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The impact of FinTech innovation on digital financial literacy in Europe: Insights from the banking industry

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ABSTRACT

Within the evolving financial industry, characterised by the proliferation of FinTech and exacerbated by the Covid-19 , this paper investigates the unexplored relationship between financial, social, infrastructural factors and the level of digital financial divide (DFD) in Europe. Applying a difference-in-difference model, the study reveals that innovation in financial services correlates with a reduced DFD, further reinforced by improved digital infrastructure and social progress. However, the post-Covid environment has widened the gap in EU financially illiterate regions. Our results hold relevance for policymakers, governments, and supervisory banking authorities, indicating the most effective areas for intervention in lowering the country's DFD, but they could also support banks in the design of tailor-made digitalization strategies.

1. Introduction

The advent of digital technologies has significantly transformed the financial industry, introducing novel products, services, and operators (BIS, 2018). The transition towards a digital economy, accelerated by the Covid-19 outbreak, has altered the traditional mechanisms of financial transactions and underscored the need for individuals to acquire digital financial literacy (DFL) to navigate this evolving industry effectively. The OECD (2022) defines DFL as the skills required to use financial products and services through digital channels. In the face of a rapidly changing global financial environment, exogenous factors such as the rise of FinTech and the Covid-19 pandemic have pushed banks to accelerate their digital transformation strategies. These challenges underline the importance of ensuring financial inclusion and digital safety for customers (EBA, 2018; BIS, 2021). Policymakers and public authorities need to fully understand the benefits and risks associated with the widespread adoption of digital financial technologies to assess their impact on customers and businesses (OECD, 2018a).

Although digitalization processes have strongly impacted the banking industry, the efficiency of intermediaries' digital banking strategies relies on customers' ability to use new products, services, and technologies. Meanwhile, the lack of digital skills among the population may hinder the effectiveness of the banking digitisation strategy (Sun et al., 2020). Exogenous events, such as the Covid-19 pandemic, have also highlighted the importance of improving knowledge and skills in using digital banking tools. As a result, the familiar concept of financial literacy (FL) has evolved into digital financial literacy (DFL), which refers to people's ability to use digital

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devices and tools to conduct safe and sound e-banking transactions.

To improve customers' financial and digital resilience, several international institutions have promoted and implemented several financial education programmes, including the "Organisation for Economic Co-operation and Development's Recommendation on Financial Literacy" (OECD, 2022), the "Action Plan for Capital Market Union" (CMU) and the "Digital Finance Strategy" (EC, 2020a, 2020b). On the digital side, the European Commission has launched a regular monitoring of citizens' digital skills through the "Digital Economy and Society Index" (DESI) (EC, 2022). The main objective of this monitoring activity is to create a European ecosystem capable of competing with other countries in the field of digitalisation and financial inclusion.

Although regulators and banking industry stakeholders have recognised the importance of monitoring and improving the level of digital financial literacy (DFL) among the population, the existing literature provides limited empirical evidence on the socio-economic determinants of the digital and financial gap across countries (e.g., Demoussis and Giannakopoulos, 2006). In particular, there is a lack of cross-country empirical analyses that can provide a comparative mapping of the distribution of digital and financial literacy levels across European countries (Dasgupta et al., 2001; Nicolini et al., 2013; Lyons et al., 2022). Some of the existing studies have focused on the financial dimension, studying the benefits linked to better FL degree among people (Van Rooij et al., 2011; Lusardi and Mitchell, 2014), such as the potential to facilitate the adoption of financial technology (FinTech) services or to promote financial inclusion (Lyons et al., 2022; Murshed et al., 2023). Instead, other scholars have focused on the digital dimension, examining the social and/or structural factors that affect the cross-country digital divide (Demoussis and Giannakopoulos, 2006; Yartey, 2008).

In contrast to these consolidated literature streams, this research contributes to the emerging body of studies examining the relationship between the digital financial divide (DFD) and technological advances in the financial system (Setiawan et al., 2022; Prete, 2022; Koskelainen et al., 2023). From this perspective, the study aims to investigate the impact of financial, social, and infrastructural factors on this relationship, considering the exogenous shock of the Covid pandemic. In previous studies, we may also encounter unobserved factors by differentiating the results according to 'financially literate' or 'financially illiterate' countries.

From a theoretical perspective, we recall the four principles described in Technology Acceptance Model (TAM) (Davis, 1989). Our empirical analysis is supported by a comprehensive conceptual model that summarizes and interrelates all the elements under investigation. Our framework encompasses and clarifies the different influencing factors contributing to the DFD level. The variable DFD, which serves as a proxy for the digital financial gap, is measured as a complement to customers' adoption of e-banking services. Specifically, to evaluate the impact of the Covid outbreak on the effectiveness of FinTech in reducing the DFD, we run a difference-in-difference (DiD) model to compare the difference in means between financially literate and illiterate EU regions. To this end, we collect balanced panel data for 2430 yearly observations of European regions from 2007 to 2022 and discriminate control/treatment samples according to the number of "financial education" initiatives for each EU country, as mapped by the OECD (2020a) and the EBA Financial Education Repository (2020 and 2022). All data are drawn from the Eurostat databank and the Cambridge Centre for Alternative Finance (CCAF) database by Cambridge University.

We contribute to the digital financial literacy (DFL) stream in several ways. First, we conducted the first European (EU) cross-country empirical study using variables related to Eurostat's NUTS2 classification. Second, we can discriminate the impact of a thriving financial environment (FinTech) on the DFD based on the level of "financial literacy" of the country. Empirical evidence suggests that increased innovation in financial services is associated with reduced DFD, possibly due to digital infrastructure and social improvements. However, in the aftermath of the Covid-19 outbreak, the development of FinTech in "financially illiterate" regions of the European Union (EU) is contributing to a widening of the DFD.

The remainder of the paper is organized as follows. Section 2 presents the literature review and outlines the research questions. Section 3 describes the data and methodology applied. Section 4 discusses the panel regression results and performs robustness checks. Finally, Section 5 draws conclusions from this paper.

2. Literature review and research questions

Although banks are intensive users of technology and manage innovation to extract value from it (Berger, 2003; Beck et al., 2016), a new form of disruptive innovation has been introduced into the market with the spread of FinTech firms (BIS, 2020 and 2021).

Even though literature has shown many advantages arising from the spread of digital innovation, such as improved productivity, customer wealth, and enhanced financial inclusion (Fuster et al., 2019; Wang et al., 2021), views differ on the likely impact of FinTech on society's demand for digital financial services. In the banking industry, the digital transformation strategy leads incumbents to modernize internal processes, strengthen existing banking products' portfolios, or simply innovate their product delivery channels (Murinde et al., 2022). The availability of digital banking services creates new risks for customers, who need to become digitally and financially sophisticated and improve their financial literacy (FL) (Engels et al., 2020). In this regard, extensive literature has shown how FL improves financial well-being at all life stages (Lusardi and Mitchell, 2014), leads to wiser saving and investment decisions (Van Rooij et al., 2011), influences planning behaviour and increases wealth holdings (Lusardi and Mitchell, 2007). According to Lynos et al. (2022), financial knowledge is also one of the most powerful forces in promoting access to FinTech services. By implementing cross-country analyses, scholars such as Nicolini et al. (2013) founded how national features and socio-demographic characteristics could affect customers' financial knowledge and behaviour. A second research body has examined the determinants that affect the digital divide and found that it is a crucial multidimensional phenomenon (Dasgupta et al. (2001); Van Laar et al. (2017) positively correlates with internet access cost, media use, and regional characteristics (Demoussis and Giannakopoulos, 2006). For Yartey (2008), a country's financial development can explain the spread of cross-country information communication technology.

Hence, previous research has analysed financial or digital dimensions, usually implementing a qualitative approach based on surveying customers' knowledge, behaviours, and attitudes (e.g., Atkinson and Messy, 2011; Lusardi and Mitchell, 2014;

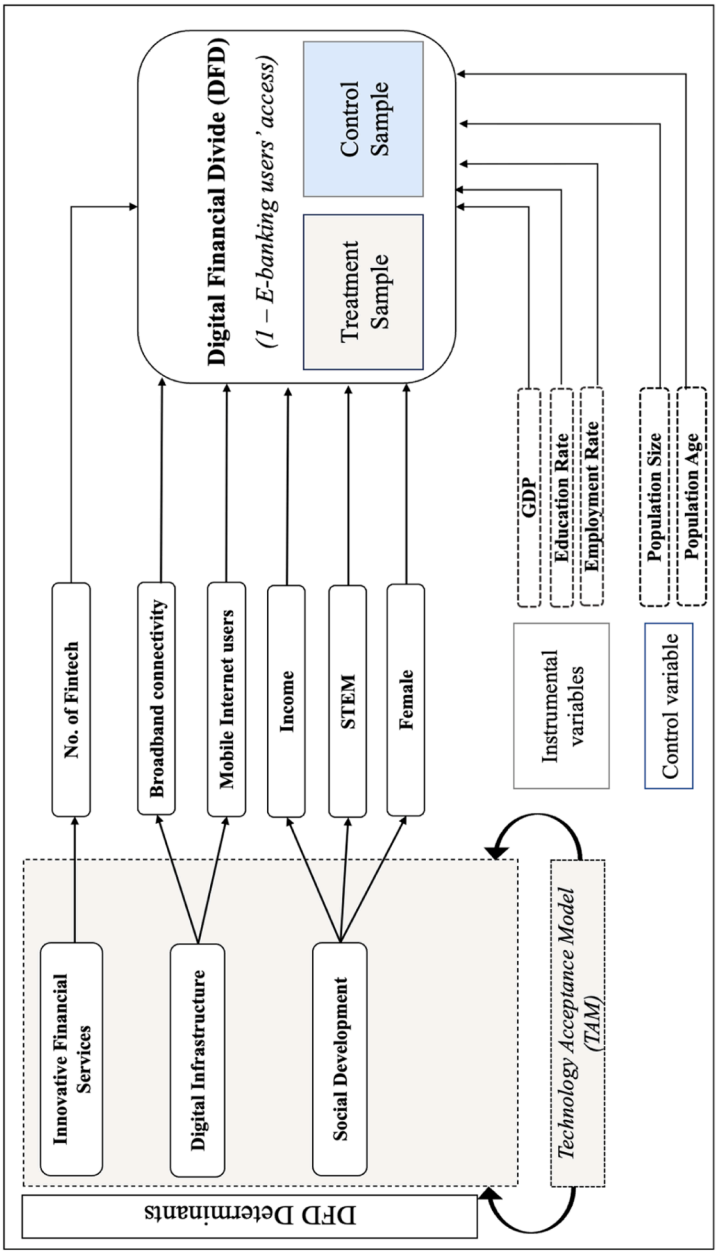

Fig. 1. Conceptual model.

Gallego-Losada et al., 2023). We also found a lack of cross-country empirical analysis to examine the determinants of digital financial literacy (DFL). In this line of research, some authors (Koskelainen et al., 2023) provided an early-stage assessment of digital financial literacy (DFL), highlighting the need to include new dimensions of analysis in the assessment of DFL. This construct recognises the limitations of traditional FL measures, which fail to capture the nuances of financial services in a digitally pervasive environment. A growing body of literature highlights that individuals who use digital financial tools without sufficient financial literacy are exposed to increased operational risks (Prete, 2022), or are unaware personal spending and saving behaviour (Setiawan et al., 2022).

Once the current literature gaps are identified, our study is still relevant in understanding which determinants (e.g., social, infrastructural, and financial) may explain countries' digital financial divide (DFD). This topic is a relevant issue for policymakers' agendas and financial intermediaries. Consequently, our paper seeks to provide empirical evidence on the drivers of the digital and financial gap in Europe. We measure this divide as the low adoption of e-banking services among customers and introduce the digital financial divide (DFD) concept. Specifically, we aim to enrich the debate by providing empirical evidence on the impact of FinTech country development on DFD. To this end, we collected the number of FinTech firms by country as a proxy of financial development. The objective is to understand whether the supply of financial technology services reduces or increases customers' access to e-banking. In particular, we develop the following research question (RQ):

RQ1. : *What is the role of FinTech development in explaining the cross-country Digital Financial Divide?*

We add a further analysis to assess whether regions' financial literacy levels reveal a different impact of FinTech development following the Covid-19 outbreak. According to OCSE (2020) classification and the number of financial education initiatives, we discriminate the effect between highly financially literate and illiterate EU countries. This approach allows us to identify regions characterised by citizens with high financial and digital skills who are more prone to accept digital financial innovation. Conversely, illiterate areas can observe an increase in DFD levels following sudden and unpredictable market reshaping triggered by exogenous events such as Covid.

The pandemic has acted as a paralysing factor for traditional business activity and has stimulated the creation of new digital services. These peculiar market conditions have allowed FinTech to flourish and increase the supply of financial services during the pandemic era and have also highlighted how innovation could disrupt a significant portion of traditional banking value networks, especially in banking business lines characterised by increased competitiveness (Cole et al., 2019). However, the range of digital financial services has also increased due to movement restrictions and sudden changes in consumer habits. Considering these challenging aspects, we aim to investigate whether and to what extent the Covid-19 outbreak affects the relationship examined in RQ1. Thus, we formulate the second RQ:

RQ2. : *Does Covid-19 outbreak affect the relationship between FinTech development and DFD among financially literate and illiterate EU regions?*

FinTech development and Covid-19 are two forces that compete to alter the level of DFD in a country. However, environmental characteristics such as a country's level of digital infrastructure and social development may also affect the propensity to adopt e-banking services and thus mitigate (or increase) the level of DFD. Therefore, we formulate a third RQ3:

RQ3. : How *do digital infrastructure and social development affect the Digital Financial Divide?*

To address our research questions, we collect yearly data for a sample of European regions according to the Eurostat NUTS2 classification from 2007 to 2022. We support our empirical analysis by outlining a conceptual model (Fig. 1) in which several dimensions of analysis (i.e., innovative financial services, digital infrastructure, and social development) affect the DFD. The theoretical foundation of this analysis is established in the conceptual application of Davis (1989) Technology Acceptance Model (TAM). This model proposes that consumer attitudes towards adopting new technology are primarily shaped by four factors: (i) perceived usefulness, (ii) perceived ease of use, (iii) attitude towards using, and (iv) actual use of technologies. Transposing these elements into a banking context, it can be inferred that these factors may explain the adoption of different customers' e-banking services. From this perspective, it is hypothesized that the determinants of the digital financial divide (DFD) act as influential factors that directly impact the theoretical constructs of TAM and indirectly alter the DFD level. Amidst these determinants, the FinTech industry's growth is identified as a critical driver of the "perceived usefulness" (first pillar of TAM) of digital banking products/services. This is attributed to the industry's inner characteristics, namely swift delivery times and tailored user experience. Simultaneously, the role of the pandemic crisis is also examined. Initially, the crisis eased access to digital financial services, mitigating the psychological barriers that often deter consumers from adopting more advanced financial services. As a result, a positive influence was cast upon the "perceived ease of use" (second pillar of TAM), which consumers face through introducing new banking tools and products. Finally, the confluence of financial development and the pandemic shock intersects with the "attitude towards using" (third pillar of TAM). This aspect directly impacts the "actual use of technologies" (fourth pillar of TAM), with the proposition that an individual's willingness to adopt can significantly determine their ultimate engagement with these technologies.

The analysis incorporates a difference-in-differences (DiD) model to measure disparities between countries characterized by varying levels of financial literacy. The DiD model estimates the impact of a specific treatment, in this instance, financial literacy, by contrasting the evolution in outcomes over time between a group exposed to the intervention and another that is not (Athey and Imbens, 2006). In this analysis, the classification of countries into control and treatment groups is based on the OECD's definition of financial literacy (OECD, 2018b; OECD, 2022). This classification thoroughly examines various surveys and data sources, including country-specific reports and financial literacy indicators. OECD and EBA attention is also given to the degree of financial literacy events organized within each country, shedding light on the country-specific efforts to enhance financial literacy (EBA Financial

Education Repository, 2020 and 2022). Countries that manifest lower financial literacy degrees are placed into the treatment group. On the other hand, those demonstrating a more sophisticated understanding and application of financial concepts are designated as the control group (EBA, 2020; OECD, 2020; OECD, 2020b).

3. Research design: data and methodology

3.1. The data

We analyse a unique sample collected by Eurostat and Cambridge Centre for Alternative Finance (CCAF) for 2007–2022. The dataset has a high level of geographical granularity, as each variable refers to the regional level according to Eurostat's NUTS2. It consists of 2430 region-year observations for each variable. In order to present a balanced dataset, we exclude from our analysis all regions with missing data for our dependent variable. The regional distribution and the dataset composition are detailed in Appendix A.

3.1.1. Dependent variables

The dependent variable, the digital financial divide (DFD), complements one of the percentages of e-banking usage among European customers. An increase in e-banking usage represents a reduction in the digital financial divide due to customers' wider adoption of online banking services (Appendix B).

3.1.2. Explanatory variables

Having established a proxy variable to express the DFD in the banking industry, we turn to analysing determinants that affect this dimension on a NUTS 2 regional level. We have selected several variables grouped into three dimensions of analysis, considering their significance in prior findings and data accessibility.

The first dimension includes the total number of operational FinTech firms by country as a proxy for financial development. In our research, we have collected FinTech firms' data from the reputable "Cambridge Centre for Alternative Finance (CCAF)" database to acquire robust information on FinTech entities. Notably, the data are collated at the country level because, owing to the inherent nature of digital financial services, which are proffered through the internet network and entirely lack physical branches, the impact of a FinTech's presence within a nation is not restricted to the mere physical existence of country division. The presence of a FinTech firm in a country impacts collaborations with financial institutions and affects country bias at the national level to adopt financial services (Johnsona et al., 1999). Therefore, in our analysis, we compare regional-level analysis (considering FinTech as a fixed effect for each country) with robustness performed considering all analysis variables at the country level. We have selected all FinTech players included in CCAF that are located in the following countries: Austria; Belgium; Bulgaria; Croatia; Cyprus; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Iceland; Ireland; Italy; Latvia; Liechtenstein; Lithuania; Luxembourg; Montenegro; Netherlands; Norway; Poland; Portugal; Romania; Serbia; Slovak Republic; Slovenia; Spain; Sweden; Switzerland; Turkey; Ukraine; United Kingdom. We provide the regional distribution of FinTech firms by geographical area (Appendix C).

To explain the impact of FinTech firms on 'traditional financial market players', we provide in Annex D the percentage distribution of FinTech firms according to their reference market in Europe. The data reflects a significant influence on banks, with a 39.57% engagement, signalling an integration of technological innovations like online banking. Asset Management is also notably affected, with a 28.18% FinTech presence, incorporating technologies that offer diversified investment platforms and automated advising. Moreover, FinTech impacts firms and financial institutions (15.30%) by introducing streamlined processes, digital payment systems, and enhanced data management capabilities. FinTech addresses individuals (12.55%) on a consumer level, providing easy access to personal finance management tools, online lending, and peer-to-peer payment platforms. The Insurance sector, although at a smaller scale of 4.41%, experiences the emergence of InsurTech, which introduces digitized claims processing and personalized insurance products. These correlations highlight the transformative role of Fintech across traditional finance environment, introducing innovative processes and altering customer experiences and expectations across the board.

Additionally, the data exhibited in Annex D illustrates the distribution of FinTech firms with a significant focus on B2C (Business to Consumer) services, accounting for 85.22%, compared to B2B (Business to Business) at 14.78%. The high percentage of B2C FinTech firms reflects a strategic concentration on providing financial services directly to individual consumers. This trend notably contributes to the diminishment of the digital financial divide by facilitating broader and more straightforward access to financial tools and services for individuals. Consequently, this growth and orientation of Fintech toward the B2C market democratises access to financial services and enhances consumer financial management capabilities while challenging traditional financial institutions to adapt to these innovative digital solutions.

Digital infrastructural variables represent the second category under analysis: (i) a percentage of mobile internet users (MOB_INT) and (ii) a percentage of broadband connectivity (BROAD) (Lusardi et al., 2017). Furthermore, the external environment is captured by a third category of variables, including nominal household income (INC), a percentage of the population with a degree in science, technology, engineering, and maths (STEM), and the percentage of females in the population (FEM) (Peng et al., 2018).

3.1.3. Control and instrumental variables

In our model, we control for the logarithm of the total population (POP) and average population age (AGE) (Yartey, 2008) residing in EU regions, while to address endogeneity issues, we use the gross domestic product (GDP) in the current market price, the employment rate (EMP), education attainment (EDUC), as instrumental variables (Peng et al., 2018; Kim et al., 2018).

Table 1
Statistical Summary.

Statistic	Dependent Variable	Financial	Infrastructural		Social			Control			Instrumental	
	DFD	FINTECH	MOB_INT	BROAD	INC	STEM	FEM	POP	AGE	GDP	EDUC	EMP
Minimum	2,75	0,00	5,63	0,53	97,80	6,45	46,65	44,40	23,50	73,51	0,60	38,90
1st Quartile	29,90	1,00	66,33	60,60	11656,78	16,85	50,85	479,43	40,20	17.409,78	6,70	60,90
Median	51,38	5,00	80,83	75,97	24537,20	20,40	52,15	872,10	42,30	35.222,43	10,10	66,10
Average	52,34	10,10	76,07	70,96	36994,35	20,34	52,11	1.265,91	42,21	56.631,07	11,88	65,31
Third Quartile	74,94	14,00	89,53	86,03	44274,34	23,50	53,10	1.551,75	44,40	66.802,76	16,70	71,80
Maximum	99,94	134,00	100,00	100,00	424148,18	35,99	59,70	11.385,07	51,60	758.527,29	36,50	86,60

Table 2
Random Effects Regression Model.

Variables	Model 1	Model 2
Constant	0.201***	0.082
	(0.070)	(0.103)
FinTech	-0.028***	-0.027***
	(0.007)	(0.006)
COVID	-0.799***	-0.774***
	(0.218)	(0.217)
INT_USER	-0.857***	-0.862***
	(0.012)	(0.012)
BROAD	-0.044***	-0.049***
	(0.011)	(0.011)
log(INC)	1.398**	1.432**
	(0.586)	(0.582)
STEM	0.003	-0.010
	(0.056)	(0.055)
AGE		0.495*
		(0.282)
FEM		0.059
		(0.345)
log(POP)		-4.028***
		(0.701)
FinTech * Treatment	0.044***	0.041***
	(0.015)	(0.015)
FinTech * COVID	6.091***	6.397***
	(0.618)	(0.534)
Observations	2430	2430
F Statistic	752.725***(df = 7; 2422)	538.287***(df = 10; 2419)

The correlation matrix can be observed in Appendix E. E_BANK_DIV indicates a negative correlation between mobile internet accessibility (MOB_INT), broadband connectivity (BROAD), income (INC), and GDP. Moreover, we observe a direct correlation between population and our dependent variable.

3.1.4. Descriptive statistics

The data in Table 1 show that the dependent variable DFD ranges from a minimum of 2.75 to a maximum of 99.94, indicating the existence of significant differences in the use of digital banking services across Europe. The infrastructure variables, MOB_INT and BROAD, representing the percentage of mobile internet and broadband users respectively, show an average of around 70%, highlighting a possible room for improvement in accessibility to digital technology in some European regions. The control and explanatory variables of the social dimension, INC and POP, and the financial dimension, FINTECH, are characterized by high variability, reflecting tangible and measurable socio-economic differences between European countries.

3.2. Methodology

In this academic paper, we employ a difference-in-difference (DID) model to examine the impact of FinTech development on the digital financial divide (DFD) across NUTS 2 European regions, considering the exogenous shock of the Covid-19 pandemic. To capture the timing of the shock, we introduce a dummy variable (COVID) that takes a value of 1 after the outbreak of Covid-19 in 2020. Our primary interest is to investigate how this shock affects DFD, considering the differences in financial literacy levels across EU regions.

We examine the effects of a treatment attributed to countries classified by the OECD (2022) with a lower level of financial literacy. Over the past decade, as reported by EBA Financial Education Repository (2020 and 2022), these countries have undertaken a substantial number of financial literacy initiatives to bridge the gap and improve their citizens' financial knowledge and skills. The treatment group comprises these countries that have actively engaged in efforts to enhance financial literacy. On the other hand, the control group consists of financially literate countries within the European Union (EU) whose citizens possess sufficient financial and digital skills to effectively utilize the new financial services offered by FinTech firms. By comparing the outcomes between the treatment and control groups, we aim to assess the impact of financial literacy initiatives on narrowing the digital divide in the pre and post covid outbreak and facilitating the adoption of FinTech services in countries with initially lower levels of financial literacy. Consequently, to answer our research questions, we elaborate on the following difference-in-difference econometric regression:

$$DFD_{rit} = \alpha + ß_1 * Fintech_{ct} + ß_2 * Covid_{ct} + ß_3 * Fintech * Treatment_{ct} + \sum_{i=1}^{2} \partial_i * Infrastructural_{rit} + \sum_{i=1}^{3} \delta_1 * Social_{rit} + \sum_{i=1}^{2} \theta_i * Controls_{rit} + u_{rt}$$

The main regressor in our analysis is the FINTECH variable, which represents the number of active FinTech firms in each country. This variable allows us to examine the association between the presence of FinTech and the level of the digital financial divide (DFD).

Additionally, we include the COVID dummy variable, which takes the value "1" after the outbreak of the pandemic, serving as an exogenous shock in our difference-in-difference model. The interaction term FINTECH*TREATMENT captures the effect of FinTech development specifically in the treated countries.

To account for digital structural factors, we include the MOB_INT variable, representing the percentage of internet users, and the BROAD variable, indicating the availability of broadband access to the internet. Furthermore, we consider social dimensions by incorporating the percentage with a degree in science, technology, engineering, and math (STEM), household income (INC) and female distribution (FEM). We include the logarithm of the region's population (POP) and regions' average age (AGE) to control for regional differences.

For the robustness checks, we first identify the presence of multicollinearity among the regressors implementing a variance inflation factor (VIF). To address potential endogeneity concerns, in line with Granger (1969), we implement a two-stage least squares (2SLS) regression (Wintoki et al., 2012). We run the Breusch-Pagan test to identify heteroskedasticity issues. We handle heteroskedasticity issues using the coefficient estimation method of Arellano and Bover (1995).

4. Empirical results

This section presents the results of the empirical model for 2430 year-based observations for European regions.

4.1. Main results

The results related to the model are presented in Table 2. The analysis findings demonstrate a negative association between various factors and the digital financial divide (DFD) level, as measured by the complement of e-banking platform usage (E_BANK_DIV). Specifically, the factors examined include the digital innovative financial environment (FINTECH), the occurrence of an exogenous event (COVID), the presence of digital infrastructure (MOB_INT and BROAD), and social development (EDUC). In line with the research objectives, the results indicate that higher levels of FINTECH, characterized by innovative financial technologies, are associated with a decrease in the DFD. Similarly, the exogenous COVID event demonstrates a negative relationship with the DFD, suggesting that the pandemic may have accelerated digital adoption in the financial sector.

More specifically, the FINTECH variable represents the country-level propensity for financial innovation. As shown in the following table, a unit increase in the number of FinTech firms reduces the DFD by 0.027. It can be concluded that the more digitally and financially sophisticated a country is, the smaller the DFD becomes, contradicting the empirical evidence found by Cole et al. (2019). This result is consistent with the literature stream highlighting how FinTech development improves financial inclusion (Fuster et al., 2019; BIS, 2021; Wang et al., 2021). The increase in FinTech can potentially decrease the digital financial divide (DFD) due to several contributing factors. FinTech companies are known to enhance efficiencies and create opportunities within the financial industry. One significant aspect is their ability to provide easier access to financial services. By leveraging digital platforms and technologies, FinTech companies can reach a broader demographic, especially those traditionally underserved by conventional banking systems, bridging the digital divide.

In our study, we investigate the potential impact of the Covid-19 pandemic on the Digital Financial Divide (DFD) by examining changes in consumption habits, technology adoption, and financial literacy levels. We employ a binary variable named 'COVID' to differentiate between the periods before and after the onset of the pandemic. This variable is set to "1" for the period succeeding the pandemic and "0" for the period prior. The regression analysis yields a coefficient of − 0.774 for the 'COVID' variable, with a 99% confidence interval, a level of certainty consistent with other variables in our model. The negative coefficient indicates that regions surveyed in the aftermath of the pandemic exhibit, on average, a reduction in DFD exceeding three percentage points. This finding implies that the pandemic, as an unexpected event, has altered how consumers engage with digital financial services. There seems to be an increased preference towards digital over traditional banking services for executing financial transactions. This shift can be attributed to the intensified digitisation efforts across European Union countries during the Covid-19 pandemic, as the DESI (Digital Economy and Society Index) report corroborated. (EC, 2022).

The interaction term between 'FinTech' and 'Treatment' in our regression model yields a coefficient of 0.041, with a 99% confidence interval. This result underscores the role of the Covid-19 pandemic as a complexity-enhancing factor for digital financial services in countries with low financial literacy. More specifically, the increase in availability and customisation of e-banking services during the post-pandemic period exacerbates the lack of financial literacy, thereby contributing to a rise in the digital financial divide (DFD). Conversely, countries with higher financial literacy levels do not display a further widening of their digital financial divide due to the pandemic. While this transformation has been largely positive, it has also unintentionally exposed and aggravated certain countries' lack of financial literacy in specific countries. This underlines the importance of financial education in leveraging the full potential of FinTech innovation, particularly in times of sudden and profound change.

Regarding digital infrastructural variables, a unit increase in the percentage of mobile users reduces the DFD main lines by 0.862% points. Thus, increasing the number of mobile users in European regions consistently reduces the DFD. In addition, broadband internet access reduces DFD by 0.049 points, consistent with Demoussis and Giannakopoulos (2006). In fact, broadband connectivity in the EU is a proxy for higher available income and lower internet access costs than in underdeveloped countries. Moreover, the size of the regression coefficient suggests that consumers prefer mobile connections to broadband connections for digital banking transactions.

Conversely, DFD increases with the logarithm of income (1.432) with a 95% confidence interval. High-income households have a more comprehensive range of financial needs than lower-income users. They tend to use more complex and sophisticated financial services to meet these needs. More specifically, access to e-banking satisfies standardisable financial operations, while more complex

Table 3
Placebo Test Results.

Description	Value
The Difference in means before the COVID threshold	40.55631
The Difference in means after the COVID threshold	32.66965
The Difference-in-difference estimate (Treatment Effect)	-7.886667
T-test p-value	5.830321e-06

and customised financial services tend to be addressed in the form of advice and tailor-made services. On the other hand, the percentage of STEM degrees is not statistically significant.

We control for the population size; its logarithm reduces DFD by 4.0128 with a 99% confidence interval. In our study, the increase in population size contributes to a widespread reduction in DFD because new citizens are more open to adopting new technologies, affecting the consumption behaviour of digital financial services. On the other side, population age increases the level of the digital financial divide by 0.495 with a 90% confidence interval, as elderly individuals are reluctant to use digital financial services. We observe non statically significant gender effect on DFD level in European regions.

4.2. Robustness

4.2.1. Placebo test and parallel trend

To verify the significance of our methodology, we conducted a placebo test. This approach allowed us to analyse whether a causal effect causes the treatment effect observed or should be attributed to randomness. For the placebo test, we simulated an intervention in the pre-COVID period while keeping the model characteristics identical to our preliminary study. The results from the placebo test affirm the validity of our main findings. We observed a difference in means before and after the COVID threshold of 40.56 and 32.67, respectively. The estimated treatment effect, computed as the difference-in-difference, was − 7.89, indicating a decrease with a p-value of near 0.000, suggesting that the observed effect is highly unlikely to be due to chance. The treatment effect was negative, suggesting a significant decrease in the outcome following the treatment. The results from our placebo test substantiate the robustness of our primary model. Table 3.

The parallel trends analysis offers a compelling justification for the use of a Difference-in-Differences (DiD) model by highlighting a divergent trend in the Digital Financial Divide (DFD) between financially literate and illiterate countries following the onset of the COVID-19 pandemic (an exogenous shock) (Fig. 2). The observed continual decrease in the average DFD level for financially literate countries compared to an increase in financially illiterate countries underscores a time-variant interaction effect. A DiD model is uniquely suited to capture this effect, allowing us to estimate the impact of financial literacy on the digital financial divide robustly in the context of an exogenous shock such as the COVID-19 pandemic. This analysis emphasizes the critical role of financial literacy in mitigating digital financial inequality, particularly during economically challenging times. Appendix F shows the main results of the difference-in-difference regression.

The observable divergence in the Digital Financial Divide (DFD) between financially literate and illiterate countries, amplified by the exogenous shock of the COVID-19 pandemic in 2020, provides a compelling rationale for using a Difference-in-Differences (DiD) model. The contrasting trends - financially literate countries showing a consistent decrease in average DFD and financially illiterate countries exhibiting an increase - underscore the differential impacts before and after the COVID-19 shock. These findings are highlighted by the DiD model results, which capture the change in trend before and after the COVID-19 shock and robustly estimate the influence of financial literacy on the digital financial divide. Such findings emphasize the fundamental role that financial literacy plays in mitigating digital financial inequality, especially during times of global economic distress.

4.2.2. Additional test

We check for multicollinearity and heteroskedasticity problems, as shown in the tables below (Table 4 and Table 5). For the analysis of the variance inflation factor, it is possible to exclude the presence of multicollinearity among the regressors by implementing a threshold of 10 (Imbens and Wooldridge, 2009).

Our study applies a two-stage least squares (2SLS) model to address potential endogeneity issues. This approach is frequently used in econometric research when there is a risk that some of the explanatory variables may be endogenous. The 2SLS model is implemented in two stages. In the first stage, each endogenous explanatory variable is regressed on all of the exogenous variables in the model, including both the exogenous variables of interest and the instrumental variables (IVs). In the second stage, the original model is estimated with the endogenous variables replaced by the predicted values from the first stage. In our case, we use log(GDP), EMP (employment), and EDUC (education) as instrumental variables. These variables are presumed to be related to the endogenous variables in our model, but importantly, they are not directly related to the error term in the main equation. This assumption is based on prior research studies, such as those by Peng et al. (2018), which provide the necessary justification for our selection of these instrumental variables. Table 6 compares the difference between 2SLS and 2SLS with Arellano coefficient estimation results. The 2SLS model enriched with the Arellano estimation allows us to obtain estimates resistant to endogeneity and heteroskedasticity.

We find that the intercept, or constant component, retains statistical significance regarding regression coefficients. The FINTECH variable also demonstrates statistical significance, as evidenced by a 95% confidence interval. However, the COVID variable exhibits a reduction in its statistical reliability. Regarding the digital infrastructure variables, MOB_INT and BROAD remain statistically

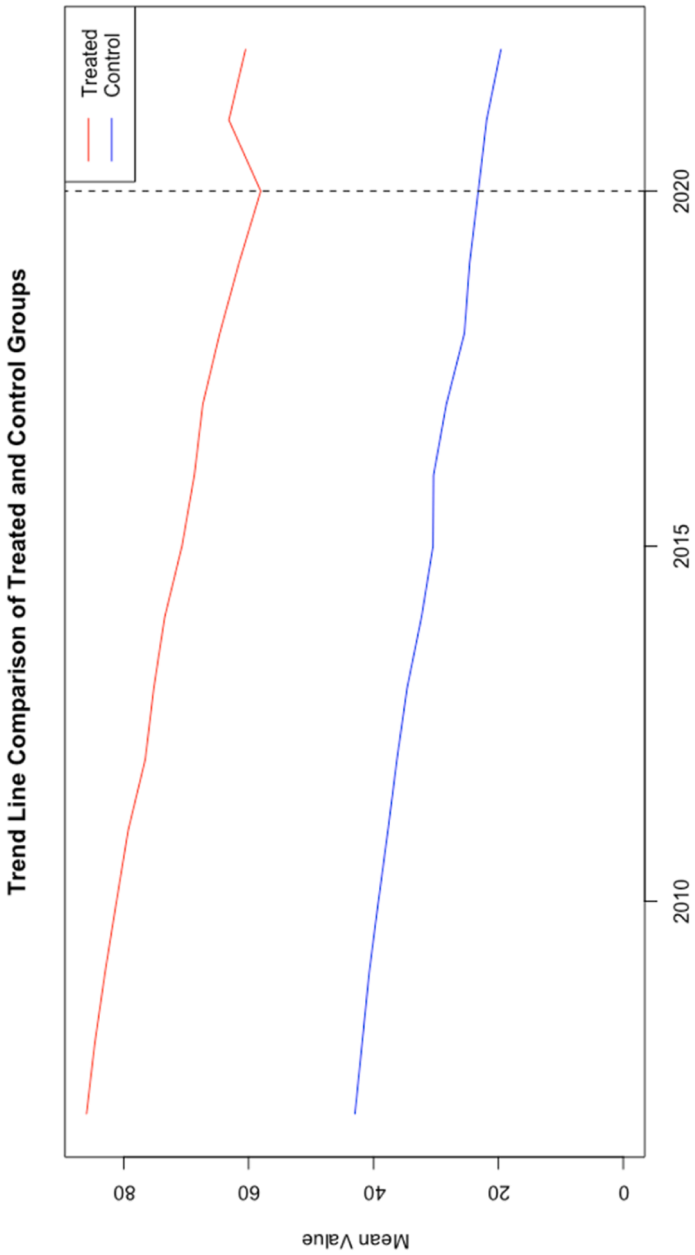

Fig. 2. Parallel Trend.

Table 4
Breusch-Pagan Test.

Breusch-Pagan Test			
BP	237.72		
Degrees of Freedom	11	p-value	0.000

Table 5
Variance Inflation Factor (VIF).

FinTech	COVID	TREATMENT	INT_USER	BROAD	log (INC)	STEM	AGE	FEM	LOG (POP)
1,50	1,29	4,29	6,52	3,31	4,06	2,37	1,42	1,34	3,72

Table 6
2SLS estimations.

Variables	Base Model	2SLS	2SLS + Arellano
Constant	0.082	86.334 ***	86.334 ***
	(0.103)	-3.307	-3.098
Endog_hat		0.264 ***	0.264 ***
		(0.042)	(0.048)
FinTech	-0.027 ***	-0.017 **	-0.017 ***
	(0.006)	(0.009)	(0.006)
COVID	-0.774 ***	0.844 ***	0.844 ***
	(0.217)	(0.322)	(0.224)
TREATMENT	0.350	0.530	0.530
	(0438)	(0.421)	(0.471)
INT_USER	-0.862 ***	-0.631 ***	-0.631 ***
	(0.012)	(0.041)	(0.077)
BROAD	-0.049 ***	-0.193 ***	-0.193 ***
	(0.011)	(0.025)	(0.043)
log(INC)	1.432 **	-0.963 ***	-0.963 **
	(0.582)	(0.210)	(0.458)
STEM	-0.010	0.010	0.010
	(0.055)	(0.037)	(0.026)
AGE	0.495 *	-0.152 ***	-0.152 ***
	(0.282)	(0.032)	(0.035)
FEM	0.059	0.085	0.085 *
	(0.345)	(0.072)	(0.049)
log(POP)	-4.028 ***	1.117 ***	1.117 **
	(0.701)	(0.224)	(0.523)
FinTech*Treatment	0.041 ***	0.077 ***	0.077 ***
	(0.015)	(0.018)	(0.020)
FinTech*COVID	6.091 ***	1.132 ***	1.132 ***
	(0.618)	(0.527)	(0.345)
Observations	2430	2430	2430
F Statistic	538.287 *** (df = 10; 2419)	549.82 *** (df = 10; 2419)	558.171 *** (df = 10; 2419)

significant, underlined by a 99% confidence interval. Furthermore, the interaction term FINTECH * Treatment continues to contribute to an increase in the Digital Financial Divide (DFD), maintaining its statistical significance at 99%.

Diverging from the results of the DiD model, log(INC) reduces DFD by 0.963 and has a negative sign. We interpret these results as a greater attitude of high-income regions to embrace digital and financial innovation. Access to a higher level of wealth contributes to reducing the digital financial divide through a high propensity to use digital financial services.

The control variable log(POP) and AGE remain statistically significant with a 95% confidence interval but present a sign reversal. A percentage increase in population size leads to a 1.117 point increase in DFD. These results are consistent with Yartey (2008), who argues that population size is an obstacle to financial development because it requires an additional effort for policymakers and government institutions to improve financial literacy. On the other hand, the prevalence of women in the population contributes to the increasing digital financial divide.

In the robustness check of our paper, the instrumental variables' strength and the lack of endogeneity in the post-estimation model are carefully examined (Table 7). The first-stage F-test result shows a significant statistic of 624.74 and a p-value around 0.00. This confirms that the instrumental variable set used is strong, as the high F-statistic exceeds standard thresholds (Sanderson and Windmeijer, 2016). Additionally, the Cragg-Donald test returns a statistic of 0.0007761 and a p-value of 0.9999943. These numbers indicate that there is no endogeneity in the model, meaning the instrumental variables are exogenous and are not linked to the error term in the main equation (Cragg and Donald, 1993). Both results contribute to the overall robustness of the model and the validity of the study's conclusions.

Table 7
Wald test, First-Stage F-test and Cragg-Donald test results.

Coefficient	Estimate	Std. Error	T-value	Pr (>|t|)	
(Intercept)	123.9161	119.0735	1.041	0.2981	
STEM	-6.9302	0.6225	-11.134	0.0000 * **	
AGE	2.1607	0.8855	2.440	0.0147 *	
FEM	-0.4189	2.6591	-0.158	0.8748	
Pre-Estimation Results	**Instrumental**	**DF1**	**DF2**	**Statistic**	**P-value**
Weak instruments	GDP	3	2588	901.3	0.0000 * **
Weak instruments	EMP	3	2588	133.4	0.0000 * **
Weak instruments	EDUC	3	2588	184.2	0.0000 * **
Wald test statistic		3		724.6	0.0000 * **
Post-Estimation Results	**Statistic**	**P-value**			
First-Stage F-test	624.7386	0.0000 * **			
Cragg-Donald test	0.0007761	0.9999943			

Table 8
Regional-level and National level analysis.

Variables	Regional Level Analysis	National Level Analysis
Constant	0.082	161.820 * **
	(0.103)	(16.989)
FinTech	-0.027 * **	-0.135 * **
	(0.006)	(0.048)
COVID	-0.774 * **	-1.085
	(0.217)	(1.431)
INT_USER	-0.862 * **	-11.436 * **
	(0.012)	(2.200)
BROAD	-0.049 * **	-0.555 * **
	(0.011)	(0.043)
log(INC)	1.432 * *	-0.108 * *
	(0.582)	(0.044)
STEM	-0.010	-5.293 * **
	(0.055)	(0.669)
AGE	0.495 *	-0.474 * **
	(0.282)	(0.174)
FEM	0.059	-1.600 * **
	(0.345)	(0.263)
log(POP)	-4.028 * **	-0.458 *
	(0.701)	(0.273)
FinTech * Treatment	0.041 * **	10.725 * **
	(0.015)	-1296
FinTech * COVID	6.397 * **	0.264 * **
	(0.534)	(0.101)
Observations	2430	368
F Statistic	538.287 * ** (df = 10; 2419)	286.980 * ** (df = 11; 356)

We further test whether an analysis based on national-level variables rather than regional ones produces empirical evidence that is still consistent. The results are exhibited in Table 8, and the findings confirm the statistical significance of the main regressors FinTech and Covid both at 99% confidence interval, as well as the interaction variables FinTech * Treatment (10.725 ***) and FinTech * COVID (0.264 ***). These results can be explained as long as digital financial services innovation produces effects on individuals' DFD at the national level because FinTech service providing is not restricted to the presence of a physical branch.

5. Conclusions

This paper has examined the joint impact of FinTech development and the Covid 19 outbreak on the cross-country Digital Financial Divide (DFD), alongside the impact of social and digital infrastructural factors on developed European regions.

We have empirically demonstrated how different dimensions of analysis could promote or hinder the fruition of customer-side "digitalization" of banking services. Specifically, we find that a high level of FinTech development reduces a country's DFD, improves the adoption of e-banking services, and increases financial inclusion in Europe. The interaction between FinTech development and Covid-19 increases the DFD due to the higher complexity of digital financial products and increased e-banking services offering.

Banks have changed their service offerings, driven on the one hand by the outbreak of the pandemic and on the other hand by leading FinTech innovations. Unfortunately, this change has not fully satisfied customer demand for e-banking services. Many individuals perceive digital banking innovations as overly complex, compounded by a lack of digital and financial literacy. The unconventional period has brought disruptive changes that have led to the dominance of the digital divide at the expense of financial

inclusion. Examining the environmental aspects suggests that digital and social elements could decrease the disparity in adopting digital banking services.

In line with OECD (2020c) and EBA (2022) policy engagement, the results of this study hold significance for policymakers, governments, and supervisory banking authorities, indicating the most effective areas for intervention in lowering the country's DFD. The results may also highlight regions where banks could invest in digital banking strategies based on the propensity of local customers to adopt. The level of digitalisation that a bank can achieve in a specific area measures the level of investment the credit institution can effectively implement. However, if the level of DFD is high, the transition from physical to digital channels can adversely affect the customer. As a result, implementing a strong digitalisation strategy may not benefit banks economically if the potential beneficiaries cannot accept such a change in banking services due to low digital and financial literacy.

Moreover, unaware digital customers are a source of reputational and operative risks for credit institutions because the misuse of innovative and digital financial services could lead customers towards losses and claims requests. Consequently, these losses merged with a crowd herding behaviour and amplified by fast information mechanisms could affect banks' reputations (Calvo, 2012; Krokida et al., 2020). From a supervisory perspective, a loss or fraud suffered by a customer due to an uninformed adoption of e-banking services breaks the relationship of trust, typical of banking activity, and leads to lower financial inclusion (Ammari et al., 2023). A critical step in building a more developed society is to make financial and digital literacy a reality for all. Financial literacy programmes should also diversify content to be "customer-inclusive" for each segment of digital banking users (OECD, 2021).

Our paper is affected by some limitations. For example, we only consider European countries, so a shared cultural background may bias our results. Indeed, focusing solely on European countries, a bias can be introduced into our findings, mainly due to shared cultural factors. Europe has a specific cultural, economic, and political cohesion level that does not represent the global community. Various shared institutions, agreements, and historical ties among these nations facilitate this. The cultural similarities and shared characteristics of European countries could potentially influence factors like the adoption and use of FinTech services, attitudes towards digital financial services, and the levels of financial literacy.

Additionally, we use as a proxy of social dimension family income, STEM degree incidence, female presence, population size, average population age and highest educational level according to the literature of reference. However, academics could assess further social dimensions directly affecting countries' digital financial divide. Finally, scholars might consider extending our results to a worldwide sample and using different metrics to capture financial environment development.

CRediT authorship contribution statement

Greta B. Ferilli: Conceptualization, Methodology, Data curation, Writing – original draft. **Egidio Palmieri:** Conceptualization, Methodology, Data curation, Writing – original draft. **Stefano Miani:** Conceptualization, Reviewing. **Valeria Stefanelli:** Conceptualization, Reviewing.

Data Availability

Data will be made available on request.

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Appendix A. Dataset of regional distribution by Country

	Initial Dataset		Final Dataset	
Country	**N. Regions**	**%**	**N. Regions**	**%**
Albania	3	0.90%	0	0.00%
Austria	9	2.71%	9	4.89%
Belgium	11	3.31%	11	5.98%
Bulgaria	6	1.81%	6	3.26%
Croatia	2	0.60%	2	1.09%
Cyprus	1	0.30%	1	0.54%
Czechia	8	2.41%	8	4.35%
Denmark	5	1.51%	5	2.72%
Estonia	1	0.30%	1	0.54%

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	Initial Dataset		Final Dataset	
Country	**N. Regions**	**%**	**N. Regions**	**%**
Finland	5	1.51%	4	2.17%
France	27	8.13%	26	14.13%
Germany	38	11.45%	9	4.89%
Greece	13	3.92%	1	0.54%
Hungary	8	2.41%	7	3.80%
Iceland	1	0.30%	1	0.54%
Ireland	3	0.90%	0	0.00%
Italy	21	6.33%	21	11.41%
Latvia	1	0.30%	1	0.54%
Liechtenstein	1	0.30%	0	0.00%
Lithuania	2	0.60%	0	0.00%
Luxembourg	1	0.30%	1	0.54%
Malta	1	0.30%	1	0.54%
Montenegro	1	0.30%	0	0.00%
Netherlands	12	3.61%	12	6.52%
North Macedonia	1	0.30%	1	0.54%
Norway	7	2.11%	6	3.26%
Poland	17	5.12%	0	0.00%
Portugal	7	2.11%	7	3.80%
Romania	8	2.41%	8	4.35%
Serbia	4	1.20%	0	0.00%
Slovakia	4	1.20%	4	2.17%
Slovenia	2	0.60%	2	1.09%
Spain	19	5.72%	19	10.33%
Sweden	8	2.41%	8	4.35%
Switzerland	7	2.11%	0	0.00%
Turkey	26	7.83%	1	0.54%
United Kingdom	41	12.35%	1	0.54%
	332	100.00%	184	55.42%

Appendix B. Variables Description

Variables	Variables Label	Description	Source
Dependent Variable			
Digital Financial Divide (DFD)	1 – E_BANK_ACCESS	Complementary of the percentage usage of e-banking platforms by NUTS2 regions.	Eurostat
Explanatory variables			
Mobile Internet Users %	MOB_INT	Percentage of internet users on the overall population by NUTS2 regions.	Eurostat
Broadband Connectivity %	BROAD	Percentage of households with internet access at home by NUTS2 regions.	Eurostat
Nominal Household Income	INC	Households' income level by NUTS2 regions.	Eurostat
Specialisation in STEM	STEM	Specialization in STEM subjects (% population)	Eurostat
Female %	FEM	% of Females in the Population	Eurostat
Total Number of FinTech	FINTECH	The number of active FinTech firms by country (2007 – 2022).	Cambridge Centre for Alternative Finance
Instrumental and Control variables			
Gross Domestic Product	GDP	GDP at current market price by NUTS2 regions.	Eurostat
Region Unemployment Rate	EMP	Unemployed rate by NUTS2 regions	Eurostat
Population Size by Region	POP	Total of population	Eurostat
Population Average Size	AGE	Population Average Age by NUTS2 Region	Eurostat
Education Participation Rate	EDUC	Population by educational attainment level (sex and age) by NUTS2 regions.	Eurostat

Appendix C. FinTech firm distribution by Country, Sector (CCAF classification) and target market

Rank	Country	%	Name	%	Traditional Market of Reference	B2C or B2B

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(*continued*)

Rank	Country	%	Name	%	Traditional Market of Reference	B2C or B2B
1	Germany	16,84%	Alternative Credit Analytics	1,08%	Bank	B2B
2	France	15,96%	Enterprise Tech Provisioning	11,89%	Firms and Financial Institutions	B2B
3	United Kingdom	9,04%	Cryptoasset Exchange	10,64%	Individuals	B2C
4	Netherlands	8,69%	Digital Banks	25,19%	Bank	B2C
5	Spain	8,69%	Digital Capital Raising	18,20%	Asset Management	B2C
6	Italy	7,98%	Digital Custody	2,91%	Asset Management	B2C
7	Sweden	5,67%	Digital Identity	1,91%	Individuals	B2C
8	Denmark	4,61%	Digital Payments	13,38%	Bank	B2C
9	Norway	2,84%	InsurTech	4,41%	Insurance	B2C
10	Belgium	2,48%	RegTech	3,33%	Firms and Financial Institutions	B2B
11	Lithuania	1,95%	WealthTech	7,07%	Asset Management	B2C
12	Portugal	1,95%		100,00%		
13	Austria	1,77%				
14	Finland	1,77%				
15	Luxembourg	1,60%				
16	Poland	1,60%				
17	Czech Republic	1,42%				
18	Turkey	1,42%				
19	Slovenia	0,89%				
20	Bulgaria	0,53%				
21	Cyprus	0,53%				
22	Greece	0,53%				
23	Croatia	0,35%				
24	Iceland	0,35%				
25	Romania	0,18%				
26	Slovak Republic	0,18%				
27	Montenegro	0,18%				
		100,00%				

Appendix D. FinTech distribution by Market of Reference

Traditional Market of Reference	%	B2B o B2C	%
Bank	39,57%	B2B	14,78%
Firms and Financial Institutions	15,30%	B2C	85,22%
Individuals	12,55%		100,00%
Asset Management	28,18%		
Insurance	4,41%		
	100,00%		

Appendix E. Correlation Matrix

CORRELATION	INT HOUSE	COVID	TREAT	DFD	E_BANK_DIV	BROAD	GDP	POP
INT_HOUSE	1.00	0.37	-0.48	-0.76	-0.78	0.96	0.16	-0.38
COVID	0.37	1.00	0.00	-0.21	-0.26	0.41	0.12	-0.02
TREATMENT	-0.48	0.00	1.00	0.77	0.76	-0.40	0.03	0.42
DFD	-0.76	-0.21	0.77	1.00	1.00	-0.71	-0.11	0.52
E_BANK_DIV	-0.78	-0.26	0.76	1.00	1.00	-0.73	-0.11	0.52
BROAD	0.96	0.41	-0.40	-0.71	-0.73	1.00	0.12	-0.34
GDP	0.16	0.12	0.03	-0.11	-0.11	0.12	1.00	0.49
POP	-0.38	-0.02	0.42	0.52	0.52	-0.34	0.49	1.00
EMP	0.55	0.18	-0.49	-0.71	-0.71	0.49	-0.08	-0.63
INT_USER	0.76	0.23	-0.80	-0.92	-0.92	0.70	0.02	-0.50
INC	0.16	0.12	0.06	-0.11	-0.11	0.13	0.90	0.46
EDUC	0.60	0.04	-0.60	-0.77	-0.76	0.51	0.13	-0.51
Fintech	0.33	0.16	-0.15	-0.20	-0.20	0.33	0.08	0.06
STEM	0.73	0.30	-0.53	-0.69	-0.70	0.68	0.05	-0.47
AGE	0.15	0.28	0.35	0.08	0.06	0.20	0.22	0.32
FEM	-0.39	-0.06	0.13	0.32	0.32	-0.31	-0.22	0.39

CORRELATION	EMP	INT_USER	INC	EDUC	Fintech	STEM	AGE	FEM

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CORRELATION	EMP	INT_USER	INC	EDUC	Fintech	STEM	AGE	FEM
INT_HOUSE	0.55	0.76	0.16	0.60	0.33	0.73	0.15	-0.39
COVID	0.18	0.23	0.12	0.04	0.16	0.30	0.28	-0.06
TREATMENT	-0.49	-0.80	0.06	-0.60	-0.15	-0.53	0.35	0.13
DFD	-0.71	-0.92	-0.11	-0.77	-0.20	-0.69	0.08	0.32
E_BANK_DIV	-0.71	-0.92	-0.11	-0.76	-0.20	-0.70	0.06	0.32
BROAD	0.49	0.70	0.13	0.51	0.33	0.68	0.20	-0.31
GDP	-0.08	0.02	0.90	0.13	0.08	0.05	0.22	-0.22
POP	-0.63	-0.50	0.46	-0.51	0.06	-0.47	0.32	0.39
EMP	1.00	0.69	-0.01	0.70	0.10	0.47	-0.23	-0.42
INT_USER	0.69	1.00	0.04	0.74	0.20	0.67	-0.14	-0.33
INC	-0.01	0.04	1.00	0.13	0.08	0.00	0.17	-0.23
EDUC	0.70	0.74	0.13	1.00	0.10	0.56	-0.19	-0.53
Fintech	0.10	0.20	0.08	0.10	1.00	0.22	0.20	-0.06
STEM	0.47	0.67	0.00	0.56	0.22	1.00	-0.10	-0.35
AGE	-0.23	-0.14	0.17	-0.19	0.20	-0.10	1.00	0.22
FEM	-0.42	-0.33	-0.23	-0.53	-0.06	-0.35	0.22	1.00

Appendix F. Difference-in-Difference Preliminary results

	Coefficient	**Standard Error**	**t-value**	**p-value**
Constant	342.087	0.5446	62.810	< 2e-16 * **
TREATMENT	405.563	0.7519	53.939	< 2e-16 * **
COVID (time)	-126.486	12.578	-10.056	< 2e-16 * **
TREATMENT: COVID	-78.867	17.364	-4.542	5.83e-06 * **

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