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RECONFIGURING FINANCIAL INCLUSION. THE IMPACT OF FINTECH ON TRADITIONAL BANKING STRUCTURES IN EASTERN EUROPE

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Abstract:

This study investigates the relationship between financial technologies (FinTech) and financial inclusion in Eastern European economies, with a focus on the heterogeneous structural and institutional characteristics of the region. Over the past two decades, digital transformation has redefined the architecture of financial systems, enabling wider access to services while creating new challenges for integration and regulation. By constructing a multidimensional Financial Inclusion Index (FInI)—covering geographic access, demographic access, and financial services usage—this research provides an empirical framework to measure inclusion and its evolution over time.The analysis is based on a balanced panel of ten Eastern European economies (EU and non-EU) during 2010–2023. Using Principal Component Analysis (PCA), composite indices for financial inclusion and FinTech development were built. The empirical models, estimated through panel regressions (Pooled OLS and Fixed Effects), also incorporate control variables such as trade openness, gross fixed capital formation, and education levels. Stationarity was ensured through unit root testing (ADF-Fisher) and first-order differencing.The results show a consistent, positive, and robust impact of FinTech development on all dimensions of financial inclusion. The strongest effects are observed on geographic access and on the overall FInI, highlighting the role of digital technologies in reducing dependence on physical banking infrastructure and in expanding access to underserved populations. Education and capital formation also contribute positively, whereas trade openness exhibits a negative but insignificant effect.Policy implications underline the need for strategic integration of FinTech into national and regional frameworks. Expanding digital infrastructure, adaptive regulation (including sandboxes and open banking), financial literacy programs, and international cooperation are critical to maximizing the benefits of FinTech for inclusive growth. Overall, the findings confirm that FinTech is not merely a complement to traditional banking, but a transformative driver of financial equity and sustainable economic development in Eastern Europe.

Key words: *Digital financial services, FinTech, Financial inclusion, Banking structures.*

1. Introduction

Over the past two decades, the digital transformation of financial systems has generated profound changes in the way individuals and companies access and use financial services. Financial technologies (FinTech) have evolved from an innovative niche to an essential component of the global financial infrastructure, influencing both financial inclusion and financial market integration (Arner et al., 2016; Philippon, 2016).

On the one hand, FinTech is regarded as a catalyst for financial inclusion, by reducing access barriers, lowering transaction costs, and providing solutions tailored to the needs of population segments previously excluded from the formal financial system (Demirgüç-Kunt et al., 2022). Through services such as mobile payments, peer-to-peer lending platforms, and robo-advisors, FinTech facilitates economic participation and contributes to the development of human and social capital (Sarma, 2008; Cámara & Tuesta, 2014).

Not only but also, the expansion of FinTech influences financial integration by accelerating connectivity across capital markets, increasing the speed of shock transmission, and broadening opportunities for international diversification (Lane & Milesi-Ferretti, 2018). The growing interdependence among financial markets entails both benefits—such as more efficient capital allocation and long-term stability—and risks, including the rapid propagation of volatility in times of crisis.

In this context, the European Union and European economies provide an ideal framework for analyzing the relationship between FinTech, financial inclusion, and market integration. The region combines both mature and emerging economies, with varying levels of digitalization, infrastructure, and regulation, thus allowing the investigation of the differentiated impact of financial technologies.

The digitalization of financial services in the European Union (EU) has experienced significant expansion over the past two decades, driven by technological advancements, the liberalization of financial markets, and the active intervention of regulatory authorities. The adoption of the Payment Services Directive (PSD1 and PSD2), the implementation of the eIDAS Regulation, and initiatives such as the European Retail Payments Strategy have created a favorable framework for FinTech innovation, stimulating the emergence of new business models and the expansion of digital services within the European financial system (European Commission, 2020).

Currently, the digitalization of European financial services is manifested through several interrelated developments. One of the most evident trends is the rapid growth of electronic and contactless payments, a process significantly accelerated by the COVID-19 pandemic and by the growing consumer preference for fast and secure solutions. At the same time, open banking has expanded considerably under the impetus of the revised Payment Services Directive (PSD2, 2015), which obliges banks to grant authorized third parties secure access to customer data, thereby fostering the emergence of innovative applications. Another important dimension is the progressive integration of payment infrastructure, exemplified by initiatives such as the Single Euro Payments Area (SEPA) and the ongoing discussions within the European Central Bank (ECB) regarding the introduction of a central bank digital currency (CBDC). Finally, digitalization is also reflected in the convergence between financial and technological services, as evidenced by the increasing prevalence of integrated platforms that simultaneously provide banking, insurance, investment, and asset management services.

However, the level of digitalization is not uniform across the Union. Eurozone countries such as the Netherlands, Finland, and Estonia rank among the global leaders in the use of digital payments and the adoption of open banking, benefiting from advanced digital infrastructures and high internet penetration rates (EBA, 2022). By contrast, emerging non-euro states in Central and Eastern Europe exhibit an adoption gap, caused by less developed digital infrastructure, lower levels of digital financial literacy, and weaker trust in online transactions (World Bank, 2022).

These differences create a unique research context: the EU represents a natural laboratory in which the interactions between technological innovation, financial inclusion, and market integration can be analyzed under conditions of economic and institutional diversity. In particular, assessing the impact of FinTech on financial inclusion must account for this structural and institutional heterogeneity, as well as for the degree of convergence of European financial markets.

Eastern Europe presents a distinct context with regard to the digitalization of financial services, characterized by pronounced heterogeneity in digital infrastructure, financial literacy, and regulatory frameworks. This diversity stems from differences in economic development, political priorities, and the pace of structural reforms across countries in the region.

From an infrastructural perspective, there are significant contrasts between EU member states and non-EU countries in Eastern Europe. Nations such as Estonia, Lithuania, and Poland have developed advanced digital infrastructures, with high broadband internet penetration rates and extensive mobile coverage, supported by proactive public policies in the field of digitalization. In contrast, other states in the Western Balkans or the Eastern Partnership face limitations related to connection speeds, rural coverage, and the high costs of services (ITU, 2021).

From a regulatory standpoint, the differences are equally evident. In some economies, the transposition and implementation of European norms, such as the PSD2 Directive, have been carried out quickly and effectively, fostering the development of FinTech ecosystems and integration with the Digital Single Market. In others, the process has been delayed by administrative barriers, lack of institutional capacity, and the reluctance of traditional banking sector actors to open payment infrastructures to third parties (European Commission, 2020).

This fragmentation has direct implications for digital financial inclusion. In countries with robust infrastructures and clear regulations, the adoption of FinTech services is faster and more uniform across the population. Conversely, in economies with deficient infrastructures or incomplete regulations, digital financial services tend to remain concentrated in urban areas and are predominantly used by higher-educated, higher-income segments.

Moreover, cross-border interoperability is hindered by the absence of common technical standards and by non-uniform licensing procedures for digital financial service providers. These differences not only limit the integration of financial markets in the region but also generate additional risks related to cybersecurity and data protection.

Therefore, the analysis of FinTech's impact in Eastern Europe must take these structural and institutional particularities into account, as they directly influence both the level of financial inclusion and the degree of integration of financial markets within the European Union as a whole.

Financial inclusion and financial system development represent two interdependent dimensions of economic progress, each influencing the other in a dynamic, bidirectional process

On the one hand, the development of the financial system—through the expansion of banking networks, product diversification, and greater efficiency in intermediation—creates the conditions for increasing financial inclusion. A well-developed financial system provides the necessary infrastructure for the population's access to basic financial services, such as current accounts, savings, credit, and insurance, as well as to more sophisticated financial instruments (Beck et al., 2011).

Also, financial inclusion stimulates the development of the financial system by expanding the client base, diversifying sources of deposits, and increasing transaction volumes. The participation of a greater number of individuals and enterprises in the formal economy leads to enhanced financial intermediation and the strengthening of banking sector stability, through a more balanced distribution of risks (Sarma & Pais, 2011).

In addition, financial inclusion supports the development of capital markets and stimulates innovation in financial products and services. Increased access to finance facilitates investment in human and technological capital, accelerating long-term economic growth (Demirgüç-Kunt et al., 2022). However, the relationship between these two dimensions is not without challenges: the rapid expansion of access to credit, without adequate risk assessment and management mechanisms, can generate systemic vulnerabilities.

Thus, for Eastern European economies, understanding this link is particularly important. In the context of the transition toward digital economic models and deeper integration into the European single market, the simultaneous development of financial infrastructure and inclusion represents a strategic objective with a direct impact on regional economic convergence.

The present study aims to contribute empirically to the literature on financial inclusion and FinTech development. Although both areas have been extensively discussed, the connections between them remain insufficiently examined, especially from a multidimensional perspective. Our research addresses this gap by developing comprehensive indices for financial inclusion and FinTech development, and by analyzing their relationship through panel econometric methods, with particular attention to the distinct dimensions of financial inclusion such as geographic access, demographic access, and usage.

In doing so, the study brings a more integrated understanding of the interplay between financial technologies and inclusive finance. The article is organized into six sections: Section 2 outlines the conceptual framework and defines the indicators, Section 3 explains the data and methodology, Section 4 presents the empirical results, Section 5 discusses their implications, and Section 6 concludes with final observations and avenues for future research.

2. Conceptual framework of financial inclusion indicators

Financial inclusion refers to the access to and use of formal financial services by the population under conditions of affordability, safety, and adaptation to the real needs of users. It presupposes the existence of the necessary infrastructure as well as the availability of products and services tailored to diverse socio-economic profiles.

In this study, the analysis is based on three essential dimensions: geographic access, demographic access, and usage. The indicators corresponding to these dimensions were integrated into a Multidimensional Financial Inclusion Index (FInI), constructed through statistical aggregation methods that provide a synthetic and comparable measure across countries and periods.

2.1 The dimensions of financial inclusion

Financial inclusion represents the process through which individuals and enterprises—particularly those in vulnerable or underserved segments—gain effective and affordable access to useful financial products and services tailored to their needs. It is an essential element of sustainable economic development, as it facilitates active participation in the formal economic system, contributing to the reduction of social inequalities and to enhanced economic resilience.

In this paper, financial inclusion is examined across three fundamental dimensions, drawing on indicators from the IMF Financial Access Survey that capture both the availability of financial infrastructure and the actual use of financial services. The first dimension, geographic access, reflects the physical proximity of financial institutions to the population, measured through indicators such as the number of bank branches and ATMs per square kilometer. This aspect is particularly relevant in emerging economies and rural areas, where underdeveloped infrastructure and long distances often constitute significant barriers to financial access. The second dimension, demographic access, refers to the extent to which the adult population is covered by financial infrastructure, with indicators such as the number of bank branches and ATMs per 100,000 adults offering insights into the penetration and equity of service distribution across different population groups. Finally, the usage dimension shifts the focus from availability to the effective utilization of financial services, which in this study is approximated by the volume of deposits and loans provided by commercial banks as a percentage of GDP. This last perspective highlights the degree of integration of financial services into everyday economic activity and the broader level of financial intermediation within an economy.

Each of these dimensions offers a complementary perspective on financial inclusion. A multidimensional approach is essential to avoid misinterpretations, since a high level of physical access (geographic or demographic) does not automatically guarantee increased use of financial services.

In the empirical analysis conducted in this research report, these dimensions were standardized and synthesized through Principal Component Analysis (PCA) in order to construct a Financial Inclusion Index (FInI), both at the aggregate level and separately for each dimension. This method allows for the objective aggregation of indicators and the reduction of multicollinearity, thereby facilitating cross-country and temporal comparisons.

2.2. The role of FinTech in expanding financial services

Financial technologies (FinTech) have profoundly redefined the way financial services are designed, delivered, and used, offering new opportunities to expand financial inclusion, particularly in emerging economies and underbanked areas. FinTech encompasses a wide range of digital applications and platforms—from mobile payments and internet banking services to peer-to-peer lending platforms, robo-advisors, and blockchain solutions—that reduce reliance on traditional physical infrastructure and enable rapid access to financial services via internet-connected devices.

In the context of Eastern Europe, where digital infrastructure and regulatory frameworks remain highly heterogeneous, FinTech assumes a dual role. On the one hand, it reduces geographic access barriers by eliminating the necessity of visiting physical bank branches and facilitating remote transactions. On the other hand, it enhances demographic coverage by providing scalable services that can reach both urban and rural populations, thereby overcoming the high costs traditionally associated with the expansion of conventional banking infrastructure.

The literature emphasizes that FinTech has the potential to enhance both the efficiency and the quality of financial services. This improvement is achieved by lowering costs for consumers and financial institutions (Philippon, 2016), facilitating faster access to credit and savings services (Beck et al., 2016), and enabling greater personalization of financial products through the use of algorithms and big data analytics tailored to individual client profiles (Jagtiani & Lemieux, 2019).

Furthermore, FinTech has the capacity to stimulate the use of financial services by integrating financial functionalities into already popular digital platforms (e-commerce applications, social networks), thereby reducing adoption costs and increasing transaction frequency (Claessens et al., 2018).

In this research, the adoption of FinTech is assessed using proxy indicators derived from the World Bank's World Development Indicators (WDI) database. These include fixed broadband subscriptions per 100 people, which capture the availability of the basic digital infrastructure necessary for the provision of online financial services to both individuals and firms; the share of the population using the internet, which reflects the degree of digital penetration and constitutes a key determinant of financial technology adoption; and mobile cellular subscriptions per 100 people, which indicate the level of mobile connectivity that underpins the use of FinTech applications and services, particularly mobile payments and digital banking.

These indicators capture both access to digital infrastructure and the level of online service usage, providing an indirect measure of FinTech penetration potential. The empirical analysis conducted for ten Eastern European countries (EU and non-EU) shows that higher levels of these indicators are associated with a higher overall Financial Inclusion Index, confirming the transformative role of financial technologies in modernizing and democratizing access to finance.

To isolate the specific effect of FinTech adoption on financial inclusion and to reduce the risk of biased estimates, the econometric models incorporate a series of theoretically grounded and empirically validated control variables. Trade openness, measured as a percentage of GDP, captures the degree of integration of an economy into international trade; higher levels of external trade are typically associated with more sophisticated financial infrastructures that facilitate cross-border payments and access to external finance, thereby indirectly influencing financial inclusion through both increased demand for services and technology transfer. Gross fixed capital formation, expressed as a share of GDP, reflects the level of investment in infrastructure and productive assets, which is often linked to the development of financial networks and digital systems that support the expansion of both banking and FinTech services. In addition, the education level, measured as mean years of schooling in line with ISCED standards, serves as a proxy for human capital, a key determinant of the capacity to use both traditional and digital financial products; higher education levels are generally associated with greater financial literacy and faster adoption of financial technologies. By integrating these control variables, with data drawn from the World Bank's WDI database, the models aim to minimize omitted-variable bias and ensure that the estimated impact of FinTech adoption is not conflated with broader macroeconomic or structural factors.

2.3 Challenges and limitations in measuring financial inclusion

Although the concept of financial inclusion is widely recognized as essential for economic development and for reducing social inequalities, its rigorous measurement remains a significant methodological challenge. This is due both to the complexity of the phenomenon and to the availability and quality of data.

Several limitations should be acknowledged in the analysis of financial inclusion. First, from a conceptual perspective, financial inclusion is inherently multidimensional, encompassing not only physical access to financial services but also their actual use and quality (Sarma & Pais, 2011). The mere existence of financial infrastructure does not automatically translate into active participation in the formal financial system. Moreover, the absence of a universally accepted definition has led to the use of heterogeneous sets of indicators across studies, which complicates the comparability of results. A second limitation relates to the availability and quality of data. In many emerging economies and in countries with weaker statistical systems, information on financial services is often incomplete, highly aggregated, or reported with considerable delays. Although our study relies on the IMF Financial Access Survey and the World Development Indicators to ensure consistency, this does not fully eliminate the risks of reporting errors or methodological inconsistencies across countries. A further challenge concerns the measurement of the digital dimension of financial inclusion. Many innovations driven by FinTech are not yet adequately reflected in official statistics, leading to an underestimation of the real extent of digital financial inclusion (Ozili, 2018). For instance, app-based payments and cryptocurrency usage remain insufficiently integrated into standardized indicators. In addition, the process of aggregating indicators carries the risk of information loss. While dimensionality-reduction techniques such as Principal Component Analysis (PCA) are valuable in synthesizing information and mitigating multicollinearity, they rely on statistically determined weights that may not accurately capture the relative importance of specific indicators in different local contexts (Cámara & Tuesta, 2014). Finally, financial inclusion is deeply shaped by contextual and structural factors—including macroeconomic stability, financial literacy, digital infrastructure, and trust in financial institutions—that are not always quantified or explicitly incorporated into composite indices. As a result, analyses may produce only partial or even distorted interpretations of the phenomenon.

In our view, measuring financial inclusion requires a combined approach that integrates traditional indicators of access and usage with new metrics that capture the adoption and use of digital financial services. At the same time, improving the quality and frequency of data collection is essential to ensure accurate monitoring of progress and the early identification of lagging areas.

3. Data and methodology

The methodology adopted in this research pursues two major objectives: first, the construction of a multidimensional index of traditional financial inclusion for a group of Eastern European countries; and second, the estimation of the impact of FinTech adoption on this index and on its sub-indices, using panel regressions (OLS and Fixed Effects).

3.1 Selection of the data sample

The research sample comprises ten emerging economies, including several of the less developed countries of Eastern Europe: Albania, Bosnia and Herzegovina, Bulgaria, Georgia, Moldova, Montenegro, North Macedonia, Romania, Serbia, and Ukraine. The selection of this group is grounded in both theoretical and practical considerations. First, it reflects a diversity of economic and institutional contexts, as the sample includes EU member states, such as Bulgaria and Romania, alongside non-EU countries that are economically and geographically linked to the region. This composition enables a comparative analysis of the effects of European legislative frameworks and financial integration policies relative to the situation of countries outside the EU. Second, all the selected economies share a similar trajectory of post-communist transition. Since the 1990s, they have undergone extensive processes of market liberalization, banking sector restructuring, and, more recently, a rapid digitalization of financial services. As highlighted in the literature, such transitional contexts generate both opportunities for innovation and vulnerabilities with respect to financial inclusion (Beck & Brown, 2011). Third, the countries exhibit significant variation in digital infrastructure, including differences in internet penetration, broadband coverage, and mobile technology adoption. This heterogeneity provides a valuable basis for examining the extent to which FinTech can complement or substitute for traditional banking infrastructure (Demirgüç-Kunt et al., 2022).

The analysis covers the period from 2010 to 2023, a timeframe chosen for both conceptual and practical reasons. The year 2010 marks an early stage in the maturity of the FinTech ecosystem in Eastern Europe, coinciding with the rapid spread of smartphones and the introduction of the first mobile payment platforms in the region. Starting from this benchmark makes it possible to capture the full trajectory of digital financial services, from their emergence to their consolidation. The endpoint, 2023, corresponds to the most recent year for which complete and comparable data are available from international sources such as the IMF Financial Access Survey and the World Development Indicators. This period also encompasses the post-COVID-19 recovery, when the use of digital financial services expanded at an unprecedented pace (BIS, 2022). By combining a set of countries with diverse structural characteristics yet bound by geographical and historical proximity, and by extending the analysis over more than a decade, the study ensures sufficient variation to rigorously test the research hypotheses while also capturing the medium- and long-term effects of FinTech adoption on financial inclusion, thus avoiding the limitations inherent in short-term assessments.

3.2 Construction of multidimensional indices for financial inclusion

The process of constructing the Financial Inclusion Index (FInI) followed a rigorous methodology, based on Principal Component Analysis (PCA), applied in several stages to ensure the comparability and statistical relevance of the results.

In the first stage of the analysis, Principal Component Analysis (PCA) was applied separately to each dimension of financial inclusion. The geographic dimension (GEOG) captures the density of bank branches and ATMs relative to surface area, while the demographic dimension reflects the density of these facilities in relation to the population. The usage dimension, in turn, is represented by indicators measuring deposits and loans as a percentage of GDP.

In the second stage of the analysis, the raw PCA results—component loadings and eigenvalues—were transformed into normalized weights for each indicator, with the restriction that the weights within each dimension sum to one. The initial values of the indicators were then multiplied by these normalized weights and aggregated, which allowed for the construction of three distinct sub-indices: the Geographic Index, the Demographic Index, and the Usage Index.

Principal Component Analysis (PCA) yields two key outputs: the loadings (PCk,v), which capture the contribution of each variable v to a given principal component k, and the eigenvalues (EV)k, which indicate the share of variance accounted for by each component.

For each indicator v, an intermediate score is calculated by summing its contributions across all retained components (K):

$$\text{Score}_v = \sum_{k=1}^{K} PC_{k,v} \cdot EV_k \quad \text{Equation (1)}$$

To obtain the normalized weight, the intermediate score of each indicator is divided by the sum of the intermediate scores of all indicators within the same dimension:

$$w_v = \frac{\text{Score}_v}{\sum_{j=1}^{n} \text{Score}_j} \quad \text{Equation (2)}$$

$$\sum_{v=1}^{n} w_v = 1.$$

For the geographic dimension (GEOG), the analysis relies on two variables: the number of ATMs per 1,000 square kilometers (ATM_KM) and the number of bank branches per 1,000 square kilometers (UBT_KM).

$$\text{Score}_{\text{ATM\_KM}} = \sum_{k=1}^{K_{\text{GEOG}}} PC_{k,\text{ATM\_KM}} \cdot EV_k^{(\text{GEOG})} \quad \text{Equation (3)}$$

$$\text{Score}_{\text{UBT\_KM}} = \sum_{k=1}^{K_{\text{GEOG}}} PC_{k,\text{UBT\_KM}} \cdot EV_k^{(\text{GEOG})} \quad \text{Equation (4)}$$

The normalized weights are explained below, in equations 5 and 6.

$$w_{\text{ATM\_KM}}^{(\text{GEOG})} = \frac{\text{Score}_{\text{ATM\_KM}}}{\text{Score}_{\text{ATM\_KM}} + \text{Score}_{\text{UBT\_KM}}} \quad \text{Equation (5)}$$

$$w_{\text{UBT\_KM}}^{(\text{GEOG})} = \frac{\text{Scor}_{\text{UBT\_KM}}}{\text{Score}_{\text{ATM\_KM}} + \text{Score}_{\text{UBT\_KM}}} \quad \text{Equation (6)}$$

$$\text{GEOG}_{it} = w_{\text{ATM\_KM}}^{(\text{GEOG})} \cdot \text{ATM}_{\text{KM}_{it}} + w_{\text{UBT}_{\text{KM}}}^{(\text{GEOG})} \cdot \text{UBT}_{\text{KM}_{it}} \quad \text{Equation (7)}$$

For the demographic dimension (DEMOG), the variables considered are the number of ATMs per 100,000 adults (ATM_POP) and the number of bank branches per 100,000 adults (UBT_POP).

$$w_{\text{ATM\_POP}}^{(\text{DEMOG})} = \frac{\sum_{k=1}^{K_{\text{DEMOG}}} PC_{k,\text{ATM\_POP}} \cdot EV_k^{(\text{DEMOG})}}{\sum_{v\in\{\text{ATM\_POP},\text{UBT\_POP}\}} \sum_{k=1}^{K_{\text{DEMOG}}} PC_{k,v} \cdot EV_k^{(\text{DEMOG})}} \quad \text{Equation (8)}$$

$$w_{\text{UBT\_POP}}^{(\text{DEMOG})} = \frac{\sum_{k=1}^{K_{\text{DEMOG}}} PC_{k,\text{UBT\_POP}} \cdot EV_k^{(\text{DEMOG})}}{\sum_{v\in\{\text{ATM\_POP},\text{UBT\_POP}\}} \sum_{k=1}^{K_{\text{DEMOG}}} PC_{k,v} \cdot EV_k^{(\text{DEMOG})}} \quad \text{Equation (9)}$$

$$\text{DEMOG}_{it} = w_{\text{ATM\_POP}}^{(\text{DEMOG})} \cdot \text{ATM\_POP}_{it} + w_{\text{UBT}_{\text{POP}}}^{(\text{DEMOG})} \cdot \text{UBT}_{\text{POP}_{it}} \quad \text{Equation (10)}$$

For the usage dimension (UTIL), the analysis employs two variables: deposits in commercial banks as a percentage of GDP (DEP_GDP) and loans granted by commercial banks as a percentage of GDP (CRED_GDP).

$$w_{\text{DEP\_PIB}}^{(\text{UTIL})} = \frac{\sum_{k=1}^{K_{\text{UTIL}}} PC_{k,\text{DEP\_PIB}} \cdot EV_k^{(\text{UTIL})}}{\sum_{v\in\{\text{DEP\_PIB},\text{CRED\_PIB}\}} \sum_{k=1}^{K_{\text{UTIL}}} PC_{k,v} \cdot EV_k^{(\text{UTIL})}} \quad \text{Equation (11)}$$

$$w_{\text{CRED\_PIB}}^{(\text{UTIL})} = \frac{\sum_{k=1}^{K_{\text{UTIL}}} PC_{k,\text{CRED\_PIB}} \cdot EV_k^{(\text{UTIL})}}{\sum_{v\in\{\text{DEP\_PIB},\text{CRED\_PIB}\}} \sum_{k=1}^{K_{\text{UTIL}}} PC_{k,v} \cdot EV_k^{(\text{UTIL})}} \quad \text{Equation (12)}$$

$$\text{UTIL}_{it} = w_{\text{DEP\_PIB}}^{(\text{UTIL})} \cdot \text{DEP}_{\text{PIB}\ it} + w_{\text{CRED}_{\text{PIB}}}^{(\text{UTIL})} \cdot \text{CRED}_{\text{PIB}\ it} \quad \text{Equation (13)}$$

Because the units of measurement of the indicators were heterogeneous, the resulting sub-indices were standardized using the z-score formula.

$$Z = \frac{X-\mu}{\sigma} \quad \text{Equation (14)}$$

Where:
X = the value of the sub-index;
μ = the mean of the sub-index;
σ = standard deviation.

After the standardization process, PCA was reapplied to the three sub-indices, using the same procedure of weighting with eigenvalues and normalization. This approach produced the Financial Inclusion Index (FInI), which subsequently served as the dependent variable in the econometric models.

$$S_{GEOG} = \sum_{k=1}^{m} \left(PC_{k,GEOG} \times EV_k\right) \quad \text{Equation (15)}$$

$$S_{DEMOG} = \sum_{k=1}^{m} \left(PC_{k,DEMOG} \times EV_k\right) \quad \text{Equation (16)}$$

$$S_{UTIL} = \sum_{k=1}^{m} \left(PC_{k,UTIL} \times EV_k\right) \quad \text{Equation (17)}$$

Where:

$PC_{k,i}$ is the coefficient of principal component k for sub-index i (GEOG, DEMOG, UTIL);

EV_k is the eigenvalue associated with component k;

m is the number of retained components.

$$W_{GEOG} = \frac{S_{GEOG}}{S_{GEOG}+S_{DEMOG}+S_{UTIL}} \quad \text{Equation (18)}$$

$$W_{DEMOG} = \frac{S_{DEMOG}}{S_{GEOG}+S_{DEMOG}+S_{UTIL}} \quad \text{Equation (19)}$$

$$W_{UTIL} = \frac{S_{UTIL}}{S_{GEOG}+S_{DEMOG}+S_{UTIL}} \quad \text{Equation (20)}$$

$$FInI = W_{GEOG} \cdot Z_{GEOG} + W_{DEMOG} \cdot Z_{DEMOG} + W_{UTIL} \cdot Z_{UTIL} \quad \text{Equation (21)}$$

In the case of the FinTech Index, the methodology was similar; however, standardization of indicators was not required, since all variables (mobile cellular subscriptions, fixed broadband subscriptions, and internet usage) were expressed in homogeneous units (per 100 people or as a percentage of the population). PCA and weighted aggregation using eigenvalues led directly to the composite index.

For each indicator $v \in \{\text{AI}, \text{UI}, \text{AT}\}$:

$$\text{Scor}_v = \sum_{k=1}^{K_{\text{FinTech}}} PC_{k,v}^{(\text{FinTech})} \cdot EV_k^{(\text{FinTech})} \quad \text{Equation (22)}$$

Where:

$PC_{k,v}$ = the coefficient of variable v on principal component k

EV_k = the eigenvalue associated with component k;

K_{FinTech} = the number of retained components;

AI = fixed broadband subscriptions per 100 inhabitants
UI = internet usage (% of population)
AT = mobile cellular subscriptions per 100 inhabitants.

The normalized weight of each indicator is obtained by dividing its score by the sum of the scores of the three indicators.

$$w_v^{(\text{FinTech})} = \frac{\text{Scor}_v}{\text{Scor}_{\text{AI}}+\text{Scor}_{\text{UI}}+\text{Scor}_{\text{AT}}} \quad \text{Equation (23)}$$

$$w_{\text{AI}}^{(\text{FinTech})} = \frac{\sum_{k=1}^{K} PC_{k,\text{AI}} \cdot EV_k}{\sum_{v\in\{\text{AI,UI,AT}\}} \sum_{k=1}^{K} PC_{k,v} \cdot EV_k} \quad \text{Equation (24)}$$

$$w_{\text{UI}}^{(\text{FinTech})} = \frac{\sum_{k=1}^{K} PC_{k,\text{UI}} \cdot EV_k}{\sum_{v\in\{\text{AI,UI,AT}\}} \sum_{k=1}^{K} PC_{k,v} \cdot EV_k} \quad \text{Equation (25)}$$

$$w_{\text{AT}}^{(\text{FinTech})} = \frac{\sum_{k=1}^{K} PC_{k,\text{AT}} \cdot EV_k}{\sum_{v\in\{\text{AI,UI,AT}\}} \sum_{k=1}^{K} PC_{k,v} \cdot EV_k} \quad \text{Equation (26)}$$

$$\text{FinTech}_{it} = w_{\text{AI}}^{(\text{FinTech})} \cdot AI_{it} + w_{\text{UI}}^{(\text{FinTech})} \cdot UI_{it} + w_{\text{AT}}^{(\text{FinTech})} \cdot AT_{it} \quad \text{Equation (27)}$$

The normalized weights of the indicators were calculated based on PCA, ensuring that their sum equals 1. They reflect the relative importance of each digital indicator (FB, IU, MC) in the construction of the FinTech Index.

To ensure the validity of the econometric estimates and to avoid spurious regressions, all-time series employed in the analysis were tested for stationarity using the ADF-Fisher method applied to panel data. The test evaluates the null hypothesis that a series contains a unit root, implying non-stationarity, against the alternative hypothesis of stationarity. The results revealed that, in levels, all variables exhibited unit roots and were therefore non-stationary. As a result, first-order differencing was applied, according to the general formula.

$$\Delta X_{it} = X_{it} - X_{i,t-1}, i = 1, \ldots, N, t = 2, \ldots, T \quad \text{Equation (28)}$$

where ΔX_{it} represents the annual variation of the variable X.

$$\Delta \text{FInI}_{it} = \text{FInI}_{it} - \text{FInI}_{i,t-1} \quad \text{Equation (29)}$$

$$\Delta \text{FinTech}_{it} = \text{FinTech}_{it} - \text{FinTech}_{i,t-1} \quad \text{Equation (30)}$$

$$\Delta \text{EDU}_{it} = \text{EducationLevel}_{it} - \text{EducationLevel}_{i,t-1} \quad \text{Equation (31)}$$

$$\Delta \text{FBCF}_{it} = \text{GrossFixedCapitalFormation}_{it} - \text{GrossFixedCapitalFormation}_{i,t-1} \quad \text{Equation (32)}$$

$$\Delta \text{DESCOM}_{it} = \text{TradeOpenness}_{it} - \text{TradeOpenness}_{i,t-1} \quad \text{Equation (33)}$$

After differencing, all series ($\triangle$ FInI, $\triangle$ FinTech, $\triangle$ EDU, $\triangle$ FBCF, $\triangle$ DESCOM) were retested and their stationarity was confirmed, which allows for the correct estimation of the econometric models.

After constructing the indices and transforming the series into stationary variables through first-order differencing, the relationships between FinTech development and financial inclusion (FInI) were estimated using panel data regression models. The estimated general linear model is:

$$\Delta FInI_{it} = \alpha + \beta_1 \Delta FinTech_{it} + \beta_2 \Delta EDU_{it} + \beta_3 \Delta FBCF_{it} + \beta_4 \Delta DESCOM_{it} + \varepsilon_{it} \quad \text{Equation (34)}$$

$$\triangle GEOG_{it} = \alpha_i + \beta_1 \triangle FinTech_{it} + \beta_2 \triangle EDU_{it} + \beta_3 \triangle FBCF_{it} + \beta_4 \triangle DESCOM_{it} + \varepsilon_{it} \quad \text{Equation (35)}$$

$$\triangle DEMOG_{it} = \alpha_i + \beta_1 \triangle FinTech_{it} + \beta_2 \triangle EDU_{it} + \beta_3 \triangle FBCF_{it} + \beta_4 \triangle DESCOM_{it} + \varepsilon_{it} \quad \text{Equation (36)}$$

$$\triangle UTIL_{it} = \alpha_i + \beta_1 \triangle FinTech_{it} + \beta_2 \triangle EDU_{it} + \beta_3 \triangle FBCF_{it} + \beta_4 \triangle DESCOM_{it} + \varepsilon_{it} \quad \text{Equation (37)}$$

where:
$\triangle FInI_{it}$ = the variation of the financial inclusion index for country i in year t;
$\Delta FinTech_{it}$ = the variation of the FinTech index;
$\triangle EDU_{it}$ = the variation of the average education level (years of schooling)
$\triangle FBCF_{it}$ = the variation of gross fixed capital formation (% of GDP);

$\triangle DESCOM_{it}$ = the variation of trade openness (% of GDP)
$\triangle GEOG_{it}$ = the variation of the geographic access index;
$\triangle DEMOG_{it}$ = the variation of the demographic access index;
$\triangle UTIL_{it}$ = the variation of the financial services usage sub-index;
ε_{it} = the error term.

Estimation using pooled OLS assumes homogeneity across countries, treating the data as a common sample without accounting for the specific characteristics of each country.To capture unobserved heterogeneity at the country level (institutions, banking traditions, structural particularities), we extended the model by including country fixed effects.

$$\Delta FInI_{it} = \alpha_i + \beta_1 \Delta FinTech_{it} + \beta_2 \Delta EDU_{it} + \beta_3 \Delta FBCF_{it} + \beta_4 \Delta DESCOM_{it} + \varepsilon_{it} \quad \text{Equation (38)}$$

$$\triangle GEOG_{it} = \alpha_i + \beta_1 \triangle FinTech_{it} + \beta_2 \triangle EDU_{it} + \beta_3 \triangle FBCF_{it} + \beta_4 \triangle DESCOM_{it} + \varepsilon_{it} \quad \text{Equation (39)}$$

$$\triangle DEMOG_{it} = \alpha_i + \beta_1 \triangle FinTech_{it} + \beta_2 \triangle EDU_{it} + \beta_3 \triangle FBCF_{it} + \beta_4 \triangle DESCOM_{it} + \varepsilon_{it} \quad \text{Equation (40)}$$

$$\triangle UTIL_{it} = \alpha_i + \beta_1 \triangle FinTech_{it} + \beta_2 \triangle EDU_{it} + \beta_3 \triangle FBCF_{it} + \beta_4 \triangle DESCOM_{it} + \varepsilon_{it} \quad \text{Equation (41)}$$

where:
α_i = a country-specific intercept (capturing time-invariant characteristics).

This specification eliminates the bias generated by the correlation between the explanatory variables and the countries' time-invariant characteristics.The coefficient β1 highlights the marginal effect of FinTech on financial inclusion, indicating that an increase in the FinTech index leads, on average, to a variation of β1 units in FInI, while the inclusion of control variables (EDU, FBCF, DESCOM) allows isolating this impact from the influence of other relevant macroeconomic factors; to test the robustness of the results and the relevance of cross-country differences, we compared the estimates obtained through pooled OLS and Fixed Effects OLS.

4. Results

Building on the methodology presented above, we now summarize the main empirical results obtained, both with respect to the construction of the multidimensional financial inclusion index and its associated sub-indices, as well as the estimates of the impact of FinTech adoption on them, based on the applied econometric models.

4.1 The effects of FinTech on geographic access (ΔGEOG)

In the OLS model, the coefficient associated with the FinTech Index variable is positive and statistically significant at the 1% level (β = 0.010178; p = 0.0053 – as presented in table 1), indicating that a one-unit increase in the FinTech Index is associated, on average, with an increase of approximately 0.0102 units in geographic access, ceteris paribus. The control variables Education Level and Gross Fixed Capital Formation also show positive and significant effects, while Trade Openness has a negative but insignificant effect.

In the Fixed Effects model, the FinTech coefficient remains positive and significant at the 1% level (β = 0.009522, p = 0.0082), even after controlling for unobserved heterogeneity across countries. The magnitude of the effect is slightly smaller compared to the OLS model, suggesting that part of the variation observed in OLS is explained by country-specific factors. The results for the control variables are similar: education and fixed investments have positive effects, while trade openness shows a negative effect without statistical significance.

The explanatory power of the models is relatively modest (adjusted $R^2 < 0.20$), indicating that although FinTech has a robust positive impact on geographic access, there are other factors not included in the model that contribute to its variation, such as physical infrastructure, government policies, or logistical barriers.

Table 1. Estimation Results for Geographic Access

Variables	OLS (β)	p-val.	Fixed Effects (β)	p-val.
ΔFinTech *(FinTech Index)*	0.010178***	0.0053	0.009522***	0.0082
ΔEDU *(Education Level)*	0.036691**	0.0484	0.039702*	0.0683
ΔFBCF *(Gross Fixed Capital Formation)*	0.012394***	0.0097	0.012342**	0.0127
ΔDESCOM *(Trade Openness)*	-0.000911	0.2861	-0.000923	0.2934
R^2	0.1613	—	0.1944	—
R^2 adjusted	0.1344	—	0.1041	—
Prob(F-statistic)	0.000187	—	0.015820	—

Note: *** p < 0,01, ** p < 0,05, * p < 0,1.
Source: author's own elaboration based on the econometric processing of data

4.2 The effects of FinTech on demographic access (ΔDEMOG)

In the OLS model, the coefficient associated with the FinTech Index variable is positive and statistically significant at the 1% level (β = 0.008624; p = 0.0031 – as shown in table 2), indicating that a one-unit increase in the FinTech Index leads, on average, to an increase of approximately 0.0086 units in the demographic access index, ceteris paribus. The control variables Education Level and Gross Fixed Capital Formation show positive and significant effects, while Trade Openness has a negative but statistically insignificant effect.

Table 2. Estimation results for demographic access

Variables	OLS (β)	p-val.	Fixed Effects (β)	p-val.
ΔFinTech (*FinTech Index*)	0.008624***	0.0031	0.008392***	0.0034
ΔEDU (*Education Level*)	0.043215**	0.0284	0.045007**	0.0312
ΔFBCF (*Gross Fixed Capital Formation*)	0.010572**	0.0147	0.010398**	0.0174
ΔDESCOM (*Trade Openness*)	-0.000745	0.3192	-0.000732	0.3289
R^2	0.1835	—	0.2012	—
R^2 adjusted	0.1578	—	0.1185	—
Prob(F-statistic)	0.000094	—	0.011427	—

Note: *** p < 0,01, ** p < 0,05, * p < 0,1.
Sursa: author's own elaboration based on the econometric processing of data

In the Fixed Effects model, the FinTech coefficient remains positive and statistically significant at the 1% level (β = 0.008392, p = 0.0034), and the magnitude of the effect is very close to that estimated in OLS, which indicates robustness with respect to controlling for structural heterogeneity across countries. The control variables retain both their sign and statistical significance, suggesting that investments in fixed capital and the level of education contribute to the increase in demographic access.

The explanatory power of the models is slightly higher than that obtained for geographic access, with adjusted R^2 values exceeding 15% in both cases. This suggests that variation in demographic access is explained to a greater extent by the factors included in the model, compared to geographic access.

4.3 The effects of FinTech on the usage of financial services (ΔUTIL)

In the OLS model, the coefficient associated with the FinTech Index is positive and statistically significant at the 5% level (β = 0.007584; p = 0.0146 – as presented in table 3), indicating that a one-unit increase in the FinTech Index is associated, on average, with an increase of 0.0076 units in the financial services usage index, ceteris paribus. Among the control variables, Education Level and Gross Fixed Capital Formation show positive and significant effects, while Trade Openness has a negative and statistically insignificant effect.

Table 3. Estimation results for the usage of financial services

Variables	OLS (β)	p-val.	Fixed Effects (β)	p-val.
ΔFinTech *(FinTech Index)*	0.007584**	0.0146	0.007251**	0.0179
ΔEDU *(Education Level)*	0.039802**	0.0417	0.041198**	0.0445
ΔFBCF *(Gross Fixed Capital Formation)*	0.009876**	0.0205	0.009723**	0.0232
ΔDESCOM *(Trade Openness)*	-0.000698	0.3478	-0.000685	0.3561
R^2	0.1792	—	0.1965	—
R^2 adjusted	0.1534	—	0.1138	—
Prob(F-statistic)	0.000118	—	0.012093	—

Note: *** p < 0,01, ** p < 0,05, * p < 0,1.
Sursa: author's own elaboration based on the econometric processing of data

In the Fixed Effects model, the FinTech coefficient remains positive and significant at the 5% level (β = 0.007251, p = 0.0179), with a magnitude very close to that estimated in OLS. This result suggests that the impact of FinTech on the usage of financial services is robust and does not essentially depend on the fixed, unobserved characteristics of each country. The control variables maintain the direction of their effects and their level of statistical significance, confirming the positive link between human and physical capital development and the intensity of financial services usage.

The explanatory power of the models is comparable to that obtained for demographic access, indicating that a significant part of the variation in the usage of financial services is captured by the variables included in the model.

4.4 The effects of FinTech on the overall financial inclusion index (FInI)

In the OLS model, the coefficient associated with the FinTech Index variable is positive and statistically significant at the 1% level (β = 0.008909; p = 0.0026 – as shown in table 4). This indicates that a one-unit increase in the FinTech Index leads, on average, to an increase of approximately 0.0089 units in the FInI index, ceteris paribus. The control variables Education Level and Gross Fixed Capital Formation have positive and significant effects, while Trade Openness shows a negative but insignificant effect.

Table 4. Estimation results for the FInI index

Variables	OLS (β)	p-val.	Fixed Effects (β)	p-val.
ΔFinTech *(FinTech Index)*	0.008909***	0.0026	0.008574***	0.0029
ΔEDU *(Education Level)*	0.042531**	0.0265	0.044178**	0.0294
ΔFBCF *(Gross Fixed Capital Formation)*	0.010981***	0.0089	0.010832***	0.0097
ΔDESCOM *(Trade Openness)*	-0.000784	0.3071	-0.000772	0.3145
R^2	0.1967	—	0.2145	—
R^2 adjusted	0.1711	—	0.1322	—
Prob(F-statistic)	0.000061	—	0.009843	—

Note: *** p < 0,01, ** p < 0,05, * p < 0,1.
Sursa: author's own elaboration based on the econometric processing of data

In the Fixed Effects model, the FinTech coefficient remains positive and significant at the 1% level (β = 0.008574, p = 0.0029), with a magnitude almost identical to that obtained in OLS. This confirms the robustness of the positive relationship between the development of the FinTech sector and the overall level of financial inclusion, independent of the structural characteristics specific to each country. The control variables retain their sign and significance, suggesting that investments in physical and human capital support improvements in financial inclusion.

From the perspective of explanatory power, the models show adjusted R^2 values higher than those obtained for the sub-indices, which suggests that FinTech and the included control variables succeed in capturing a greater share of the variation in the FInI index.

5. Implications and discussions

Practical implications can be highlighted from several perspectives, given the robustness of the results. For public policies, the findings suggest that accelerating FinTech adoption may contribute to reducing access disparities, particularly in rural or remote areas where the operating costs of traditional banks are high.

From the perspective of banks and financial service providers, our results point to the opportunity to more intensively integrate digital solutions to expand the client base and increase the frequency of financial product usage, while for consumers, the development of the FinTech Index facilitates quick and low-cost access to a wide range of services—from mobile payments to microloans and online investments—reducing traditional barriers related to location or complex documentation.

In the past, the expansion of banking networks required massive investments in physical infrastructure, whereas today, a single efficient mobile application can serve thousands of clients across different regions at almost zero marginal costs. Moreover, data integration and process automation enable the provision of products tailored to each user's profile, thereby enhancing both inclusion and the actual usage of services.

Taken together, the results indicate that the FinTech Index is not merely a complement to the traditional banking system, but rather a transformative factor that redefines how the financial system is perceived and accessed in Europe. However, the consolidation of this trend depends on coherent policies regarding financial education, consumer protection, and the establishment of a regulatory framework adapted to technological innovation.

Extending the impact of the research findings, we argue that financial technologies have real potential to accelerate financial inclusion, but their maximum benefits can only be achieved through their strategic integration into national and regional policies. In our view, such integration requires coordinated action along three major dimensions: infrastructure, regulation, and education.

First, regarding the development of digital and financial infrastructure, we consider it necessary to expand broadband coverage and improve access to mobile internet, particularly in rural and peripheral areas, in order to reduce digital divides. In addition, the creation of interconnected platforms between banks, FinTechs, and other financial institutions is required to facilitate data transfer and service interoperability. Furthermore, we emphasize the importance of fostering innovation through regulatory sandbox environments, where FinTech solutions can be tested without major risks to the financial system.

Second, with respect to adapting the regulatory framework, we argue that it is necessary to simplify authorization and licensing procedures for FinTech startups, while maintaining cybersecurity standards, and to implement common standards for digital identity and KYC (Know Your Customer) that are accepted nationally and, ideally, regionally. At the same time, it is essential to establish a mandatory open banking framework, allowing clients to securely transfer their data between different financial service providers.

Third, giving due importance to financial education and consumer trust, we consider it vital to introduce digital financial education programs in schools and universities, as well as in disadvantaged communities, along with national awareness campaigns on the safety of online transactions, in order to reduce reluctance toward using FinTech services. Equally necessary is the expansion of partnerships between governments, NGOs, and the private sector to support the digital literacy of vulnerable groups, particularly the elderly and low-income individuals.

Finally, we highlight the opportunity to stimulate innovation with social impact by creating public and private funds dedicated to FinTech projects with clear financial inclusion objectives. In the same context, we argue that it is necessary to prioritize solutions addressing unmet needs such as microloans for small entrepreneurs, low-cost insurance, and accessible savings instruments. By extension, collaboration between traditional banks and FinTechs should be encouraged to co-create hybrid financial products that combine the advantages of technology with the existing physical network.

If governments treat FinTech merely as a market phenomenon, its benefits for financial inclusion will be distributed unequally, amplifying existing disparities. Conversely, through strategic integration into public policies, FinTech can become a catalyst for financial equity, reducing gaps between urban and rural areas, between young and elderly populations, and between developed and emerging economies.

The practical implications of the research findings can also be directed toward central banks and financial supervisory authorities. These institutions play a central role in ensuring a safe and stable framework for the development of financial technologies while supporting financial inclusion objectives. In the context of the rapid growth of the FinTech sector in Europe, they must balance the promotion of innovation with the management of risks associated with the digital transformation of financial systems.

A first area of action is the creation and implementation of adaptive regulatory frameworks that provide legal clarity to FinTech operators and reduce uncertainty for investors. Regulatory sandbox models allow for the controlled testing of innovative products and services, while at the same time enabling authorities to monitor emerging risks.

Furthermore, central banks are responsible for supporting the standardization of payment infrastructure and the interoperability of financial systems—essential elements for reducing market fragmentation and expanding access to financial services. In this regard, projects such as instant payments, unique digital identity, and open banking can significantly contribute to accelerating financial inclusion.

From the perspective of financial stability, supervisory authorities must develop advanced mechanisms for monitoring cyber, operational, and systemic risks associated with FinTech. The implementation of strict security protocols, together with the promotion of financial and digital literacy, helps strengthen public trust and protect consumers.

Last but not least, central banks can stimulate innovation through public–private partnerships and by supporting research and development projects in financial technologies with social impact. This proactive role, aimed at balancing benefits and risks, is essential for FinTech to contribute in the long term to an inclusive, safe, and sustainable financial system.

In turn, international organizations and regional cooperation frameworks are key actors in facilitating an ecosystem conducive to FinTech development, particularly by creating common standards and promoting the exchange of best practices among states. In the European context, institutions such as the European Union (EU), the European Central Bank (ECB), the International Monetary Fund (IMF), the World Bank, and the Organization for Economic Co-operation and Development (OECD) exert major influence on the regulatory framework, digital infrastructure, and financial inclusion policies.

An important role of these organizations is the harmonization of regulations and the reduction of cross-border barriers that may limit the expansion of FinTech services. Through common directives and regulations, such as PSD2 or initiatives related to the European digital identity, the EU lays the groundwork for interoperability of digital financial services and non-discriminatory access to markets.

International organizations also support knowledge transfer and capacity building through technical assistance programs, conferences, collaboration platforms, and the financing of innovative projects. The World Bank's programs for the digitalization of government payments and the support of SMEs through FinTech solutions are relevant examples in this regard.

Regional cooperation also facilitates the management of cross-border risks such as digital fraud, money laundering, or cyberattacks. The creation of regional centers for cyber incident monitoring and response can provide enhanced protection for users and financial institutions.

Moreover, through multi-stakeholder collaboration platforms, international organizations can stimulate partnerships between the public sector, the private sector, and academia, accelerating innovation and reducing digital divides among member states. Thus, the active involvement of these entities not only complements but also amplifies national efforts, steering FinTech development toward financial inclusion objectives and sustainable economic stability.

6. Conclusions

The analysis of the effects of financial technologies on financial inclusion in Europe highlights a positive, consistent, and robust impact of FinTech Index development across all dimensions considered in the study: geographic access, demographic access, usage of financial services, and the overall FInI index. The coefficients associated with the FinTech Index are statistically significant in all models, with relatively close values between OLS and Fixed Effects specifications, suggesting that the observed relationship is not driven by country-specific structural factors but rather reflects a general trend in the region.

In terms of magnitude, the strongest effect is observed on geographic access and the overall FInI index, followed closely by demographic access and financial services usage. This can be interpreted as evidence that the FinTech Index simultaneously operates along two main directions: (1) expanding geographic coverage through the digitalization of services and the reduction of dependence on physical infrastructure (bank branches, ATMs); (2) diversifying and personalizing the financial offering for previously underserved or excluded population segments, both in terms of access and usage of services.

In summary, the research results confirm that FinTech is not merely a complementary tool but a true catalyst for financial inclusion in emerging economies of Eastern Europe. Its positive, consistent, and robust impact across all dimensions analyzed—geographic access, demographic access, usage, and the overall financial inclusion index—demonstrates that financial technologies have the capacity to redefine the architecture of financial systems, reducing dependence on traditional infrastructure and broadening the base of participants in the economic circuit. At the same time, the practical implications reveal that the maximum benefits of FinTech do not emerge spontaneously, but rather require strategic integration into public policies and the strategies of financial institutions, supported by an adaptive regulatory framework, solid digital infrastructure, and a high level of financial literacy.

Thus, FinTech is not merely a technological innovation but a transformative factor with profound social and economic implications: it can reduce disparities between urban and rural areas, between young and elderly populations, and between advanced and emerging economies, while also accelerating regional convergence. To the extent that governments, central banks, international institutions, and private actors collaborate to create an enabling ecosystem, FinTech has the potential to become a key pillar of financial equity and stability in Europe, fostering more inclusive and sustainable long-term economic development.

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