THE EFFECT OF BANK DENSITY ON FINANCIAL DEVELOPMENT AND ECONOMIC PERFORMANCE

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ABSTRACT
This paper provides evidence about the link between bank density as a form of financial deepening, and financial development and economic performance. We construct a panel of European countries and develop a dynamic regression model with GDP dynamics up to three lags and a full set of fixed effects to study the effect that the number of bank branches and automated teller machines per capita have on real GDP per capita. Our baseline estimates point out to a weak negative impact of the increased number of bank branches per capita on economic performance by around 0.3 per cent annually. We find similar results from the subsequent IV and GMM estimates as well as when swapping the population basis of the bank density measures with the area. The IV strategy reveals that our both measures are endogenous with the respect to the level of urbanisation and the share of Internet users up to three lags. We further include financial development as a covariate and find weaker negative impact of the number of bank branches and a weak positive impact of the number of automated teller machines by about 0.15 per cent annually. Our estimates with respect to financial development reveal that both bank measures can be considered significant drivers given the positive impact of about 0.8 to 1.2 percentage points obtained for the number of bank branches and about 0.6 to 0.7 percentage points for the number of automated teller machines. We do not find any significant differences between the countries with harmonised regulations and shared currency as a result of the EU and Eurozone membership.

Keywords: *bank density, financial development, economic performance*

JEL Classification: *G21, O10*

1. INTRODUCTION AND BACKGROUND

The link between finance and economic growth is a subject of debate that has been boggling economists for a long time. After the early argumentation in favour of the finance-growth nexus made by Bagehot (1873) and Schumpeter (1912), many economists directed their attention to the origin of the relationship and have come to the conclusion, albeit not universally, that causal relationship goes from financial development to economic growth. In this vein, Schumpeter (1912) pioneered the idea that economies driven by efficient financial institutions grow faster; Kurt and Levine (1993) provided sufficient evidence for a robust long-run causal relationship from financial to economic development in a seminal paper that eventually invited the coming of a new wave of economic research in the same context; and

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Nobel laureate Miller (1998) argued that the proposition that financial markets affect economic growth is too obvious for discussion. On the other hand, Robinson (1952) was an early proponent of the notion of a reversed causality, that is, economies with good growth prospects efficiently develop financial institutions that mount those good prospects; and Lucas (1988) also refused finance as an 'over-stressed' determinant of economic growth. However, the accumulation of economic literature on the topic has recognised its subtlety and did not entirely throw away the possibility of reverse causality, reflected through the growing amount of papers with findings on the existence of bi-directional relationship (see for example Berthelemy and Varoudakis, 1996; Luintel and Khan, 1999; Shan, Morris and Sun, 2001; Calderon and Liu, 2003; and Ghirmay, 2004).

Economists nowadays generally see financial development as a complex system of many integral parts, such as quality of financial services, diversity of financial products, efficient provision and inclusive reach, whereby the amount of credit extended to the private sector relative to GDP has become a standard proxy for financial development. An important concept underpinning financial development in its entire complexity is that of financial deepening. While Levine, Loayza and Beck (2000) present strong evidence that financial depth promotes economic growth, the forthcoming strand of literature went deeper to examine in what form and to what extent financial deepening can affect economic growth (see for instance Deidda and Fattouh, 2002; Rousseau and Wachtel, 2002; Rioja and Valev, 2004a, 2004b; Aghion, Howitt and Mayer-Foulkes, 2005; Demirguc-Kunt, Feyen and Levine, 2011; Arcand, Berkes and Panizza, 2011; and Barajas, Chami and Yousefi, 2016).

In this paper, we use bank density as a measure of financial deepening to investigate its linkage with financial development and economic performance in 41 European countries during the period from 2004 to 2018. Our definition of bank density relates the feature of inclusive reach of financial services, which makes up the initial assumption that developed networks of bank branches and automated teller machines significantly contributes to increased financial development and favourably affects economic performance. We test the validity of this relationship by developing a dynamic panel-regression model. However, the estimation of whether and how bank density affect financial development and economic performance faces several challenges. Firstly, legislation and bank regulations at national level vary across countries and the harmonised regulation of the EU member states along with the shared currency in the Eurozone defines a homogenous area with greater interconnectedness compared to the non-EU member states. Secondly, the bank presence is subject to geographic factors such as population density and urbanisation, and their dismissal in the analysis may severely bias the estimation results. Thirdly, the eminent rise of electronic and mobile banking throughout the period weakens the relevance of the initial assumption as increased financial deepening may not have come as a result of the bank presence but rather because of the widespread use of the digital services. In order to address these challenges, we make several extensions of the baseline model to perform robustness checks.

This paper contributes to the related economic literature in that it observes financial deepening through the little-studied concept of bank density, thus adding to a new perspective of examining the finance-growth nexus. Furthermore, it develops a model that takes into consideration the development of new technologies inevitably impacting the provision of bank services. Finally, it produces a study that coalesces socio-economic, demographic and geographic factors in a more realistic attempt to estimate the effect of financial deepening.

2. DATA, SUMMARY STATISTICS AND MAIN TENDENCIES

We construct a panel of 41 European countries[1] with data collected from World Bank's World Development Indicators database for the period from 2004 to 2018. For the measurement of bank density, we adopt the number of commercial bank branches (CBBs) and the number of automated teller machines (ATMs) per 100,000 adults from the database and additionally introduce two similar measures per 1,000 square kilometres. On the other side, we use domestic credit extended by financial sector as proxy for financial development and the real GDP per capita to measure economic performance. We also include a set of additional variables to study the potential endogeneity of bank density such as the share of urban population and share of Internet users.

Although the countries in our sample belong to a single geographic region and share many commonalities, there is pronounced heterogeneity in regulation and development stemming from the history of economic systems and mutual integration. Therefrom, we tell apart the countries that are part of the European Union and the Eurozone from those that are not in order to examine the existence of patterns that might be familiar with process of integration. Furthermore, we construct a set of two dummy variables that capture country's EU and Eurozone membership at the end of the year, respectively, and use them as additional inputs in the model to test the extent of the differences between country groups.

Table 1. Summary statistics for the main variables used in the model

Variable	EU members			Other countries		
	Obs.	*Mean*	*St. Dev.*	*Obs.*	*Mean*	*St. Dev.*
CBBs (per 100,000 adults)	383	35.296	21.607	215	28.555	17.312
ATMs (per 100,000 adults)	380	82.348	36.068	217	57.193	33.600
CBBs (per 1,000 sq km)	383	39.034	37.031	215	18.256	19.949
ATMs (per 1,000 sq km)	380	91.894	76.089	217	34.189	37.408
Domestic credit of GDP (in per cent)	375	128.037	61.585	223	38.586	52.687
Real GDP per capita (in intl. dollars)	390	34,060	21,367	225	18,962	27,087
Urban population (share of total pop.)	390	0.722	0.119	225	0.636	0.133
Internet users (share of total pop.)	390	0.696	0.173	220	0.517	0.271

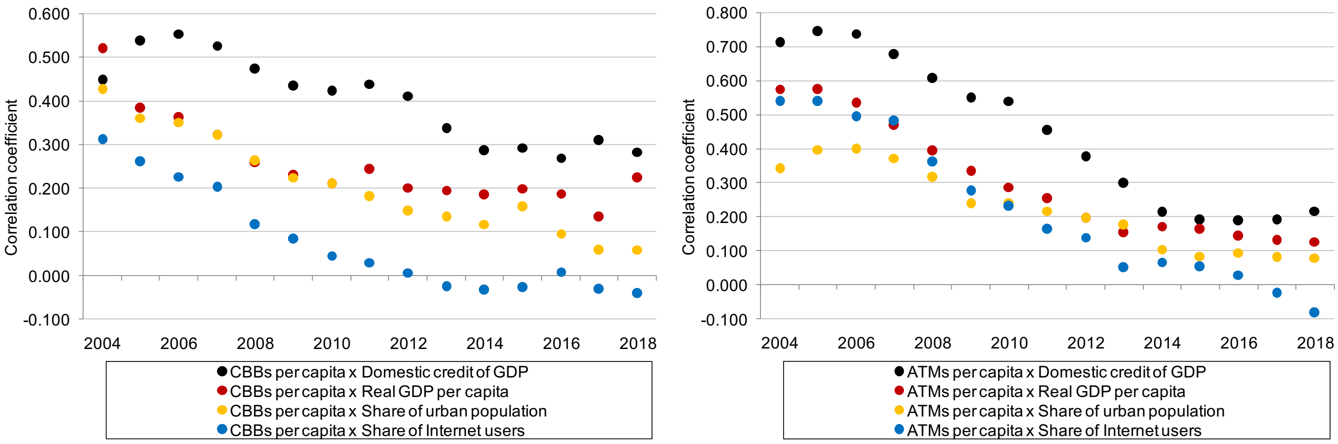
Notes: The sample is split into two sub-samples depending on the value of the EU dummy (1 for EU members and 0 for non-EU members). Statistics are calculated after all variables have been previously normalised to address the bias from differences between countries in terms of population and area.

Summary statistics for the main variables in our analysis are reported in Table 1. EU members clearly have substantially greater bank density on average with regards to all four measures and the means for the other variables are also higher for this group of countries. The statistics for the group of non-EU countries should be taken with a grain of salt, though, as it combines high-income EFTA members with middle-income countries from Southeast and East Europe, which can be plausibly concluded from the greater volatility expressed through the standard variations relative to the means. One way to get rid of this heterogeneity is by removing the EFTA countries and adding them to the group of EU members with whom they share more similar values but this is not going to be of great practical value for the paper's goal because the EU dummy was purposely defined to capture the effect of the harmonised bank regulation resulting from the adopted EU directives. For that reason, we move on to an observance of the time-variant correlation coefficients between different pairs

[1]Countries in the panel were selected on the basis of their membership and association with the European Banking Federation. Thus, a total of 45 countries (32 members and 13 associates) was sampled. Of this number, the four microstates – namely, Andorra, Liechtenstein, Malta and Monaco – were removed because of the outlying tendency of their figures, which eventually resulted in the final sample size.

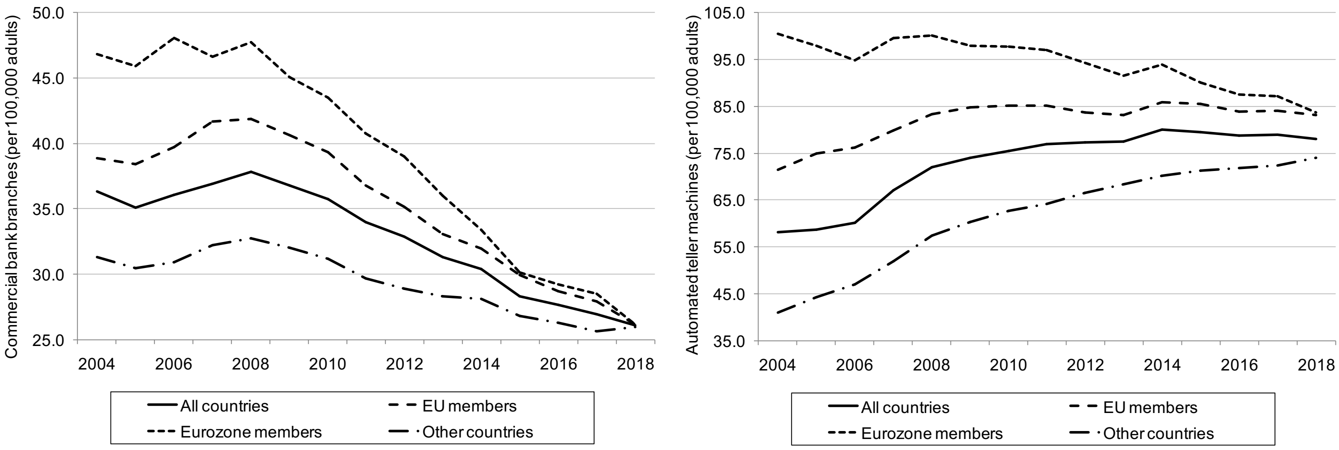
of variables in order to examine if high-income countries with higher level of urbanisation and higher share of Internet users really have denser bank services and how this develops over time.

Figure 1. Correlation between number of CBBs and ATMs per 100,000 adults and selected variables



Development of correlation coefficients over time is depicted in Figure 1. A positive correlation with a varying strength from weak to strong has been established for all pairs in the initial period but the downward trend with sporadic ups at some pairs has weakened it to a weak positive correlation in the end year and even a very weak negative correlation for the pairs involving the share of Internet users. But the correlation weakening for most pairs has ceased around the year of 2014 and the correlation coefficients remained fairly constant afterwards. We reveal an interesting pattern from the observance of the correlation pairs involving the share of Internet users. Namely, the sign change by the end of the time horizon indicates that higher shares of Internet users are associated with slightly lower numbers of CBBs and ATMs per capita, which points out to a possible migration of the bank services from the CBBs and ATMs to the online e-banking platforms. However, the conclusiveness of this pattern should be supported by additional observations on the numbers of CBBs and ATMs per capita, and we therefore take a look at these movements over time in order to study the level of convergence across country groups.

Figure 2. Average number of CBBs and ATMs per 100,000 adults across country groups over time



Notes: Montenegro has unilaterally adopted the euro as its official currency but it is not part of the Eurozone and is included in the Other countries group rather than the Eurozone members as such.

The time series of the average numbers of CBBs and ATMs per capita are plotted in Figure 2. For the sake of greater detail, apart from the sub-samples of EU members and Other countries based on the values of the EU dummy, we make a further step in sampling a new group of Eurozone countries based on the values of the Eurozone dummy. The charts clearly show that there is convergence in both the average number of CBBs and ATMs per capita across all groups. We note that the convergence is stronger when CBBs is an underlying variable, where the averages for all groups in the end year are almost equal, while there is still some gap between EU and non-EU members when observing the ATMs. Furthermore, we also find different patterns in the convergence processes. That is, the average number of CBBs per capita follows a decline after 2008 with sharpest fall at the EU member states as opposed to the upward trend in the average number of ATMs at all groups but the Eurozone members with that of the non-EU members being the most pronounced.

3. BASELINE MODEL

The baseline model that we use to estimate the effect of bank density on economic performance is a dynamic panel regression of the form

$$y_{c,t} = \beta d_{c,t} + \sum_{i=1}^{p} \gamma_i y_{c,t-i} + \alpha_c + \delta_t + \varepsilon_{c,t}, \tag{1}$$

where the $y_{c,t}$ denotes real GDP per capita for country c in year t, $d_{c,t}$ is the bank density measure with respect to population, α_c is a full set of time-invariant country fixed effects, δ_t is a full set of year fixed effects and $\varepsilon_{c,t}$ is the error term. We include p lags of the dependent variable in this specification to examine the GDP dynamics.
We impose the following assumptions on the specified model above.

Assumption 1 (Sequential exogeneity): $\mathbb{E}\left(\varepsilon_{c,t} \middle| y_{c,t}, \dots, y_{c,t_0}, d_{c,t}, \dots, d_{c,t_0}, \alpha_c, \delta_t\right) = 0$.

This assumption is a standard one when working with dynamic panel regression models, which implies that the past values of real GDP per capita and the bank density measure are orthogonal to the error term in the current period. Importantly, the assumed exogeneity is not strict because of the inclusion of lagged values of the real GDP per capita.

Assumption 2 (No serial correlation): $\mathbb{E}\left(\varepsilon_{c,t} \middle| \varepsilon_{c,t-1}, \dots, \varepsilon_{c,t_0}\right) = 0$.

Along with Assumption 1, this is another standard assumption made and it essentially states the same with the difference that orthogonality should be established between the error term in the current period and its past values. In order to obey Assumption 2, we opine that the inclusion of lagged values of real GDP per capita, albeit violating strict exogeneity, is helpful in eliminating the residual serial correlation.

Assumption 3 (Stationarity): *The characteristic equation* $r^p - \sum_{i=1}^{p-1} \gamma_i r^{p-i} = 0$ *of the time series* $y_{c,t} = \sum_{i=1}^{p} \gamma_i y_{c,t-i} + \varepsilon_{c,t}$ *does not have a root* $r = 1$.

The notion of stationarity is important in time-series analyses, although it is frequently dropped when $C > T$. In that light, we simplify our baseline model with the assumption that the characteristic equation of our dependent variable has no unit root, that is the time series is stationary, but later we test the validity of this assumption using the panel unit root test by Levin, Lin and Chu (2002).

Table 2. Effect of bank density measured per capita on economic performance

Independent variable	*Dependent variable: log GDP per capita*					
	(1)	(2)	(3)	(4)	(5)	(6)
log GDP per capita first lag	0.720***	0.999***	1.050***	0.761***	1.067***	1.165***
	(0.039)	(0.057)	(0.060)	(0.068)	(0.056)	(0.048)
log GDP per capita second lag		-0.223***	-0.405***		-0.261***	-0.515***
		(0.044)	(0.075)		(0.051)	(0.060)
log GDP per capita third lag			0.138***			0.239***
			(0.050)			(0.042)

CBBs (per 100,000 adults)	-0.117***	-0.141***	-0.131***			
	(0.034)	(0.038)	(0.042)			
ATMs (per 100,000 adults)				-0.049	-0.014	-0.045
				(0.032)	(0.027)	(0.031)
European Union dummy	0.053	-0.064	0.013	0.131*	0.084	0.299
	(0.066)	(0.079)	(0.083)	(0.076)	(0.059)	(0.284)
Eurozone dummy	0.015	0.002	0.001	0.035**	0.015	-0.002
	(0.014)	(0.015)	(0.012)	(0.015)	(0.016)	(0.013)
Unit root test adjusted t-statistic	-7.444	-8.977	-7.860	-7.444	-8.977	-7.860
p-value (rejects unit root)	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Observations	520	480	440	525	488	448
Countries	41	41	41	41	41	41

Notes: The reported coefficient of bank density is multiplied by 100. All specifications include a full set of country fixed and year effects. Standard errors robust against heteroscedasticity and serial correlation at country level are reported in parentheses. Symbols *, ** and *** denote statistical significance at the level of 1, 5 and 10 per cent, respectively.

Table 2 reports the estimation results from the baseline model. The results show statistically significant coefficients on the GDP dynamics in all equations, implying alternating impact with growing magnitude of the first lag coefficient as the GDP dynamics gets enriched with additional lags, while the magnitude of the last lags asymptotically diminishes. Bank density measured through the number of CBBs has negative effect on economic performance. The estimated coefficients ranging from -0.117 to -0.141 point out that any unit in the number of CBBs per 100,000 adults adversely affects economic performance by 0.269 to 0.324 per cent. When the number of ATMs is used as a bank density measure, we again find negative effect but with less intensity and much higher standard errors. Statistically insignificant results are found for the dummies as well in all but the specification with one lag and the ATMs as bank density measure, indicating to a better economic performance of EU and Eurozone members under the given circumstances. Finally, the panel unit root test on a demeaned time series of the GDP measure strongly rejects the existence of a unit root, thus confirming the validity of Assumption 3.

An important issue that needs to be addressed in a dynamic panel regression is the failure of the LSDV estimator known as the Nickell's bias (see Nickell, 1981; and Anderson and Hsiao, 1982). This results from the violation of the strict exogeneity with the introduction of lagged values of the dependent variable and, in our case, it might severely affect the validity of results considering that it is of asymptotic order $1/T$ and our observation period is $T = 15$. There are several techniques developed as solutions to this bias but the most common ones when working with macroeconomic data are the IV approach (Anderson and Hsiao, 1982) and the GMM approach (Arellano and Bond, 1985) that we elaborate in greater detail in the rest of the paper.

3.1. IV estimates

Apart from the failure of strict exogeneity in a dynamic-panel setup, the general notion of exogeneity per Assumption 1 may not hold, which leads to measurement errors in the effects of bank density on economic performance. For the purpose of solving this potential issue, we develop an IV strategy with the lagged values of the share of urban population and share of Internet users used as instrumental variables. The selection of the two variables was made under two reasonable considerations: firstly, banks operating in regions with different level of urbanisation are likely to exhibit different preferences towards their presence; and secondly, differences in the number of Internet users may be linked with higher use of the online e-banking platforms and that might severely affect the use of bank services provided through other means. There is one additional assumption that the instruments have to obey.

Assumption 4 (Exclusion restriction): $\mathbb{E}(\varepsilon_{c,t}|x_{c,t-i},, z_{c,t-i}, \alpha_c, \delta_t) = 0$.

This assumption is nothing new but an extension of Assumption 1 in the sense that there has to be a specification for which exogeneity holds. In other words, if exogeneity fails for the bank density measures in the model, then we are in the search of variables impacting the endogenous bank density measure that are orthogonal to the error term.

Given that we use lagged values of two variables as instruments to a single bank density measure, we over-identify the model that allows us to implement the 2SLS approach with the following two stages. In the first stage, we estimate the equation of the form

$$d_{c,t} = \sum_{i=1}^{p} \tau_i y_{c,t-i} + \xi_i x_{c,t-i} + \zeta_i z_{c,t-i} + +\eta_c + \theta_t + u_{c,t}, \tag{2}$$

where the bank density measure $d_{c,t}$ is treated as an endogenous variable and is regressed on the GDP dynamics with $p = 3$, and $x_{c,t-i}$ and $z_{c,t-i}$ denote the instrumental variables with up to three lags. We opt for the GDP dynamics with three lags given the statistically significant regression coefficients that reveal the patterns already discussed. Then, we re-run a slightly modified version of the model specified in (1) in the form

$$y_{c,t} = \beta d_{c,t} + \sum_{i=1}^{p} \gamma_i y_{c,t-i} + \alpha_c + \delta_t + \epsilon \hat{u}_{c,t} + \varepsilon_{c,t}, \tag{3}$$

where the key difference is the decomposition of the error term to $\epsilon \hat{u}_{c,t}$ and $\varepsilon_{c,t}$. In order to remove endogeneity from the model, we use the Durbin-Wu-Hausman test (see Durbin, 1954; Wu, 1973; and Hausman, 1978) on the coefficient ϵ. In the second stage, we estimate the regression coefficients of the model in (3).

Table 3. Instrumental variables estimates on the effect of bank density on economic performance

Endogeneity test estimates (stage one of 2SLS)						
$H_0: \epsilon = 0, H_1: \epsilon \neq 0$						
	Endogenous variable					
Instrument	Share of urban population			Share of Internet users		
	Instrumental lags					
	One lag	Two lags	Three lags	One lag	Two legs	Three lags
	(1)	(2)	(3)	(4)	(5)	(6)
Share of urban population	-1.321***	-1.344***	-1.352***	-2.772***	-3.015***	-3.213***
	(0.276)	(0.281)	(0.291)	(0.691)	(0.546)	(0.570)
Share of Internet users	-0.120***	-0.167***	-0.206***	0.691***	0.593***	0.482***
	(0.025)	(0.025)	(0.025)	(0.046)	(0.047)	(0.048)
IV regression estimates (stage two of 2SLS)						
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)
log GDP per capita first lag	1.169***	1.169***	1.156***	1.211***	1.211***	1.200***
	(0.048)	(0.048)	(0.048)	(0.048)	(0.048)	(0.048)
log GDP per capita second lag	-0.423***	-0.423***	-0.407***	-0.484***	-0.484***	-0.469***
	(0.071)	(0.071)	(0.071)	(0.070)	(0.070)	(0.070)
log GDP per capita third lag	0.124***	0.124***	0.135***	0.131***	0.132***	0.147***
	(0.043)	(0.043)	(0.043)	(0.048)	(0.048)	(0.050)
CBBs (per 100,000 adults)	-0.095***	-0.094***	-0.096***			
	(0.020)	(0.019)	(0.019)			
ATMs (per 100,000 adults)				0.013	0.013	0.011
				(0.020)	(0.020)	(0.021)
European Union dummy	0.009	0.009	0.009	0.007	0.007	0.008
	(0.009)	(0.009)	(0.009)	(0.011)	(0.011)	(0.011)
Eurozone dummy	0.002	0.002	0.001	0.013**	0.013**	0.011*

	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)
Observations	520	480	440	525	488	448
Countries	41	41	41	41	41	41

Notes: The reported coefficient of bank density is multiplied by 100. All specifications include a full set of country fixed and year effects. Symbols *, ** and *** denote statistical significance at the level of 1, 5 and 10 per cent, respectively.

The estimation results from the IV strategy are presented in Table 3. In the first stage of the 2SLS approach, we identify strong endogeneity of both bank density measures with respect to the selected instruments in any specification up to three lags. Subsequently, we find general consistency of the results in the second stage with those from the baseline model. In fact, very similar results are obtained in the equations where the endogenous variable is instrumented with one or two legs, while differences are noticeable in those with three lags of the instrumental variables. GDP dynamics still shows alternating impact that asymptotically diminishes as the number of lags increases. Bank density has statistically significant negative impact when measured through the number of CBBs, which is slightly less than the baseline estimates, ranging from -0.094 to -0.096. This implies an adverse impact by 0.216 to 0.221 per cent. The Eurozone dummy coefficient has statistically significant positive impact only in the specifications with the number of ATMs as bank density measure.

3.2. GMM estimates

Although the IV approach developed by Anderson and Hsiao (1982) solves the problems posed by violating Assumption 1, it has a low asymptotic efficiency due to the somewhat large asymptotic variance. In order to attain higher asymptotic efficiency of the estimated results, we move on to the GMM estimator proposed by Arellano and Bond (1991), which has lower asymptotic variance and might provide more efficient estimates.

Table 4. General method of moments estimates on the effect of bank density on economic performance

Independent variable	*Dependent variable: log GDP per capita*					
	(1)	(2)	(3)	(4)	(5)	(6)
log GDP per capita first lag	0.703***	0.878***	0.924***	0.745***	0.959***	1.027***
	(0.039)	(0.057)	(0.063)	(0.053)	(0.058)	(0.062)
log GDP per capita second lag		-0.176***	-0.363***		-0.226***	-0.443***
		(0.046)	(0.060)		(0.042)	(0.061)
log GDP per capita third lag			0.144***			0.186***
			(0.038)			(0.040)
CBBs (per 100,000 adults)	-0.122***	-0.118***	-0.123***			
	(0.029)	(0.029)	(0.032)			
ATMs (per 100,000 adults)				-0.016	$-\beta < 0.001$	-0.011
				(0.018)	(0.015)	(0.016)
European Union dummy	0.012*	0.017**	0.025	0.026***	0.022***	0.072
	(0.007)	(0.008)	(0.021)	(0.010)	(0.008)	(0.062)
Eurozone dummy	0.009	0.013	0.013	0.025**	0.027**	0.022**
	(0.010)	(0.009)	(0.010)	(0.012)	(0.011)	(0.011)
AR (2) z-statistic	-4.288	-3.772	0.679	-4.048	-3.525	0.813
p-value (serial correlation)	[0.000]	[0.000]	[0.497]	[0.000]	[0.000]	[0.416]
Observations	520	480	440	525	488	448
Countries	41	41	41	41	41	41

Notes: The reported coefficient of bank density is multiplied by 100. All specifications include a full set of country and year fixed effects. Standard errors robust against heteroscedasticity and serial correlation at country level are reported in parentheses. Symbols *, ** and *** denote statistical significance at the level of 1, 5 and 10 per cent, respectively.

Table 4 reports the GMM estimation results. The findings are generally consistent with those from the baseline model in terms of statistical significance, the sign of the effect and its magnitude. Differences can be noted for the dummy coefficients with evidence of positive statistically significant effect, especially in the specifications with the number of ATMs as bank density measure. Yet the consistency in the estimation results, the AR (2) test shows no serial correlation only in the specification with three lags.

4. ROBUSTNESS CHECKS

In this section, we test the robustness of the estimated results from the baseline model.

4.1. The effect of financial development

The estimates so far show the bank density's effect on economic performance, while keeping the impact of everything else contained in the residual. But it is reasonable to guess that potential impact on economic performance might have come from elsewhere. We therefore extend the baseline model by adding domestic credit of GDP as a covariate in order to test extent to which the level of financial development affect economic performance and additionally study the consistency of the estimated regression coefficient of bank density.
The estimation results from this extended model are presented in Table 5.

Table 5. Effect of bank density on economic performance including a covariate for financial development

Independent variable	*Dependent variable: log GDP per capita*					
	(1)	(2)	(3)	(4)	(5)	(6)
log GDP per capita first lag	0.764***	0.910***	0.928***	0.666***	0.871***	0.944***
	(0.035)	(0.056)	(0.066)	(0.052)	(0.058)	(0.067)
log GDP per capita second lag		-0.108**	-0.335***		-0.147***	-0.378***
		(0.052)	(0.059)		(0.046)	(0.063)
log GDP per capita third lag			0.211***			0.244***
			(0.054)			(0.052)
Domestic credit of GDP	-0.033***	-0.033***	-0.050***	-0.060***	-0.059***	-0.064***
	(0.006)	(0.008)	(0.012)	(0.013)	(0.013)	(0.015)
CBBs (per 100,000 adults)	-0.087***	-0.109***	-0.079			
	(0.033)	(0.040)	(0.049)			
ATMs (per 100,000 adults)				0.061**	0.067**	0.016
				(0.027)	(0.032)	(0.031)
European Union dummy	0.051	-0.047	0.010	0.083	0.036	0.125
	(0.055)	(0.067)	(0.078)	(0.063)	(0.048)	(0.137)
Eurozone dummy	0.006	-0.008	-0.010	0.020	0.002	-0.010
	(0.013)	(0.015)	(0.015)	(0.017)	(0.020)	(0.018)
Unit root test adjusted t-statistic	-7.444	-8.977	-7.860	-7.444	-8.977	-7.860
p-value (rejects unit root)	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Observations	507	470	432	512	478	440
Countries	41	41	41	41	41	41

Notes: The reported coefficients of bank density and financial development are multiplied by 100. All specifications include a full set of country fixed and year effects. Standard errors robust against heteroscedasticity and serial correlation at country level are reported in parentheses. Symbols *, ** and *** denote statistical significance at the level of 1, 5 and 10 per cent, respectively.

While GDP dynamics is highly consistent with that in the baseline model, the coefficients of the dummies are still statistically insignificant and the assumption about unit root can again be comfortably rejected, we pay attention to three conclusions. Firstly, the financial development measure has weak negative statistically significant effect on economic performance. Secondly, the introduction of the financial development measure as a covariate commensurately reduced the adverse effect of bank density in the baseline model on account of its own. Thirdly, the commensurate split-up of bank density's impact resulting from the negative coefficient of financial developments brings up the effect of the number of ATMs to a positive statistically significant one in the specifications with one and two lags. The magnitudes of 0.061 and 0.067 indicate that a unit increase in the number of ATMs per 100,000 adults leads to higher economic performance by 0.141 and 0.154 per cent, respectively.

4.2. Population coverage vs area coverage

Our analysis so far presumed that banks diffuse their services to cover population as a primary goal but another possibility is that banks expand their network of services to cover the area that they serve. We check this by running the model in (1), where CBBs and ATMs per capita as bank density measures are swapped with CBBs and ATMs per area.

Table 6. Effect of bank density per area on economic performance

Independent variable	*Dependent variable: log GDP per capita*					
	(1)	(2)	(3)	(4)	(5)	(6)
log GDP per capita first lag	0.712***	1.024***	1.094***	0.734***	1.070***	1.160***
	(0.040)	(0.056)	(0.053)	(0.064)	(0.051)	(0.046)
log GDP per capita second lag		-0.243***	-0.439***		-0.277***	-0.515***
		(0.042)	(0.071)		(0.040)	(0.064)
log GDP per capita third lag			0.152***			0.205***
			(0.048)			(0.056)
CBBs (per 1,000 sq km)	-0.107**	-0.129***	-0.112***			
	(0.044)	(0.045)	(0.045)			
ATMs (per 1,000 sq km)				-0.053	-0.004	-0.022
				(0.034)	(0.024)	(0.031)
European Union dummy	0.088	-0.027	0.076	0.131*	0.078	0.285
	(0.087)	(0.061)	(0.106)	(0.079)	(0.057)	(0.274)
Eurozone dummy	0.030	0.019	0.014	0.042**	0.016	0.002
	(0.016)	(0.015)	(0.013)	(0.017)	(0.016)	(0.013)
Unit root test adjusted t-statistic	-7.444	-8.977	-7.860	-7.444	-8.977	-7.860
p-value (rejects unit root)	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Observations	520	480	440	525	488	448
Countries	41	41	41	41	41	41

Notes: The reported coefficient of bank density is multiplied by 100. All specifications include a full set of country fixed and year effects. Standard errors robust against heteroscedasticity and serial correlation at country level are reported in parentheses. Symbols *, ** and *** denote statistical significance at the level of 1, 5 and 10 per cent, respectively.

Table 6 reports the estimation results from this modified version of the model and shows very high consistency with those obtained from the baseline model. Of the statistically significant coefficients, we note that the magnitude of bank density's negative impact is somewhat lower and ranges from -0.107 to -0.129, which translates to an adverse effect on economic performance by 0.246 to 0.297 per cent.

5. BANK DENSITY AND FINANCIAL DEVELOPMENT

We used the financial development measure in all previous equations as a fixed explanatory variable that potentially accounts for a large portion of the impact on economic performance. Since financial deepening underpins the concept of financial development, it is reasonable to shed light on bank density as potential driver of financial development. In the context of this discussion, we reverse our baseline model in (1) so that real GDP per capita is the fixed explanatory variable and domestic credit of GDP by the financial sector is taken as a dependent variable. Then, the model takes the form

$$f_{c,t} = \beta d_{c,t} + \sum_{i=1}^{p} \varphi_i f_{c,t-i} + \alpha_c + \delta_t + \varepsilon_{c,t}. \tag{4}$$

Table 7. Effect of bank density per capita on financial development

Independent variable	*Dependent variable: Domestic credit of GDP*					
	(1)	(2)	(3)	(4)	(5)	(6)
Domestic credit of GDP first lag	0.696***	1.021***	1.013***	0.653***	1.154***	1.115***
	(0.052)	(0.132)	(0.138)	(0.063)	(0.114)	(0.122)
Domestic credit of GDP second lag		-0.200*	-0.082		-0.343***	-0.108
		(0.106)	(0.112)		(0.083)	(0.135)
Domestic credit of GDP third lag			-0.151*			-0.225***
			(0.080)			(0.080)
CBBs (per 100,000 adults)	1.163***	1.030***	0.815***			
	(0.325)	(0.241)	(0.222)			
ATMs (per 100,000 adults)				0.592*	0.703**	0.658**
				(0.311)	(0.311)	(0.323)
European Union dummy	65.726	136.544	87.644	-139.093	-174.633	-48.288
	(95.451)	(148.477)	(119.534)	(132.985)	(155.648)	(84.906)
Eurozone dummy	-1.579	-1.118	4.646	-12.567	0.360	-1.591
	(12.722)	(8.616)	(4.989)	(17.837)	(7.462)	(4.216)
Observations	503	463	423	508	471	431
Countries	41	41	41	41	41	41

Notes: The reported coefficient of bank density is multiplied by 100. All specifications include a full set of country fixed and year effects. Standard errors robust against heteroscedasticity and serial correlation at country level are reported in parentheses. Symbols *, ** and *** denote statistical significance at the level of 1, 5 and 10 per cent, respectively.

The estimation results from the reversed model are presented in Table 7. The financial development dynamics exhibits statistically significant coefficients with opposite signs for the first and third lags, while the coefficient for the second lag loses statistical significance and changes sign as the number of lags gets increased. Both bank density measures have positive statistically significant impact on financial development. For the number of CBBs, it suggests that a unit increase leads to higher financial development in the range from 0.815 to 1.163 percentage points; and for the number of ATMs, the increase caused by a unit change upwards is between 0.592 and 0.703 percentage points. Given the unbalanced data for the lagged variable, we could not verify Assumption 3 with the panel unit root test.

6. CONCLUSION

Our approach to examine the link between finance and economic growth through the concept of bank density as a form of financial deepening for a panel of 41 European countries for the period from 2004 to 2018 yields results that differ substantially from the orthodox belief that financial development is a source for growth. We identify the number of commercial bank branches per 100.000 adults and the number of ATMs per 100,000 adults as measures of bank density, and observe a high level of convergence over time across countries grouped as EU and non-EU members along with decreasing correlation of both bank density measures on one hand and the financial development and economic performance measures on the other hand.

The baseline dynamic regression model that we develop to study the effect of bank density on economic performance measured by real GDP per capita reveals a weak negative statistically significant impact of 0.269 to 0.324 per cent annually for a unit increase of the number of bank branches and no statistically significant impact for the ATMs. The estimation results from our subsequent IV estimates with 2SLS approach and Arellano-Bond GMM estimator largely verify the consistency of the results from the baseline model. In the first stage of the 2SLS approach, we find that our bank density measures are both endogenous with respect to the level of urbanisation and the share of Internet users; and in the second stage, we obtain a weaker negative statistical significant impact in the range of 0.216 to 0.221 per cent annually for the bank branches. Our robustness checks performed in addition further confirm the consistency of the estimates as we get statistically significant negative impact of 0.247 to 0.296 per cent annually when swapping the population basis of the number of bank branches with the area. In the case with financial development included as a covariate, we estimate that the domestic credit of GDP has weak negative impact on real GDP per capita and get statistically significant results for both bank density measures with an opposite impact. We also conclude that the financial development measure commensurately splits up the effect of bank density, resulting in weaker negative impact for the bank branches and stronger positive impact between 0.141 and 0.154 per cent annually for the ATMs. From the regressions on domestic credit of GDP as a dependent variable, we find that both measures are drivers of financial development with a unit increase in the number of bank branches contributing to higher financial development by 0.815 to 1.163 percentage points and between 0.592 to 0.703 for a unit increase of ATMs. In all specifications, we estimate positive impact of the dummy coefficients for EU and Eurozone membership but we safely dismiss its overall validity due to the lack of statistical significance in most cases.

By summing up the foregoing findings, we conclude that the numbers of bank branches and ATMs, albeit important drivers of financial development, do not contribute to better economic performance across Europe. This can be explained through the increased number of Internet users and growing use of e-banking services. There is also no strong evidence that the harmonised bank regulation across EU countries and the shared currency help these countries perform better than the rest.

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