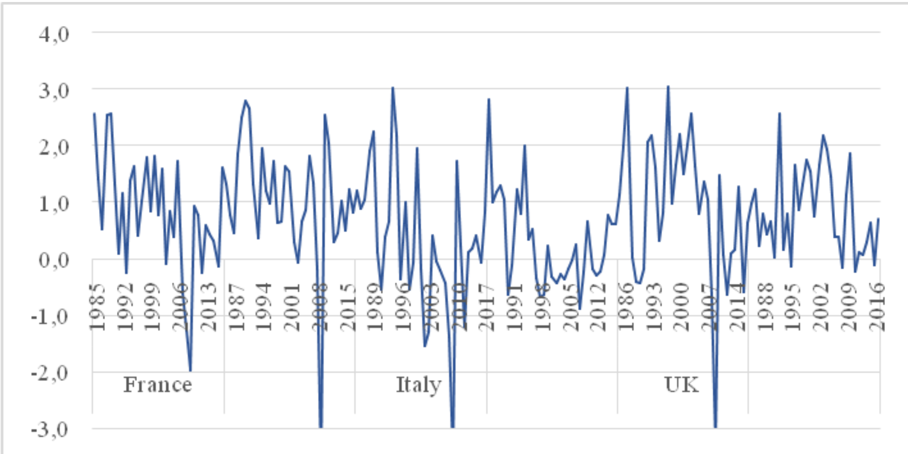
Source: OECD Productivity Statistics

Figure 3. Average hours worked per person employed, annual growth/change (%)



Source: OECD Productivity Statistics

Figure 4. Multifactor productivity, annual growth/change (%)



Source: OECD Productivity Statistics