Internet Banking: A New Digital Divide Between the European Regions?

Fernando Lera-Lopez[1]
Department of Economics,
Public University of Navarra
Campus Arrosadía s/n 31006 Pamplona Spain
Phone: 00 34 948 169351; Fax: 00 34 948 169721
Email:lera@unavarra.es
ORCID iD: 0000-0002-9230-9405

Rocío Marco
Department of Applied Economy,
Universidad Autónoma de Madrid
Ciudad universitaria de Cantoblanco, 28049 Madrid Spain
Phone: 00 34 91 4972899; Fax: 00 34 91 4974676
Email: rocio.marco@uam.es
ORCID iD: 0000-0002-2854-9121

Margarita Billon
Department of Economic Structure and Development Economics,
Universidad Autónoma de Madrid
Ciudad universitaria de Cantoblanco, 28049 Madrid Spain
Phone: 00 34 31 4978777; Fax: 00 34 91 497971
Email: margarita.billon@uam.es
ORCID iD: 0000-0003-4860-9133

[1] Corresponding author

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Abstract

The purpose of this chapter is to develop a regional approach for studying internet banking use rates in Europe. To that aim, we analyse internet banking use in 244 European regions in 2019, considering the role played by technological, economic, social, and demographic factors. First, we apply a clustering technique to create a taxonomy of three groups of regions according to their levels of internet banking use: low, middle, and high levels of internet banking use. The results show great heterogeneity between european regions. Second, applying a multinomial logistic regression, we obtain that apart from ICT infrastructure, economic variables and education level are the main predictors to explain internet banking diffusion. These findings may contribute to a better understanding of the European regional internet baking divides and the variety of socioeconomic factors that may explain them. We contribute to the literature, first, because we provide a characterisation of the European region in terms of internet banking adoption; and second, because we identify the regional determinants that explain this taxonomy.

Keywords: Internet; banking; Europe; region; taxonomy; digital divide.

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1. Introduction

Information and Communication Technologies (ICT) has become a key determinant in the recent evolution of the financial system, favouring the development of digital innovations that have changed the landscape of the global financial environment (Asongu & Nwachukwu, 2019; Dumičić et al., 2015; Lechman & Marszk, 2019). The increasing penetration of the internet has boosted the adoption of electronic systems and the emergence of innovative financial products and services (Marszk & Lechman, 2019; Sadigov et al., 2020) that have led to important transformations in the relationship between financial agents. In a context of intense and increasing competition, banks and other financial institutions are forced to develop digital innovations as a key strategy, not only to boost efficiency and reduce costs, but also to augment profitability and expand their activities to gain market share (Aktan et al., 2009; Mahmoodi & Naderi, 2016; Nazaritehrani & Mashali, 2020).

In the banking system, digital innovations such as the development of e-banking have transformed financial services, impacting the relationships between banks and customers (European Banking Authority, 2019). In addition to these effects at the micro-level, the adoption of internet banking may have important socioeconomic impacts at higher levels of analysis, such as regional or country ones. In fact, the development of digital innovations in the financial sector may have an impact on economic growth (Sadigov et al., 2020). In turn, its effects on the socioeconomic context could lead to new socioeconomic inequalities at regional and macro levels (Lucendo-Moreno et al., 2020; Takieddine & Sun, 2015) that may be considered as new sources of digital divides and that deserve attention academically.

From this point of view and within the framework of the Digital Agenda for Europe, research on the use of internet banking at the regional level in the EU may be understood as a key topic that can help to identify possible existing disparities and divides within the European regions. Moreover,

the European Commission (2020) is currently preparing a new Digital Finance Strategy oriented to guarantee that the European consumers and the financial industry can benefit from the potential advantages of the digital transformation while reducing the possible new risks associated to the digital revolution. According to the European Commission, it is essential to overcome the fragmentation of the Single Market for digital financial services, in particular in the context of the COVID-19 pandemic. The coronavirus emergency that has led to lockdowns suffered by a great part of the population in Europe has evidenced the relevance of the digitalisation process of financial products and services.

In this context, analysis of internet banking in Europe could contribute to a better understanding of digital finance implementation in this geographical area. Although internet banking is on the rise in the European Union and more than half of the EU population is using online banking (European Banking Authority, 2019), there are still important divides among countries and regions (Eurostat, 2020). Nevertheless, the available academic evidence on internet banking in Europe is mainly at the country level (Blagoev & Shustova, 2019; Dumičić et al. 2015; Takieddine & Sun 2015) and is mostly devoted to explaining the cultural determinants of internet banking use. To our knowledge, there are only very few studies exploring internet banking adoption at the regional level in Europe (Lucendo-Monedero et al., 2020). The analysis of internet banking diffusion at the regional level could provide interesting insights into the usage of digital financial services in Europe from a comparative perspective.

The present research aims to fill this gap. In particular, the chapter analyses the situation of internet banking use in the European Union at the regional level from a geographical and socioeconomic perspective. Following this approach, the main purpose of this paper is twofold. First, we aim to classify the European regions into differentiated groups to create a taxonomy of regions according to their levels of internet banking use. Second, we are interested in defining the main regional technological and socioeconomic characteristics that explain the regional classification

obtained by identifying the decisive regional characteristics that might explain the use of internet banking among European regions. We contribute to the literature in various ways. First, our research provides a characterisation of the European regions in terms of internet banking adoption. Second, the study identifies the regional determinants that explain this taxonomy. Finally, the findings may contribute to a better understanding of the existent regional e-banking divides and the variety of technological and socioeconomic factors that may explain them in the case of the European regions.

2. Literature review and conceptual framework

Internet banking can be defined as a banking channel that allows customers to perform financial and non-financial services through a bank's website at a place and time of their choosing (Hoehle et al., 2012; Sharma et al., 2020). Following Takieddine and Sun (2015), online banking saves up to 40% of operational costs in comparison with offline banking. At the same time, banks may increase revenue not only by reducing operational costs but also by retaining actual customers and attracting new ones, while increasing customers' satisfaction and loyalty. Also, it could represent a source of competitive advantage throughout the differentiation of e-banking services. For customers, internet banking provides them flexible access to their latest financial information and aids with conducting financial transactions, making and scheduling payments, saving and investing money, checking account balances, printing statements, and finding other information related to accounts anytime, etc. But internet banking could cause some concern, too, mainly associated with security issues and the potential fast obsolescence of some e-banking tools and systems (ISPO, European Commission, 2001).

Given the importance of internet banking for both banks and customers, the academic literature has been mainly focused on analysis of the determinants of internet banking use from the perspective of banks and consumers' acceptance, usually using data for specific countries and world

regions. Takieddine and Sun (2015) and Keskar and Pandey (2018) provide useful reviews of the available empirical evidence at this level of analysis.

However, while these studies provide a better understanding of internet banking development at an individual level (a specific banking system or country), they do not provide a general picture at the regional or macro levels. The huge disparities in internet banking adoption in different contexts, such as those between developed versus developing countries (Takieddine & Sun, 2015; Yuen et al., 2010) motivate the interest to analyse the factors that explain those differences. This type of analysis would allow researchers to gain knowledge about internet banking diffusion and about the factors that may be associated with the disparities between countries and regions and, therefore, would help to identify the factors behind the e-banking use divide.

At the country level, very few studies analyse the situation in Europe. Dumičić et al. (2015) investigate the determinants of internet banking use for a sample of 28 European countries in 2011-12. Their results point to the role played by ICT infrastructure, mainly broadband and internet access. In a similar vein, Takieddine and Sun (2015) demonstrate for a group of 33 European countries in 2013 the role played by technological factors, especially internet access, to explain internet banking use. Internet access mediates, in turn, the impacts of socio-economic factors on internet banking usage. Blagoev and Sustova (2019), using a sample of 30 European countries in 2018, show the relevance of national culture differences in explaining internet banking diffusion. At the regional level, the available empirical evidence is even more scarce. Druhov et al. (2019) investigate financial innovation in Europe. To our knowledge, at the regional level in Europe, only Lucendo et al. (2019) take into account e-banking use to create an index to measure access and use of ICT in the European regions.

Following the analysis of the literature developed by Hoehle et al. (2012), we can find different theoretical approaches that have been used to frame internet banking diffusion, although all of them focus on customers' adoption. These approaches are the TAM (Technology Acceptance

Model) (Davis, 1989), the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003), and the Theory of Planned Behavior (TPB) (Ajzen, 1991). Among the theories that are not limited to the individual level of adoption, the Diffusion of Innovations (DOI) (Rogers, 1995) is the most known and applied at the national and regional levels. As this research refers to the regional level, and we cannot measure individuals' attitudes and behaviors or customers´ satisfaction, we argue that the best theoretical framework for understanding the differences in internet banking at the regional level is the DOI and heterogeneity models (Rosenberg, 1972)

According to Rogers (2003), social interactions affect an individual's perception of any technology use, including internet banking use. These social interactions are developed in a specific socioeconomic context where the individual lives. In this framework, heterogeneity models (Rosenberg, 1972) highlight the relevance of differences in social and economic features of users and countries to explain ICT diffusion (Kondo & Ishida, 2014). In this vein, empirical evidence about ICT diffusion has emphasised the relevance of economic and demographic regional features in internet diffusion (Lera-López et al., 2010; Vicente & López, 2006). Moreover, some authors argue that the process of technology diffusion is constrained by the economic structure and the country's economic development (Comín & Mestieri, 2014; Karshenas & Stoneman, 1995). These arguments justify the inclusion of some economic variables such as GDP, unemployment, and economic activity rates as well as the importance of the main economic sectors at the regional level. Besides, as a way to consider potential economic difficulties in people within regions, we have included in our analysis a particular indicator of economic and social poverty.

The literature review has also shown that the adoption of new technology is mainly constrained by appropriate infrastructure. In this case, the adoption of internet banking in Europe is closely associated with ICT infrastructure, mainly internet accessibility and internet speed (Dumičić et al., 2015, Takieddine & Sun, 2015). Following this previous evidence, we include internet use in our analysis because it is necessary for conducting internet banking.

Also, the DOI argues that the individual's degree of willingness to adopt innovations, in this case, internet banking, is mainly constrained by the individual's prior knowledge about this technology and its risk aversion. In this sense, because education level could play a significant role in internet banking diffusion, we take this variable into account in our empirical analysis. Similarly, young people have been more disposed to adopting new technologies than older people. Consequently, we have included two variables associated with the age groups of the population.

Last but not least, the academic evidence has shown that technology diffusion may be developed to a greater extent in urban areas that exhibit higher population density, where ICT infrastructure is expected to be high, and where technology knowledge could be more easily expanded (Schleife, 2010). We have included the population density variable to check these arguments.

To sum up, following the DOI theory, we develop a framework based on four types of variables (economic variables, economic specialisation in the main sectors, demographic variables, and education level) to explain internet banking use at the regional level in European countries. We also include internet use as a preliminary condition for using internet banking.

3. Data and Methodology

Our variable of analysis is internet banking use (IBU) in Europe. This variable is defined as the percentage of individuals between the ages of 16 and 74 using the internet for internet banking in the last 12 months. Unfortunately, there is no information about the frequency of internet banking use. The data related to IBU in our analysis correspond to regional information provided by Eurostat in its website's regional statistics category (Eurostat, 2020), specifically, the 2nd level of Eurostat Nomenclature d'Unité Territoriales Statistiques (NUTS2), excluding data from the UK, Polish, Greek, and German regions because no information about the NUTS2 level is provided. In these countries, regional data correspond to the NUTS1 level. The territory examined is finally composed of a total of 244 European regions belonging to 36 countries: the 27 EU countries plus Albania,

Iceland, Montenegro, North Macedonia, Norway, Serbia, Switzerland, United Kingdom, and Turkey. We will focus the analysis in 2019, the last year with available regional data for IBU, although we also analyse the evolution of IBU overtime at the country level from 2006, the first year with available IBU data.

In line with the aim of the research, we first create a taxonomy of the European regions according to their levels of IBU. Based on the frequency distribution of the variable, we cluster the European regions into three groups: regions with low, middle, and high penetration of IBU. The regional group membership is the qualitative outcome that is subsequently modeled by applying a multinomial logistic regression (MLR). Using the battery of variables described in the previous section, the econometric model allows us to identify the factors influencing the probability of belonging to one of the clusters. The probabilities in a multinomial logit model (Greene, 2012) are:

$$Prob(Y_i = j) = P_{ij} = \frac{\exp(x'_i\beta_j)}{1+\sum_{g=1}^{J}\exp(x'_i\beta_g)} \qquad (1)$$

where Y_i represents the value that indicates the qualitative response for the ith region and takes a discrete set of values reflecting J categories, $\boldsymbol{x}_i$ represents the vector that characterises the ith region, and $\boldsymbol{\beta}_j$ is the coefficient vector for the jth category of the dependent variable. The log-odds can be computed between any pair of alternatives. Taking h as the baseline category, the model consists of $J-1$ logits for the response variable to compare each categorical level to the reference category:

$$ln\left[\frac{P_{ij}}{P_{ih}}\right] = x'_i\beta_j \quad \text{when } j \neq h \qquad (2)$$

Therefore, the odds ratio for alternative j, P_{ij}/P_{ih}, will also depend on the h alternative used as the baseline category. The maximum-likelihood method was used to estimate the parameters of the model.

Regarding the potential variables influencing the probability of belonging to one of the clusters, and considering both the available academic literature and conceptual framework, we include the Gross Domestic Product at current market prices purchasing power standard per inhabitant (GDP) at the regional level. GDP explains to a great extent the variation in internet banking

use within European countries (Dumičić et al., 2015). Since we aim to develop a detailed analysis of the regional economic situation, we have considered other variables such as unemployment, economic activity rates, and the percentage of the regional population at risk of poverty or social exclusion (AROPE). The second group of variables captures regional economic specialisation, including regional percentages of employment in agriculture (agriculture, forestry, and fishing), industry (industry and construction), and services (Billon et al., 2017). Since demographic features and education levels are key determinants of internet banking use (see, e.g., Zagalaz Jiménez & Aguiar Díaz, 2019 for a recent literature review), we consider population density, the young-age dependency ratio (population aged 0-14 to population 15-64 years), the old-age dependency ratio (population 65 and over to population 15 to 64 years), and population with tertiary education. Finally, we have included internet use (IU), which measures the frequency of people who access the internet at least once a week. ICT use is a necessary condition for e-banking. All variables are taken from Eurostat for the year 2019 (Eurostat, 2020), with population density, GDP, and AROPE corresponding to 2018 due to a lack of 2019 data. Table 1 shows the main descriptive statistics for IBU and the set of demographic, educational, structural, economic, and internet-use indicators of regional ICT infrastructure.

Table 1. Main Descriptive Statistics

Variable	obs	Minimum	Maximum	Mean	Median	Std. Dev.	Variable Description
Internet banking use	244	2.000	97.000	56.529	60.000	23.544	Internet banking use. Users per 100 people (% of individuals aged 16 to 74)
Internet use	244	53.000	100.000	83.902	85.000	9.719	Frequency of internet access: once a week (including every day). Users per 100 people (% of individuals aged 16 to 74)
Education	243	11.700	59.600	31.842	31.700	10.500	Tertiary education (levels 5-8) (in %), age from 25 to 64 years. Percentage of individuals.
Density	244	3.400	7471.500	374.133	117.750	927.180	Population density. People per square kilometre
Young dependency	243	17.200	57.600	24.762	24.100	4.839	Young-age dependency ratio. Population aged 0-14 to population 15-64 years.
Old dependency	243	8.100	47.200	30.387	30.700	7.005	Old-age dependency ratio. Population 65 and over to population 15 to 64 years.
GDP	236	8.000	80.900	28.542	26.450	11.473	Gross domestic product at current market prices, purchasing power standard per inhabitant. Thousands of euro.
Unemployment	243	1.300	27.000	7.144	5.600	4.980	Unemployment rate, age 15 years or over, in %.
Economic Activity	243	39.800	81.200	58.068	58.100	6.349	Economic activity rate, age 15 years or over, in %.
AROPE	241	7.900	53.600	22.484	20.000	8.963	People at risk of poverty or social exclusion, in %.
Agriculture	243	0.000	45.428	5.490	3.087	7.395	People working in agriculture, forestry and fishing, percentage of individuals (over total employment).
Industry	243	0.000	48.463	23.386	22.525	8.167	People working in Industry and Construction, percentage of individuals (over total employment).
Services	243	34.003	91.873	69.808	71.105	10.596	People working in Service, percentage of individuals (over total employment).

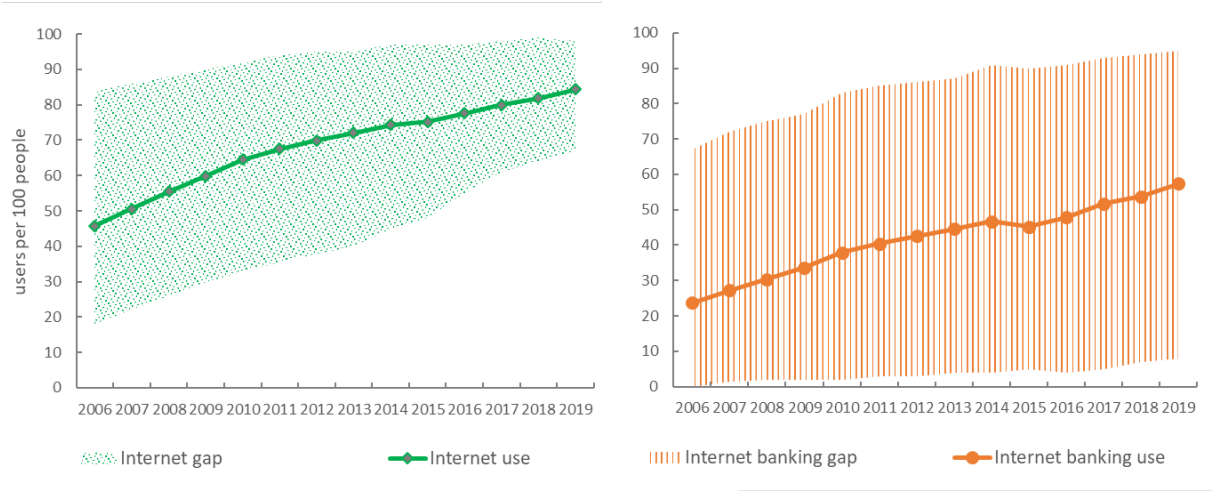
Note: All variables correspond to 2019, except for Density, GDP and AROPE that correspond to 2018.

4. Exploratory Analysis

In order to explore the relationship between internet banking use and ICT infrastructure, described in the literature review section, first we analyse the relationship between IBU and internet use in the period 2006-2019. This will show a parallel evolution, denoting a positive relationship. In a second step, we will consider the situation of IBU in the year 2019 at the regional level by country in Europe as a preliminary stage to establish a taxonomy of regions in 2019 according to their IBU.

4.1. Relationship Between Internet Use and Internet Banking Use

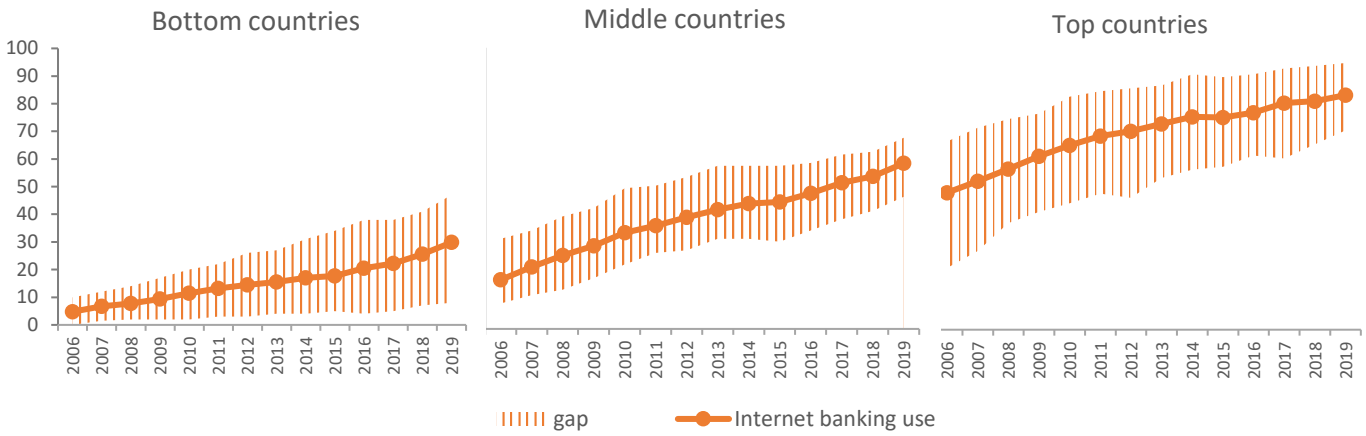
Figure 1 depicts the time evolution of the internet and internet banking penetration in Europe based on country-level data (NUTS0). Specifically, the sample corresponds to the 33 countries with data over the whole 2006-2019 period. Regional data for IBU is not available until 2011. The lines correspond to the European averages, while the shaded areas represent the gap of IU (left side) and IBU (right side) across countries over time. The gap depicts the difference between the countries with the largest and lowest use. An increasing, parallel evolution of IU and IBU is observed, which denotes a positive relationship between both variables. The results confirm the existing digital divide among European countries observed for other indicators, such as general internet use. Internet penetration has evolved towards convergence across countries: the divide evolves from 66 users in 2006 to 31 users in 2019. However, the IBU divide has only grown during the same period: from 67 users in 2006 to 87 users in 2019, confirming previous empirical evidence about the heterogeneity in internet banking adoption in European countries and regions (Dumičić et al., 2015; Lucendo et al., 2019).



Source: Author's own elaboration from Eurostat database

Figure 1. Evolution of Internet and Internet banking use, 2006-2019

Next, we divide the 33 countries into three groups according to their IBU level in 2019: bottom, middle, and top countries. The time evolution by group is depicted in Figure 2. The risen digital divide noticed in Figure 1 is mainly due to the bottom countries, the countries with the lowest IBU levels. For this group of countries, the gap has increased since 2006.



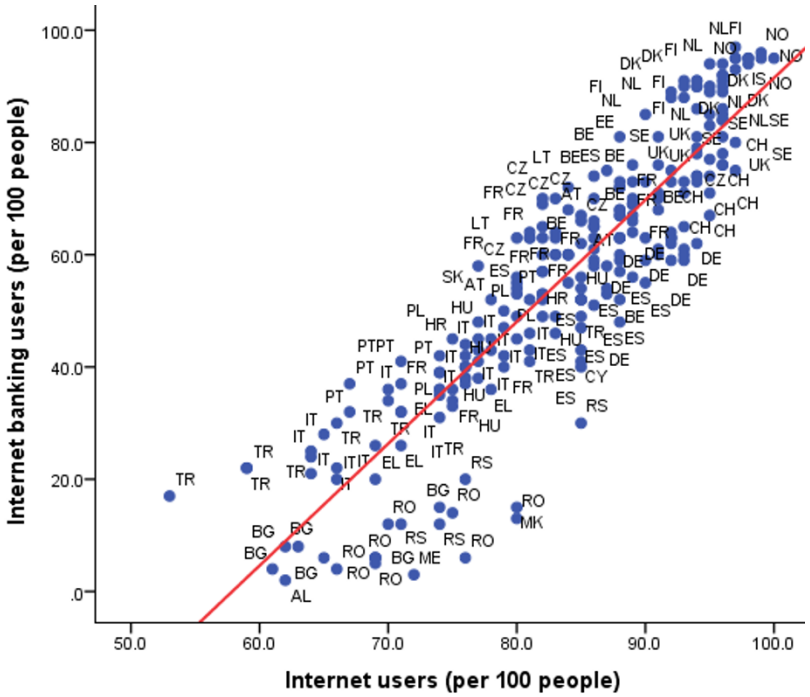
Source: Author's own elaboration from Eurostat database

Figure 2. Internet banking use by levels

The positive relationship between IU and IBU over time observed in Figure 1 is also noticed from a cross-section perspective. The scatterplot in Figure 3 depicts the 244 European regions with available data in 2019. There is a large, positive linear relationship between IBU

and IU (correlation coefficient equal to 0.897). There are some bivariate outliers, mostly located in regions with low IBU: Romania, Bulgaria, Macedonia, and Serbia show an IBU level below expected values given their internet penetration. Conversely, some Turkish regions have a relatively large level of IBU compared to that of IU.

Like Figure 1, the scatterplot in Figure 3 also denotes the larger divide in IBU compared to IU: from 2 IBU users in Albania to 97 users in the Norwegian Nord-Norge region (NO07). The IU gap is narrower: from 53 users in the Turkish Güneydogu Anadolu region (TRC) to 100 users in the Norwegian Agder og Rogaland region (NO04).



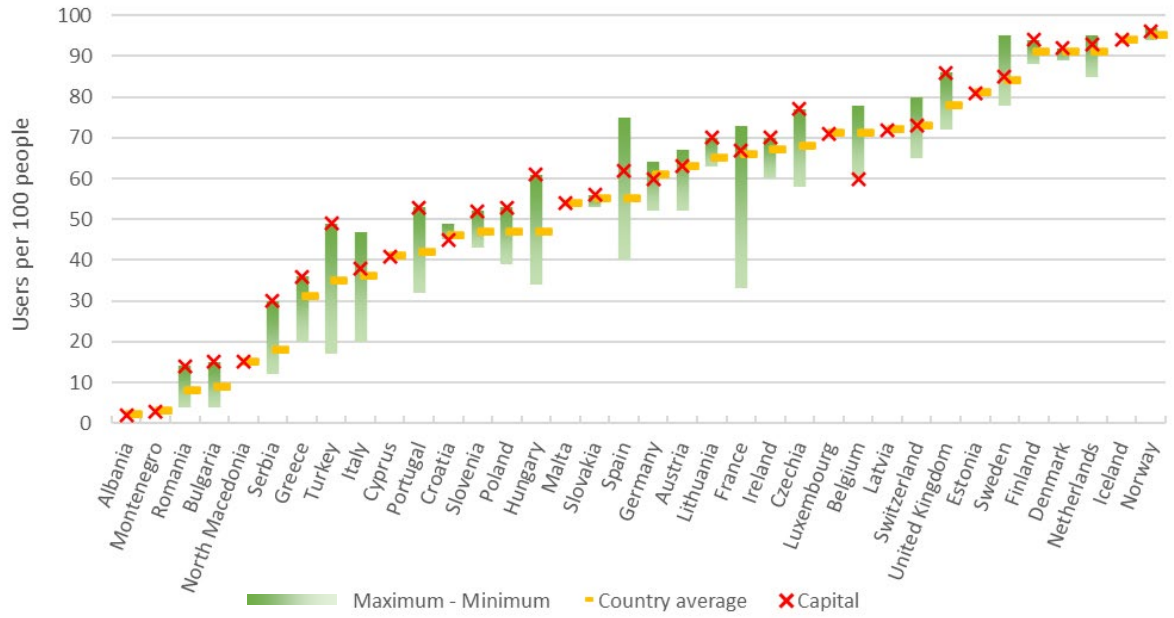
Source: Author's own elaboration from Eurostat database

Figure 3. Regional Internet use versus Internet banking use, 2019

4.2. Internet Banking Use by Countries

Figure 4 shows the average IBU level and the countries' divide for the 36 countries with available data in 2019. The maximum and minimum regional values within a country are depicted by the grey vertical bar, the country's average IBU is represented by the cross, and the

"x" depicts the region where the country's capital is located. In most cases, the IBU level in the capital region is above the country's average, except for the case of Belgium and Croatia.



Source: Author's own elaboration from Eurostat database

Figure 4. Internet banking use, European countries, 2019.

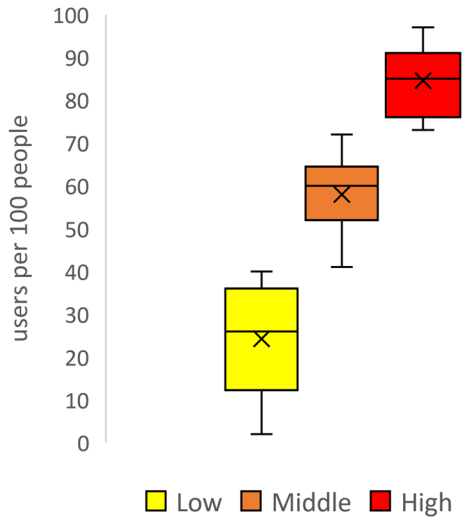
Again, it is noticeable that the IBU level observed in Europe practically covers all the potential 0 – 100 range: from 2 users in Albania to 97 users in the Norwegian Nord-Norge region (NO07). The length of the grey bar depicts the within-country IBU gap. The countries' divide seems related to their geographical extensions. The largest countries, such as France, Spain, Italy, or Turkey, show in turn larger IBU diversity.

4.3. Clustering the European Regions According to IBU Level

Finally, in this section, we develop the regional analysis to create a taxonomy of regions by considering rates of IBU. We cluster the European regions into three groups according to the quartiles of the IBU distribution in 2019. The first quartile groups the regions with the lowest IBU, where 40% or less of the population use e-banking. This cluster is named the low-

IBU group. In contrast, the fourth quartile clusters the top-IBU regions, those where more than 72% of people using internet banking. Finally, the regions with e-banking users ranging between 40% and 72% are grouped in the middle-IBU cluster, which captures the 50% central observations.

Figure 5 shows the boxplots and main descriptives for both the overall sample and by group. As in Figure 3, the lower the level of IBU, the larger their variability: the low-IBU group shows the largest standard deviation.

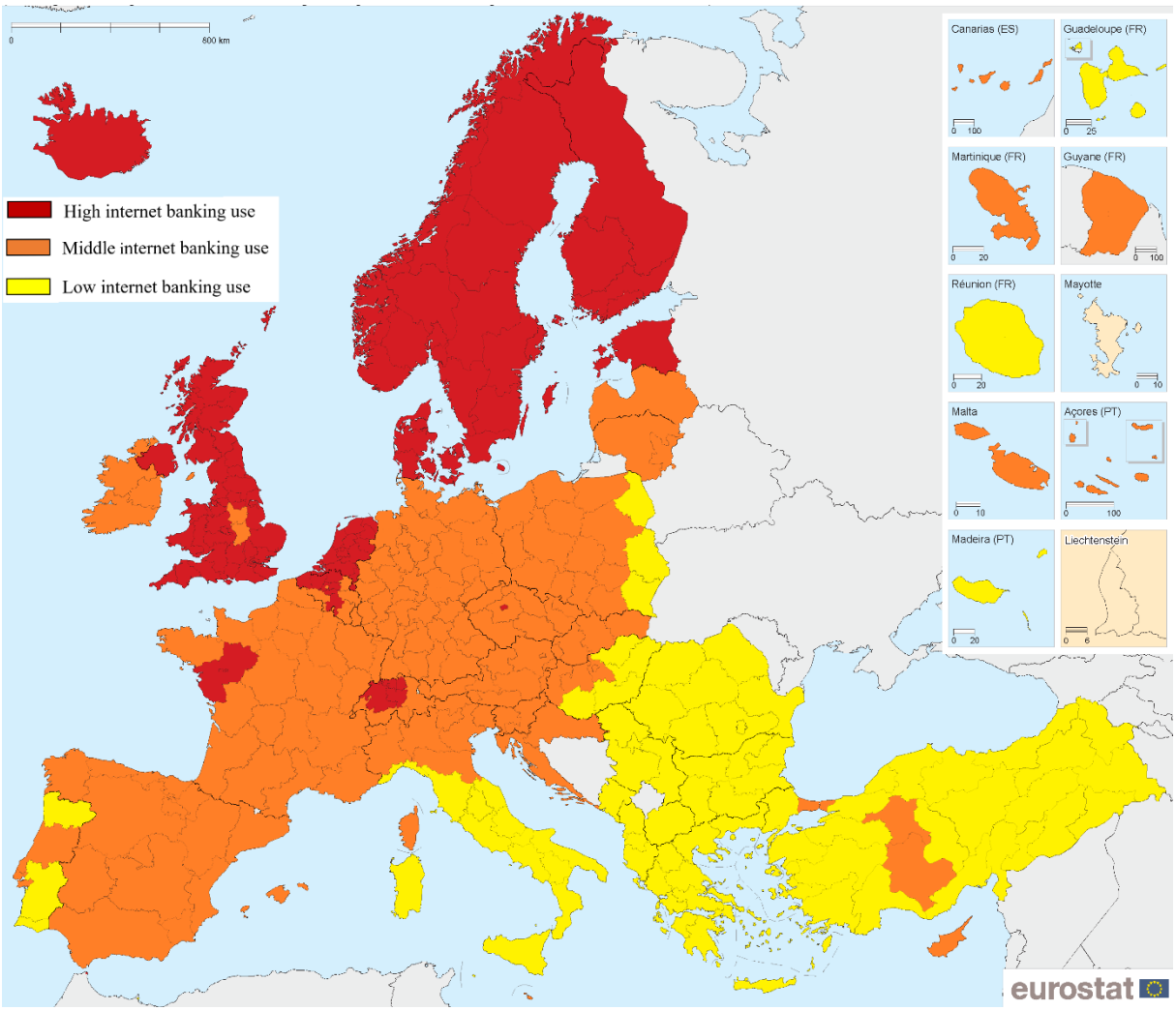


	n	Min	Max	Mean	Median	Std. Deviation
Low	60	2	40	24.267	26	12.644
Middle	121	41	72	57.942	60	8.785
High	63	73	97	84.540	85	7.915
Total	244	2	97	56.529	60	23.544

Source: Author's own elaboration from Eurostat database

Figure 5. Internet banking use by groups: boxplots and main descriptive statistics

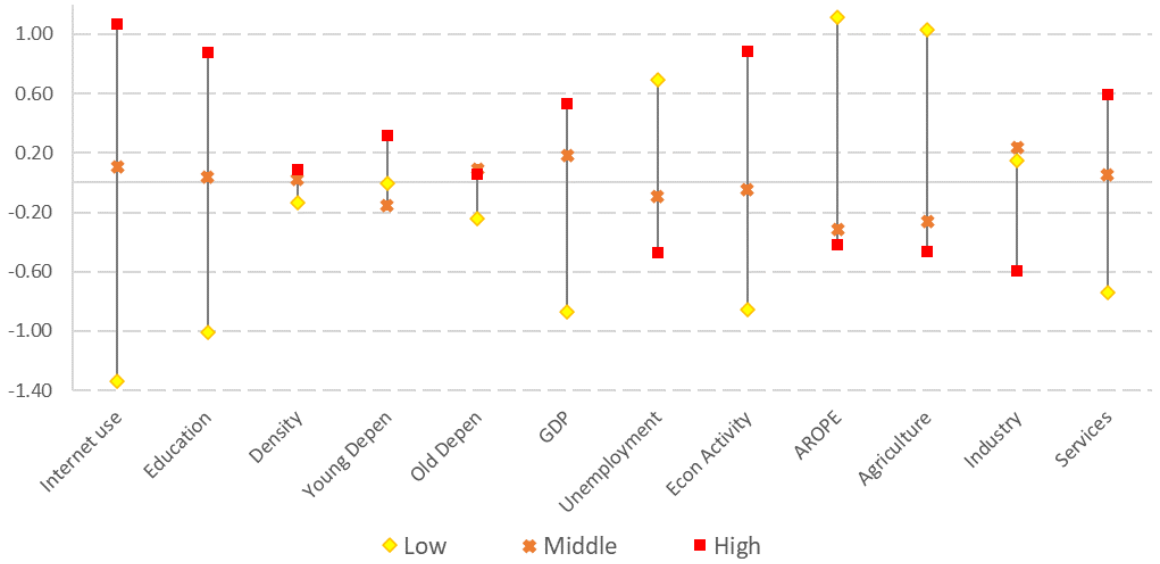
Figure 6 depicts the map of the European regions according to their IBU level. This map suggests east-west and north-south gaps in terms of IBU level, showing the highest level of IBU in the northern regions. The corresponding list of regions included in each cluster is available in Table A1 in the appendix.



Source: Author's own elaboration from Eurostat database

Figure 6. Map of European NUTs2 regions according to the level of Internet banking use

To explore the socio-economic differences across the three clusters defined by IBU level, Figure 7 depicts the cluster mean values for each indicator. Standardised values of the indicators are here represented to avoid the problem of comparison due to different units. As shown in Figure 7, the differences between means across clusters seem remarkable in the case of internet use, education, GDP, unemployment, economic activity rate, AROPE, agriculture, and service sectors.



Source: Author's own elaboration from Eurostat database

Figure 7. Average values of (standardized) socio-economic indicators by IBU cluster

Next, one-way analyses of variance (ANOVA) are carried out in order to statistically assess the differences of the demographic and socio-economic indicators across clusters that have been previously identified. In this bivariate analysis, the categorical factor is the three-cluster grouping that classifies the European regions into low, middle, and high IBU. The null hypothesis stands for no differences across the population group means. The ANOVA results are shown in Table 2.

Regarding the ANOVA outcomes, the regional level of IBU is related to all the considered indicators at the usual 5% significance level, except for population density and old dependency rate. Pairwise multiple comparisons point to the rejection of the null hypothesis due to significant differences between all pair groups in most indicators.

Table 2. One-way ANOVA results

Variables	*F*	*p*-value	Post hoc multiple comparisons
Internet users[a]	346.708	.000	L ≠ M ≠ H
Education	98.329	.000	L ≠ M ≠ H
Density	1.820	.442	-
Young dependency[a]	4.209	.018	M ≠ H
Old dependency[a]	2.301	.104	-
GDP[a]	55.369	.000	L ≠ M ≠ H
Unemployment[a]	24.517	.000	L ≠ M ≠ H
Economic activity[a]	67.019	.000	L ≠ M ≠ H
AROPE[a]	69.748	.000	L ≠ M ≠ H
Agriculture [a]	44.616	.000	L ≠ M ≠ H
Industry[a]	17.508	.000	L, M ≠ H
Services[a]	31.623	.000	L ≠ M ≠ H

Notes: *F* reports the *F*-ratio statistic testing the null hypothesis of equal means.

[a] *F* statistic reports the Brown-Forsythe robust test of equality of means for the indicators where the assumption of variance homoscedasticity is not accepted according to the Levene's statistic test (α =5%).

Pairwise multiple comparisons report the clusters pairs with significant mean differences at 5% significance level using the Bonferroni procedure. Tamhane's T2 procedure is used for those indicators ([a]) where variance homoscedasticity is not accepted.

5. Explicative Analysis with Multinomial Logistic Regression

After developing a taxonomy of European regions according to IBU, we determine the potential variables which explain this taxonomy of regions, considering the set of indicators described in our conceptual framework. We apply a multinomial logistic regression (MLR) where we have as dependent variable the regions' membership to one of the three clusters. The MLR model predicts the IBU cluster that a region is likely to belong to given the socio-economic indicators used to characterise it. Table 3 shows the parameter estimates for the MLR model. Regarding the explanatory variables, agriculture is removed from the explanatory set to avoid perfect multicollinearity in the model. Therefore, agriculture is the variable acting as a reference for the subset of economic sector weights: industry (including construction), services, and agriculture.

Concerning the model fitting, the Cox & Snell's and Nagelkerke's pseudo-R^2 values (0.695 and 0.796, respectively) point to the substantive significance of the model, as does the change in -2 Log-Likelihood *(-2LL*) that compares the model with only the intercept to the final model (χ^2_{20}= 277.01, p <.001). The low-IBU cluster is acting as the baseline category for the pair-comparisons in the multinomial model.

Table 3. Multinomial logistic regression: parameter estimates

				95% CI for *Exp(b)*	
Variables	*b*	Std. Error	*Exp(b)*	Lower bound	Upper bound
Middle- versus Low-banking use					
Education	0.152	(0.048)***	1.164	1.060	1.278
Density	0.001	(0.000)	1.000	0.999	1.000
Young dependency	0.120	(0.076)	1.128	0.971	1.310
Old dependency	0.023	(0.053)	1.024	0.923	1.136
GDP	0.093	(0.049)*	1.097	0.996	1.208
Unemployment	0.061	(0.080)	1.062	0.908	1.243
Economic activity	0.184	(0.083)**	1.202	1.022	1.415
AROPE	-0.079	(0.043)*	0.924	0.850	1.006
Industry[a]	0.149	(0.067)**	1.149	1.007	1.310
Services[a]	0.063	(0.064)	1.065	0.940	1.207
Intercept	-25.655	(9.176)***			
High- versus Low-banking use					
Education	0.235	(0.061)***	1.264	1.121	1.426
Density	0.001	(0.000)	1.000	0.999	1.000
Young dependency	0.462	(0.117)***	1.587	1.261	1.998
Old dependency	0.232	(0.081)***	1.261	1.076	1.478
GDP	0.040	(0.059)	1.040	0.927	1.168
Unemployment	-0.254	(0.146)*	0.776	0.582	1.034
Economic activity	0.436	(0.113)***	1.547	1.240	1.930
AROPE	-0.030	(0.073)	0.970	0.841	1.119
Industry[a]	-0.142	(0.090)	0.867	0.727	1.035
Services[a]	0.005	(0.075)	1.005	0.868	1.163
Intercept	-46.804	(13.040)***			

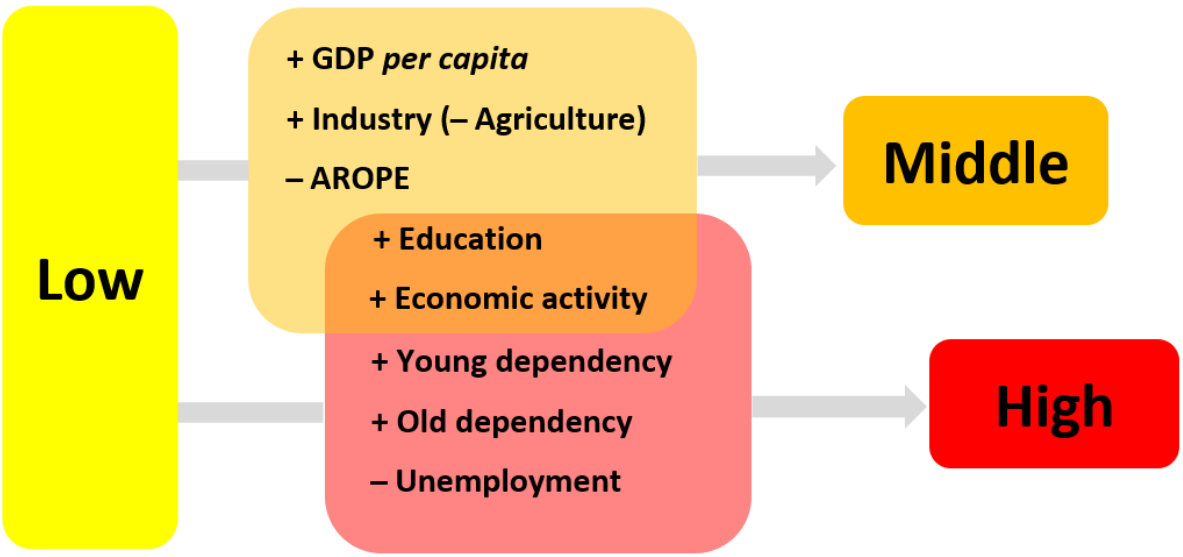
Note: -2*LL* model change χ^2_{20}= 277.010, p <.001; Pseudo R^2 = 0.695 (Cox & Snell), 0.796 (Nagelkerke).
[a] Agriculture is the reference variable for the economic sectors set (Industry, Service and Agriculture).
***, ** and * denote significance at 1% (p<0.01), 5% (p<0.05) and 10% (p<0.10), respectively.

Tertiary education, economic activity, economic structure, GDP *per capita* and AROPE rate help to predict whether a region belongs to the middle-banking or low-banking group (top panel, Table 3). An odds ratio, *Exp(b)*, statistically greater than 1 means that as the indicator increases, the odds of a region having middle-banking (rather than low-banking) use increase.

Specifically, a 1 percentage rise in the proportion of tertiary educated people increases by 1.164 the odds of being a middle-banking rather than low-banking region. Raising the weight of industry-construction sector by 1 percentage point (to the detriment of agriculture sector, its base variable) also increases the odds of being a middle-banking region (odds rate 1.149). The same applies to the economic activity rate (odds rate 1.202) and GDP *per capita* (odds rate 1.097). However, a larger AROPE rate decreases the chance to be a middle-banking region (odds rate 0.924). In short, the larger the tertiary education rate, the economic activity rate, the industry weight, the GDP *per capita*, and the lower the AROPE rate, the more likely a region is to be classified as a middle-banking rather than a low-banking region.

The second panel of Table 3 shows the odds between the high and the low IBU groups. An increase in tertiary education (odds rate 1.264), young dependency rate (1.587), old dependency rate (1.261), and economic activity (1.547) helps to generate a switch from the low-baking to the high-banking cluster, while a rise in unemployment would decrease the odds of being a high e-banking in favour of low e-banking region (odds rates 0.776). Population density and size of services, although with the expected sign, are not statistically significant to explain the probability of belonging to any of the IBU clusters in the MLR model.

Figure 8 summarises these results and highlights the heterogeneity of European regions regarding the determinants of IBU.



Source: Author's own elaboration

Figure 8. Summary of results

Finally, we introduce internet use as explanatory variable in the MLR model together with the previous explanatory set of variables (economic level and structure specialisation, demographic variables, and education level). Table 4 shows these new results. The IU variable is strongly significant in explaining the region's membership to the high- and the middle-banking clusters. Nevertheless, the presence of IU in the model diminishes the influence of some of the variables that were previously statistically significant (model in Table 3). For example, the inclusion of IU reduces the direct influence that education, GDP, economic activity or unemployment would exert on IBU. These variables would be partially absorbing the influence of IU when this variable is not considered directly under analysis.

Table 4. Multinomial logistic regression including Internet users

Variables	*b*	Std. Error	*Exp(b)*	95% CI for *Exp(b)* Lower bound	Upper bound
Middle- versus Low-banking use					
Internet users	0.604	(0.137)***	1.830	1.400	2.393
Education	0.018	(0.059)	1.018	0.907	1.143
Density	0.001	(0.000)	1.000	0.999	1.000
Young dependency	0.110	(0.149)	1.117	0.834	1.495
Old dependency	0.018	(0.090)	1.019	0.854	1.215
GDP	0.095	(0.062)	1.099	0.974	1.241
Unemployment	0.033	(0.117)	1.033	0.821	1.301
Economic activity	0.124	(0.114)	1.132	0.905	1.415
AROPE	-0.130	(0.071)*	0.878	0.764	1.009
Industry[a]	-0.029	(0.109)	0.972	0.785	1.203
Services[a]	-0.079	(0.108)	0.924	0.749	1.141
Intercept	-54.858	(17.344)***			
High- versus Low-banking use					
Internet users	1.465	(0.250)***	4.326	2.653	7.056
Education	0.126	(0.094)	1.134	0.944	1.364
Density	0.001	(0.001)	1.000	0.998	1.001
Young dependency	0.573	(0.217)***	1.773	1.159	2.714
Old dependency	0.123	(0.131)	1.131	0.875	1.462
GDP	-0.016	(0.078)	0.984	0.845	1.147
Unemployment	-0.330	(0.212)	0.719	0.474	1.090
Economic activity	0.206	(0.160)	1.229	0.898	1.681
AROPE	0.131	(0.134)	1.140	0.877	1.482
Industry[a]	-0.271	(0.184)	0.763	0.532	1.093
Services[a]	0.208	(0.125)*	1.231	0.964	1.573
Intercept	-130.39	(29.207)***			

Note: -2*LL* model change χ^2_{22}= 381.003, p <.001; Pseudo R^2 = 0.805 (Cox & Snell), 0.921 (Nagelkerke).
[a] Agriculture is the reference variable for the economic sectors set (Industry, Service and Agriculture).
***, ** and * denote significance at 1% (p<0.01), 5% (p<0.05) and 10% (p<0.10), respectively.

6. Conclusions and Discussion

This research analyses IBU in the European Union at the regional level from a geographical and socio-economic perspective. First, we have classified European regions into three different groups to create a taxonomy of regions according to their levels of IBU. At first glance, the results show a great disparity in IBU at the regional level, confirming previous evidence at the national and regional levels among EU countries (e.g., Dumičić et al., 2015; Lucendo et al., 2019). Particularly, these disparities are higher among the regions with a lower adoption rate than in the other two groups of EU regions. This low-banking group of regions is

composed of 60 regions, mainly belonging to Eastern countries, such as Bulgary, Romania, Hungary, Turkey, and some southern countries like Portugal, Greece, and Italy. In contrast, the regions with the highest use of internet banking are 63 regions, mainly belonging to the North of Europe (Norway, Finland, Denmark, and Sweden), The Netherlands, Belgium, and the UK. Our results also suggest east-west and north-south gaps in terms of IBU level, showing the highest level of IBU in the northern regions.

Second, we have defined the main socio-economic characteristics that explain the previous regional classification obtained by identifying the decisive regional features that might explain the different levels of e-banking use among European regions. We have found that education and economic variables such as economic activity rate are the main factors associated with more intense use of internet banking in European regions, confirming previous empirical evidence of adoption of internet banking among EU countries (Dumičić et al., 2015; Zagalaz Jiménez & Aguiar Díaz, 2019). For example, increasing GDP *per capita* and reducing the AROPE rate or the size of agriculture in favour of the industry sector are factors that might help low-internet banking regions to become middle-banking regions. Meanwhile, larger young and old dependency rate (demographic variables) and less unemployment are the key factors that support a "big jump" from the low- to the high-banking group. Finally, internet use plays a key role in explaining IBU among European regions, also confirming the previous evidence in Europe (Dumičić et al., 2015; Takieddine & Sun, 2015). Accounting for internet use leads to diminished direct influence of some indicators such as the economic ones and education levels.

Our empirical results can be put into the context of the DOI theory and heterogeneity models, emphasising the relevance of a set of economic, demographic, and social features to explain IBU at the regional level in European countries. Also, this research shows how the adoption of internet banking in Europe is closely associated with internet use.

The results of this research can lead to important implications for policy-makers in order to reduce the heterogeneity in IBU by European citizens at the regional level. In order to facilitate and develop IBU in Europe, emphasis should be put on promoting education and internet skills among the population and boosting economic development. In that way, by providing an economically favourable environment for IBU, the banking sector and financial development should be enhanced. This might be positively affected by rising ICT adoption, which seems to have a positive impact on economic development and structural shifts in European economies (Lechman & Marszk, 2019). Also, any progress in internet use seems to have a direct and positive impact on IBU. At the same time, any increase in internet banking adoption, in a context of a multi-channel strategy, could boost a greater share from the market (Nazaritehrani & Mashali, 2020) and improve the efficiency and effectiveness of financial services (Mahmoodi & Naderi, 2016). In this way, a reduction of heterogeneity in IBU at the regional level, shown in our results, could be useful to overcome the fragmentation of the European Single Market in digital financial services.

This research presents some limitations; one of the main ones is the lack of information at the regional level in Eurostat. Information about the frequency of IBU and some aspects of ICT infrastructure, such as internet speed or internet security, is not available at the regional level in the EU. In addition, financial services literature has mainly focused on internet banking. In the future, it should be of interest to apply a multi-focus approach to consider different online channels (internet, mobile apps, etc.) to explain digital banking diffusion in Europe. This approach might offer interesting and useful implications in the context of the new digital finance strategy in Europe.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*, 170-211.

Aktan, B., Teker, E., & Ersoy, P. (2009). Changing face of banks and the evaluation of internet banking in Turkey. *Journal of Internet Banking and Commerce*, *14*, 1–11.

Asongu, S., & Nwachukwu, J. (2019). ICT, financial sector development and financial access. *Journal of the Knowledge Economy, 10*, 465-490.

Billon, M., Marco, R., & Lera-Lopez, F. (2017). Innovation and ICT use by firms and households in the EU: A multivariate analysis of regional disparities. *Information Technology & People*, *30*, 424-448.

Blagoev, V., & Shustova, E. (2019). The national culture effect on the adoption of Internet-banking. *Economic Studies Journal, 28*(6), 19-38.

Comín, D., & Mestieri, M. (2014). "Technology diffusion: Measurement, Causes and Consequences". In Aghion, P. & Durlauf, S. (Eds.): *Handbook of Economic Growth*, Volume 2, chapter 2, pp. 565-622. The Netherlands: Elsevier.

Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319-339.

Dumičić, K., Časni, A. Č., & Palić, I. (2015). Multivariate analysis of determinants of Internet banking use in European Union countries. *Central European Journal of Operations Research*, *23*(3), 563-578.

European Banking Authority (2019). *Consumer Trend Report 2018-2019*. Retrieved 18th August 2020 from https://eba.europa.eu/eba-publishes-consumer-trends-report-for-2018-19.

European Commission (2020). *Consultation on a new digital finance strategy for Europe*. Retrieved 15th September 2020 from https://ec.europa.eu/info/consultations/finance-2020-digital-finance-strategy_en

Eurostat (2020). *Database.* Retrieved 22th May 2020 from https://ec.europa.eu/eurostat/data/database.

Greene, W.H. (2012). *Econometric Analysis.* 7th ed. New Jersey: Prentice Hall.

Hoehle, H., Scornavacca, E., & Huff, S. (2012). Three decades of research on consumer adoption and utilization of electronic banking channels: A literature analysis. *Decision Support Systems, 54*, 122-132.

ISPO, European Commission (2001). “Internet Banking in Europe”. In SCN Education BV-(Ed.) *Electronic Banking*, pp 53-65. Berlin: Springer.

Karshenas, M., & Stoneman, P. (1995). "Tecnological diffusion". In Stonemann, P. (Ed.). *Handbook of the Economics of Innovation and Tecnological Change*, pp- 265-297. Oxford: Blackwell.

Keskar, M., & Pandey, N. (2018). Internet banking: a review (2002-2016). *Journal of Internet Commerce, 17*(3), 310-323.

Kondo, F., & Ishida, H. (2014). A cross-national analysis of intention to use multiple mobile entertainment services. *Journal of Global Information Technology Management, 17*, 45–60.

Lechman, E., & Marszk, A. (2019). *ICT-Driven Economic and Financial Development. Analyses of European Countries*. London, Academic Press.

Lera-Lopez, F., Billon, M., & Gil, M. (2010). Determinants of internet use in Spain. *Economics of Innovation and New Technology, 20*, 127–152.

Lucendo-Monedero, A. L., Ruiz-Rodríguez, F., & González-Relaño, R. (2019). Measuring the digital divide at regional level. A spatial analysis of the inequalities in digital development of households and individuals in Europe. *Telematics and Informatics*, *41*, 197-217.

Mahmoodi, S., & Naderi, H. (2016). Assessment of modern banking services to achieve and realization of E-commerce and its impact on the profitability of banks listed on the Tehran stock exchange. *Modern Applied Science, 10(*9), 263-273.

Marszk, A., & Lechman, E. (2019). New technologies and diffusion of innovative financial products: Evidence on exchange-traded funds in selected emerging and developed countries. *Journal of Macroeconomics, 62*, 1-29.

Nazaritehrani, A., & Mashali, B. (2020). Development of E-banking channels and market share in developing countries. *Financial Innovation, 6* (12), 1-19.

Rogers, E. (2003). *Diffusion of Innovations*. 5th ed.New York: The Free Press.

Rosenberg, N. (1972). Factors affecting the diffusion of technology. *Explorations in Economic History, 10*, 3–33.

Sadigov, S., Vasilyeva, T., & Rubanov, P. (2020). Fintech in Economic Growth: Cross-country analysis. *Economic and Social Development: Book of Proceedings*, 729-739.

Schleife, K. (2010). What really matters: Regional versus individual determinants of the digital. *Research Policy, 39,* 173–185.

Sharma, R., Singh, G., & Sharma, S. (2020). Modelling internet banking adoption in Fiji: A developing country perspective. *International Journal of Information Management, 53*, 102116.

Takieddine, S., & Sun, J. (2015). Internet banking diffusion: A country-level analysis. *Electronic Commerce Research and Applications, 14*, 361-371.

Venkatesh, V. Morris, M.G., Davis, G.B., & Davis, F.D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425-478.

Vicente, M. R., & López, A. J. (2006). Patterns of ICT diffusion across the European Union. *Economic Letters, 93*, 45-51.

Yuen, Y., Yeow, P., Lim, N. & Saylani, N. (2010). Internet Banking Adoption: Comparing Developed and Developing Countries. *Journal of Computer Information Systems, 51*(1), 52-61.

Zagalaz Jiménez, J.R. & Aguiar Díaz, I. (2019). Educational level and Internet banking. *Journal of Behavioral and Experimental Finance, 22*, 31-40.

Appendix

Table A1. Regional classification according to the Internet banking use

Cluster 1: Low internet-banking use

AL - Albania	RO11 - Nord-Vest	ITG1 - Sicilia	ITI2 - Umbria
ME - Montenegro	RO32 - Bucuresti - Ilfov	ITF2 - Molise	PT20 - Região Autónoma dos Açores (PT)
BG42 - Yuzhen tsentralen	BG41 - Yugozapaden	RS11 - Beogradski region SERBIA	FRY4 - La Réunion
RO22 - Sud-Est	MK - North Macedonia	TR8 - Bati Karadeniz	ITI3 - Marche
RO31 - Sud - Muntenia	TRC - Güneydogu Anadolu	TR7 - Orta Anadolu	PT11 - Norte
BG32 - Severen tsentralen	EL6 - Kentriki Ellada	ITF1 - Abruzzo	HU23 - Dél-Dunántúl
BG33 - Severoiztochen	ITF5 - Basilicata	PT18 - Alentejo	ITI4 - Lazio
RO21 - Nord-Est	RS12 - Region Vojvodine	TR6 - Akdeniz	TR4 - Dogu Marmara
RO41 - Sud-Vest Oltenia	ITF6 - Calabria	FRY1 - Guadeloupe	PL8 - Makroregion Wschodni
RO42 - Vest	ITF3 - Campania	HU31 - Észak-Magyarország	PT15 - Algarve
BG31 - Severozapaden	TRA - Kuzeydogu Anadolu	TR2 - Bati Marmara	ES64 - Ciudad Autónoma de Melilla (ES)
BG34 - Yugoiztochen	TRB - Ortadogu Anadolu	TR3 - Ege	HU32 - Észak-Alföld
RO12 - Centru	TR9 - Dogu Karadeniz	EL3 - Attiki	HU33 - Dél-Alföld
RS21 - Region Sumadije i Zapadne Srbije	ITF4 - Puglia	EL5 - Voreia Ellada	ITC3 - Liguria
RS22 - Region Juzne i Istocne Srbije	EL4 - Nisia Aigaiou, Kriti	ITG2 - Sardegna	ITI1 - Toscana

Cluster 2: Middle internet-banking use

CY00 - Kypros	ES12 - Principado de Asturias	DE3 - Berlin	FRE1 - Nord-Pas-de-Calais
ITC1 - Piemonte	ES23 - La Rioja	ES51 - Cataluña	FRI2 - Limousin
PT16 - Centro (PT)	PL5 - Makroregion Poludniowo-Zachodni	FRD2 - Haute-Normandie	CZ03 - Jihozápad
TR5 - Bati Anadolu	SI04 - Zahodna Slovenija	FRF1 - Alsace	FRE2 - Picardie
FRY3 - Guyane	ES52 - Comunidad Valenciana	FRJ1 - Languedoc-Roussillon	FRL0 - Provence-Alpes-Côte d'Azur
ITH3 - Veneto	PL9 - Makroregion Województwo Mazowieckie	IE04 - Northern and Western	AT31 - Oberösterreich
PT30 - Região Autónoma da Madeira (PT)	PT17 - Área Metropolitana de Lisboa	DE7 - Hessen	AT33 - Tirol
ES43 - Extremadura	SK04 - Východné Slovensko	ES22 - Comunidad Foral de Navarra	CH01 - Région lémanique
ITH5 - Emilia-Romagna	DED - Sachsen	HU11 - Budapest	FR10 - Île de France
PL7 - Makroregion Centralny	ES11 - Galicia	DE9 - Niedersachsen	IE05 - Southern
SI03 - Vzhodna Slovenija	MT00 - Malta	ES30 - Comunidad de Madrid	BE33 - Prov. Liège
ITC2 - Valle d'Aosta/Vallée d'Aoste	ES53 - Illes Balears	FRB0 - Centre - Val de Loire	BE34 - Prov. Luxembourg (BE)
HR04 - Kontinentalna Hrvatska	SK02 - Západné Slovensko	AT12 - Niederösterreich	CZ08 - Moravskoslezsko
ITH1 - Provincia Autonoma di Bolzano/Bozen	SK03 - Stredné Slovensko	AT13 - Wien	FRH0 - Bretagne
ITH4 - Friuli-Venezia Giulia	ES24 - Aragón	AT34 - Vorarlberg	CZ02 - Strední Cechy
PL4 - Makroregion Pólnocno-Zachodni	HU21 - Közép-Dunántúl	BE32 - Prov. Hainaut	CZ06 - Jihovýchod
ES42 - Castilla-la Mancha	SK01 - Bratislavský kraj	DEA - Nordrhein-Westfalen	FRK2 - Rhône-Alpes
ITH2 - Provincia Autonoma di Trento	DEG - Thüringen	DEB - Rheinland-Pfalz	CZ05 - Severovýchod
ES41 - Castilla y León	FRD1 - Basse-Normandie	DEE - Sachsen-Anhalt	FRI3 - Poitou-Charentes

ITC4 - Lombardia	FRY2 - Martinique	DEF - Schleswig-Holstein	FRJ2 - Midi-Pyrénées
ES62 - Región de Murcia	CZ04 - Severozápad	FRC2 - Franche-Comté	IE06 - Eastern and Midland
HU22 - Nyugat-Dunántúl	ES13 - Cantabria	FRF3 - Lorraine	LT01 - Sostines regionas
HR03 - Jadranska Hrvatska	ES70 - Canarias (ES)	FRK1 - Auvergne	BE22 - Prov. Limburg (BE)
HU12 - Pest	AT32 - Salzburg	FRM0 - Corse	CH05 - Ostschweiz
PL6 - Makroregion Pólnocny	DE1 - Baden-Württemberg	LT02 - Vidurio ir vakaru Lietuvos regionas	LU - Luxembourg
TR1 - Istanbul	DE5 - Bremen	CZ07 - Strední Morava	FRI1 - Aquitaine
PL2 - Makroregion Poludniowy	DE6 - Hamburg	DE2 - Bayern	LV - Latvia
ES61 - Andalucía	ES21 - País Vasco	DEC - Saarland	UKF - East Midlands (UK)
AT11 - Burgenland (AT)	AT21 - Kärnten	FRF2 - Champagne-Ardenne	
DE4 - Brandenburg	AT22 - Steiermark	CH07 - Ticino	
DE8 - Mecklenburg-Vorpommern	BE10 - Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest	FRC1 - Bourgogne	

Cluster 3: High internet-banking use

BE23 - Prov. Oost-Vlaanderen	UKC - North East (UK)	NL12 - Friesland (NL)	NL33 - Zuid-Holland
BE31 - Prov. Brabant wallon	CZ01 - Praha	UKI - London	DK01 - Hovedstaden
CH02 - Espace Mittelland	BE24 - Prov. Vlaams-Brabant	FI1D - Pohjois- ja Itä-Suomi	DK04 - Midtjylland
CH06 - Zentralschweiz	SE32 - Mellersta Norrland	NL34 - Zeeland	NL32 - Noord-Holland
FRG0 - Pays-de-la-Loire	UKM - Scotland	DK03 - Syddanmark	FI1B - Helsinki-Uusimaa
UKL - Wales	CH04 - Zürich	FI19 - Länsi-Suomi	IS - Iceland
BE35 - Prov. Namur	EE00 - Eesti	NL41 - Noord-Brabant	NO06 - Trøndelag
UKD - North West (UK)	SE22 - Sydsverige	DK02 - Sjælland	NL31 - Utrecht
UKE - Yorkshire and The Humber	SE31 - Norra Mellansverige	FI1C - Etelä-Suomi	NO02 - Hedmark og Oppland
UKG - West Midlands (UK)	UKK - South West (UK)	NL21 - Overijssel	NO03 - Sør-Østlandet
ES63 - Ciudad Autónoma de Ceuta (ES)	SE21 - Småland med öarna	NL22 - Gelderland	NO04 - Agder og Rogaland
UKJ - South East (UK)	SE23 - Västsverige	NL23 - Flevoland	NO05 - Vestlandet
UKN - Northern Ireland (UK)	UKH - East of England	NL42 - Limburg (NL)	SE33 - Övre Norrland
BE21 - Prov. Antwerpen	NL11 - Groningen	DK05 - Nordjylland	NO01 - Oslo og Akershus
BE25 - Prov. West-Vlaanderen	SE11 - Stockholm	FI20 - Åland	NO07 - Nord-Norge
CH03 - Nordwestschweiz	SE12 - Östra Mellansverige	NL13 - Drenthe	