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REGIONAL DEVELOPMENT UNDER DIGITAL TRANSITION: FINTECH, GEOPOLITICAL SHOCKS, AND SUSTAINABILITY IN EASTERN EUROPE

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Abstract

Digitalisation has gained momentum in the last decade, on the grounds of global economic instability, amplified by disruptions related to pandemics and geopolitical tensions. The lockdown in 2020 has accentuated the dynamics of financial technology development, forcibly reshaping financial and banking mechanisms, the operation of regional economic systems, as well as territorial governance systems. This paper analyses how regional development, especially in Eastern European countries, is affected by FinTech that interacts with the dynamics of economic growth, territorial development strategies, considering the challenges related to environmental sustainability during socio-political-economic shocks. This study suggests a conceptual framework that links FinTech to territorial economic resilience and the transition to sustainability, using a mixed-methods analysis design that combines comparative regional analysis. The findings reveal that ecosystems based on digital financial innovation help strengthen regional resilience by increasing the implementation of new financial technologies, supporting the liquid assets of small firms and facilitating the movement of financial flows in times of crisis. Nevertheless, FinTech adoption remains spatially unevenly distributed, being concentrated in metropolitan areas and building or consolidating core-periphery growth models. The paper highlights that the coordination of investment policy with that of digital finance expansion and green digitalisation strategies is a key point to ensure that digital finance innovation effectively contributes to balanced and sustainable regional expansion in Eastern Europe.

Keywords: Regional development; Digitalization; FinTech; Sustainability; Eastern Europe
JEL Classification: N14, O11, O19, P25, P51, Q55, R11

1. Introduction

The global socio-economic picture of the last decade is increasingly marked by systemic instability. Political tensions, pandemics and climate disruptions have led to economic and financial crises or recessions and have created a framework of ongoing uncertainty for sustainable economic development. Against this background, digital development appears as an essential mechanism through which economies can adapt to structural shocks on the fly. This paper considers Eastern Europe, which has been subject to many shocks in the last 20-30 years, and represents a relevant framework for examining these dynamics. Since the late 1990s and early 2000s, member states in this region have been undergoing significant economic transformations, seeking to integrate into global financial markets and to adapt and implement digital infrastructure at an accelerated pace. Rodríguez-Pose and Ketterer (2020) also argue that, during that period, the economies of Eastern European countries showed significant regional disparities in innovation between metropolitan and peripheral centres.

Researchers Arner, Barberis and Buckley (2015) reiterate that financial technology is an important step in the positive transformation of the economy. In the same line, Moşteanu et al. (2020) also underline that digital financial innovation, especially that related to digital payments, peer-to-peer lending platforms, and mobile payment banking services, has led to a radical change in the architecture of financial systems and the way in which financial services are operated and provided. All these socio-political-economic disruptions that have marked the international landscape after 2020 have pushed digital technology to profoundly transform and reshape global economies, giving a boost to digital finance adoption, while affecting regional growth models and territorial development (Gomber, Koch, and Siering, 2017; Feyen et al., 2021).

After 2020, the digital financial revolution also made its presence felt in Eastern European countries. States such as Romania, Poland, Hungary, Bulgaria, Estonia, Latvia and Lithuania have paid increased attention to implementing digital transformation to integrate more quickly and profitably into European and international financial systems. Having much to catch up on in the transition to a market economy, these countries have paid dedicated attention to the development and implementation of new technologies. Lately, Eastern Europe has certainly been marked by several economic and geopolitical shocks (the financial crisis of 2007, 2008; the 2020 pandemic; energy market disruptions due to political tensions in northern Eastern Europe as well as new geopolitical tensions in Asia and/or the Middle East) which, contrary accelerated the enhancement of digital finance innovation. Nevertheless, economists Piotrowski and Piotrowska (2025) observe a growth in ecosystems of small entrepreneurs in the digital financial systems market, offering an advanced range

of dedicated digital services. And yet, we remain in the same line: digital transformation maintains the line of existing disparities. Thus, all large cities, such as Warsaw, Tallinn, Bucharest, Budapest, Riga, Vilnius and Sofia, taking advantage of the already existing infrastructure, have become innovative technological centres, while rural areas, perhaps also due to accessibility to internet infrastructure, continue to face structural development difficulties. It seems that, to date, these territorial discrepancies determine the spatial distribution of technological innovation and digital architecture.

The present research highlights that FinTech platforms have played a crucial role in sustaining economic activity during times of instability, facilitating digital transactions, offering alternative credit options, and supporting entrepreneurial efforts. However, digital development also raises significant environmental concerns, as all these activities demand substantial energy resources. Therefore, as Eastern European countries develop and implement digital financial systems aimed at reducing regional development gaps, the ecological footprint becomes an important policy issue that should be addressed collaboratively with others in the field (Moşteanu, 2026).

This research investigates the nexus between digital finance innovation, regional advancements, territorial development and environmental stability in times of shock and uncertainty following socio-geopolitical-economic changes in Eastern European countries.

Lakkol and Rao (2026) highlight that the current geopolitical landscape has increased systemic risk. The present research is in the same vein, feeling that the unpredictability of recent geopolitical movements can be thought of as uncertain, complex and entangled phenomena. However, these shocks accelerate the adoption of digital finance as a mechanism for economic resilience and regional inclusion.

The work paper considers the following research questions:

1. How does FinTech-led digitalisation influence regional economic resilience in Eastern European countries during times of crisis?

2. What spatial development patterns characterise the distribution of FinTech ecosystems in Romania, Poland, Hungary, Bulgaria, Estonia, Latvia and Lithuania?

3. How does environmental sustainability interact with the large-scale deployment of digital financial infrastructures?

4. What policy strategies can support the balanced and sustainable development of FinTech in the region?

2. Literature review

These days, technological modernization is considered a key factor of regional economic evolution. The way in which digital technologies are assimilated, spread, and implemented affects the

development of the labour market, productivity growth and innovation systems at different spatial scales. The theory of regional innovation developed by Cooke (2002) and supported by Asheim and Coenen (2005) shows that technological development tends to focus on knowledge-based clusters, where there is continuous interaction between the academic, private and institutional environments.

The direct link between digital financial technology and regional economic development is increasingly being considered by researchers in regional economic geography. It is thus argued that digital infrastructure can play a primary role in facilitating economic innovation, productivity growth and the development of small business activity (Radu and Constantin, 2007; Fischer and Nijkamp, 2009; Malecki, 2018).

The development and implementation of digital technologies is found especially in metropolitan areas, requiring high-speed internet/connectivity, a skilled workforce and openness to new things by partner public and private institutions. According to Asheim and Coenen (2005), this dynamic has led to the development of regional innovation clusters. This paper, however, considers that digitalisation can help peripheral areas to address territorial inequalities over time. However, Rodríguez-Pose and Ketterer (2020) show that urban regions tend to take advantage of most of the advantages of digital innovation, while peripheral areas struggle with the adoption of new technologies. This phenomenon has been called *the digital divide* and refers to discrepancies in terms of internet access, skilled personnel and institutional capacity. In Eastern Europe, in particular, digital technologies advancements have shown an accelerated growth, especially after 2020, but regional development gaps are still felt. Thus, large cities have shown significant economic growth, while rural areas continue to struggle with innovation capacity and digital architecture. Here, countries like Estonia and Lithuania have become prominent digital financial centres, while Poland and Romania have registered fast expansion in digital payments use and FinTech startup activity.

Socio-political-economic disruptions are increasingly affecting balanced and sustainable economic development. These shock series include financial crises, pandemics, geopolitical conflicts and environmental disasters (Tooze, 2021).

In addition to the 2020 pandemic, geopolitical crises that have contributed to changing the approach to finance include: The Russian invasion of Ukraine, which disrupted energy supplies, increased defence spending, and repositioned investment flows (Szeberényi and Bakó, 2023; Audretsch et al., 2025); The conflicts between Israel and the sponsors of the Gaza Strip, or more recent between Israel, The USA and Iran have also contributed to global energy volatility and uncertainty in financial markets, including in European countries (Butter, 2024; Kholoud, 2024); and, The new US trade and economic policy quickly led to trade fragmentation and tariffs, creating increased uncertainty for economies dependent on exports and digital financial networks (McKibbin, Noland, and Shuetrim, 2025; Hayakawa, 2026). Later in this article, it will be referred to as socio-

economic-geopolitical shocks. In accordance with Demertzis and Lipsky (2023), this paper supports the viewpoint that these shocks have boosted technological development, and digital financial platforms have emerged as resilient alternatives, maintaining cross-border transactions and supporting economic activity. Likewise, the research aligns with Brynjolfsson et al. (2020) who point out that these shocks often accelerate technology adoption, as public administrations support the development of digital tools to maintain economic activity. Certainly, the implementation of technological innovations also entails the emergence of vulnerabilities in financial systems, vulnerabilities that can exacerbate regional disparities. The economies of Eastern European states, still strongly linked in European supply chains, are directly exposed to shocks, and the effects are found in economic instability and hesitant development trends. However, in times of crisis, it seems that those that have shown considerable resistance are FinTech platforms, allowing secure digital transactions, offering lending alternatives, secure digital signatures for contracts, and services accessible online 24/7 at low costs.

Territorial development theory, as an integrated multidimensional approach, emphasizes the role of local institutions in determining economic outcomes. Regional governance structures influence innovation policies, infrastructure development, and economic diversification strategies (OECD, 2025). Following this theory, FinTech ecosystems are significantly influenced by regulatory frameworks and policy support mechanisms, such as regulatory testing zones, innovation centres, digital identity systems, and startup financing programs. In Eastern European countries, institutional frameworks vary significantly, creating different trajectories for FinTech development across countries (Zetzsche et al., 2020). As will be seen throughout this article, the development and integration of FinTech, along with the related legal frameworks, is focused on urban areas that have a strong digital architecture, a skilled workforce, and related financial resources (Hutukka, 2024). Cities such as Vilnius, Warsaw, Tallinn and Bucharest function as regional innovation hubs, followed by, while peripheral regions face limited access.

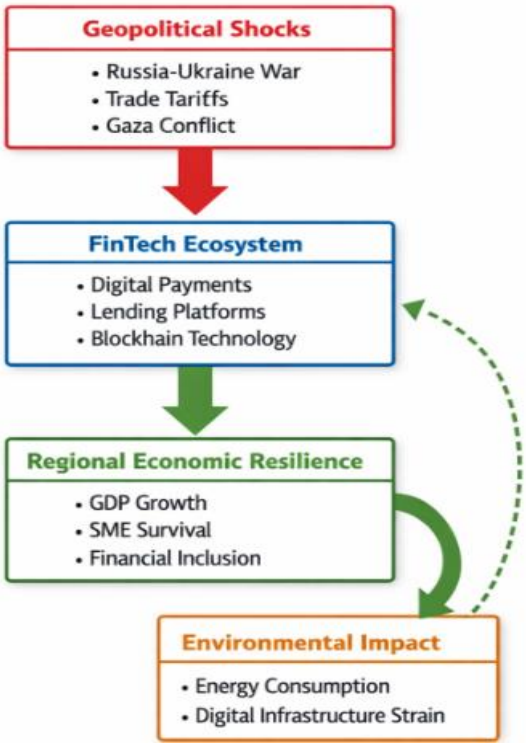
Regarding the link between digital finance, resources, and sustainable regional development, it is a direct one. Significant energy resources are needed to implement the digital financial architecture. This is because cloud computing systems, data centres, and blockchain networks require an increase in electricity consumption and the existence of a skilled workforce in the field. However, once implemented, new financial technologies will provide sustainability to transactions by facilitating green finance and climate investments (Sachs et al., 2019). Consequently, the environmental implications of digital financial innovation should not be neglected but instead be treated with priority. This is because the adoption of digital infrastructure requires a substantial amount of energy, raising environmental concerns, and can often unbalance regional development in

the respective areas. Balancing economic resilience with new technologies and environmental sustainability is essential for the development of regional policies.

3. Method

The present study embraces a mixed-methods research design, mixing quantitative regional analysis with qualitative institutional case studies and dedicated policy studies. The research considers that the method enables an adequate understanding of the macroeconomic models and governance mechanisms that define the advancement of FinTech in Eastern Europe. Analytical methods include descriptive statistics cross-country comparison; panel regression linking FinTech implementation to regional economic resilience; and spatial analysis of FinTech clusters.

Figure 1. The conceptual framework



Source: Author's elaboration.

The current study offers a conceptual framework to investigate how geopolitical shocks such as trade disputes, military conflicts and global socioeconomic uncertainty act as external stressors affecting the growth and operation of FinTech ecosystems. According to the article, developments in digital finance lessen these disruptions and improve regional economic adaptability through a more robust financial presence, sustaining SMEs' operations and ongoing economic growth. Evidence suggests that FinTech adoption generates a cyclical relationship between sustainability and technological advancement, with increased energy consumption having a direct environmental impact. As a result, the proposed framework unifies digital finance, geopolitics, environmental issues,

and regional development into a single analytical model that illustrates how FinTech functions under systemic stress (Figure 1). This framework exhibits a feedback loop: robust FinTech implementation shrinks vulnerability to external disruptions, but digitalisation must be sustainable.

To account for the impact of geopolitical shocks, the empirical analysis incorporates a temporal dimension that reflects the last three-year period, marked by the onset of the Russian invasion of Ukraine and the subsequent global economic instability, including the dynamics of trade fragmentation associated with policy shifts related to the United States' foreign policy vision and the broader financial uncertainty resulting from the Israel-Hamas military unrest. Although periods of uncertainty are not explicitly modelled as stand-alone variables in the baseline regression, their effects are implicitly captured through observed changes in macroeconomic and financial indicators. This approach allows the analysis to think beyond real-world structural disruptions while maintaining model parsimony.

The analysis focused on the following countries from Eastern Europe: Romania, Poland, Hungary, Bulgaria, Estonia, Latvia and Lithuania as they present a diverse FinTech advancement trend within the analysed region. Data was collected from official reports presented by the World Bank, DESI, OECD, national FinTech associations reports, start-up ecosystem databases, and regional economic development statistics. Data on the number of FinTech firms were compiled from several complementary sources, including OECD Ecosystem Reports, World Bank Digital Economy Datasets, publications of national FinTech associations, and industry databases. This data is mainly available at the country level, reflecting the total number of active FinTech firms in each national economy. In the empirical analysis, country-level data are used for econometric estimation, ensuring consistency across variables. City-level data are used descriptively to support spatial analysis and illustrate the territorial concentration of FinTech ecosystems (see Appendix 1). To ensure cross-country comparability and reduce potential scale effects, the empirical analysis relies primarily on standardised indicators, including GDP growth rates, SME survival rates, financial inclusion percentages, and DESI scores (see Appendix 2). These variables are inherently normalised and thus not affected by country size. Variables expressed in absolute terms, such as the number of FinTech firms and Digital infrastructure energy consumption, are treated with caution. The number of FinTech firms is used exclusively for descriptive and spatial analysis and is not included in the econometric model. Energy consumption is interpreted as an aggregate proxy for digital infrastructure intensity rather than a direct measure of efficiency. While additional normalisation could further refine these indicators, data limitations across countries constrain full standardisation. This aspect is acknowledged as a limitation and an avenue for future research.

4. Results

Periods of socio-economic-political shocks have helped accelerate the development of digital finance platforms. For example, the lockdown period during the COVID-19 pandemic boosted the use of mobile banking services in all seven countries.

During this period, SMEs were developed to grow digital platforms for implementing digital finance. The findings indicate that FinTech increases economic resilience, but that innovation and implementation occurred in urban areas, which already benefited from the desired information architecture, but also from rapid access to a skilled workforce in the field. We believe that geopolitical instability has given weight to digital financial networks and highlighted the importance of securing energy resources and supporting green finance.

Table 1. Key FinTech Ecosystem indicators for Eastern Europe

Country	Major Hub	Number of FinTech Firms	Digital Infrastructure Score (DESI 2025)	FinTech Adoption Rate (%)
Romania	Bucharest	180	0.62	55
Poland	Warsaw	310	0.70	68
Hungary	Budapest	120	0.65	52
Bulgaria	Sofia	100	0.60	48
Estonia	Tallinn	140	0.85	80
Latvia	Riga	90	0.78	75
Lithuania	Vilnius	280	0.82	78

Source: OECD (2024, 2025), World Bank (2025), European Commission (2025)

Table 1 underlines the cross-national variation. These screenings aim to correlate DESI scores and FinTech embracing to recognise digital leaders in Eastern European countries. The table provides a factual basis for the subsequent regression analysis. Therefore, the results indicate that, in the analysed period (2024-2025), in Romania, Bucharest is the main FinTech hub, with a focus on digital payments and e-commerce credits, with a DESI score of 0.62 and an adoption rate of 55%, but regional discrepancies between Bucharest and rural regions are significant. In Poland, Warsaw presents the largest ecosystem with 310 FinTech firms, with a high integration of SMEs that have implemented digital finance. Hungary has a capital, Budapest as an emerging digital banking sector with a moderate adoption of FinTech (52%). In Bulgaria, Sofia hosts FinTech startups, but the adoption of digital payments is lower (48%), still presenting disparities in the infrastructure necessary for the inclusion of these platforms. In Estonia, the capital Tallinn is quite advanced with a DESI of 0.85 and an adoption of digital payments of 80%, benefiting from significant support in terms of regulation and synergy between e-government. Latvia has Riga as its emerging hub, with DESI 0.78, and adoption 75%. Here, it seems that active integration and cooperation with the EU framework support the growth of FinTech implementation. The second main European hub is in Vilnius,

Lithuania, with 280 companies, with high integration and acceptance. Figure 2 presents the spatial distribution of FinTech clusters across Eastern Europe.

Figure 2. Spatial Distribution of FinTech Clusters in Eastern Europe

Source: Author's elaboration based on EU, 2025; OECD, 2024; World Bank, 2023.

To check whether digital finance technologies application statistically affects territorial resilience, the study suggests a panel of regression (Table 2) to provide causal statistical evidence.

Table 2. Regression Results (Panel Analysis)

Dependent Variable	Independent Variables	Coefficient	p-value
Regional GDP Growth	FinTech Adoption	0.34	0.001
SME Survival Rate	Digital Infrastructure	0.27	0.003
Financial Inclusion Index	Regulatory Support	0.31	0.002
Energy Consumption	Digital Infrastructure	0.29	0.005

Source: Author calculations from World Bank and DESI data

From Table 2, Figures 3 and 4, it can be noted that, in terms of regional GDP growth vs. FinTech embracing, a coefficient of 0.34 ($p<0.01$), which displays that for every 1% increase in FinTech adoption, regional GDP progression expands by ~0.34%, holding other variables constant. This means that FinTech platforms sustain economic activity, especially during periods of disruption caused by geopolitical shocks. The findings reveal that FinTech has an optimistic impact (0.27, $p<0.01$) on SME flexibility to adapt, if it is taken into consideration the SME strength ratio vs. digital architecture. The results indicate that regions with higher internet accessibility, mobile connectivity and access to digital banking platforms lead to advanced SME survival rates. This implies that FinTech plays a steady role for smaller businesses in Eastern Europe.

Figure 3. FinTech adoption and regional GDP growth

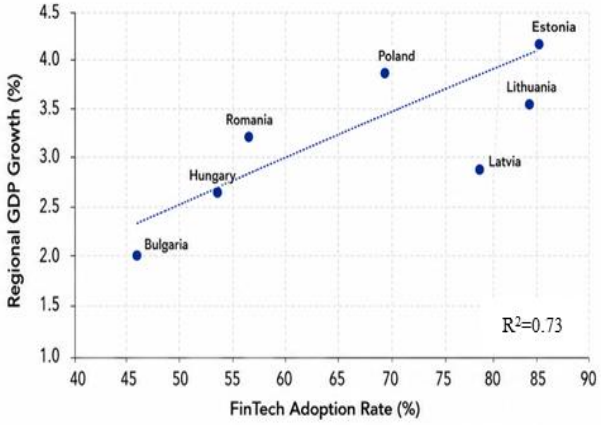
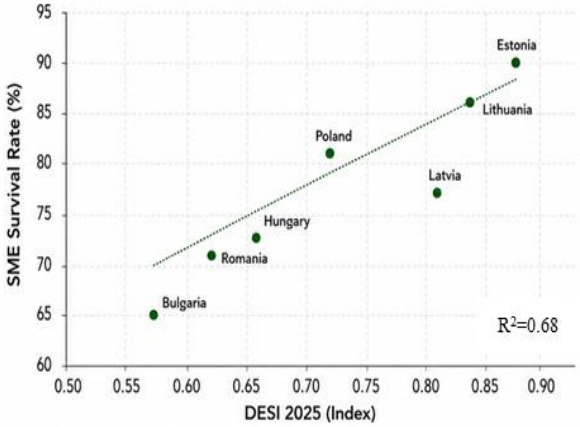


Figure 4. Digital Infrastructure (DESI) and SME survival



Source for figure 3: Author's elaboration founded on comparative regional FinTech–growth literature (adapted from He,Tang and Zhang, 2024; Alalmaee, 2026) and Tables 1 and 2.

Source for figure 4: Author's elaboration (adapted from Savvakis, Kenourgios, and Trakadas, 2024), and Tables 1 and 2.

Now, if we examine the relationship between legislation and the adoption of new technologies in FinTech systems, we find that in nations like Estonia and Lithuania, proactive FinTech legislation and regulations for testing new developments correlate with a 0.31 rise in inclusion indicators. This indicates that policy bases are essential to ensuring that the benefits of FinTech are widely distributed. If we want to compare the digital finance infrastructure with energy consumption, then it can be observed that FinTech development requires significant energy consumption (coefficient 0.29), indicating the environmental trade-off. Even though financial technologies promote adaptability to unexpected situations, the operational footprint (data centres, blockchain mining) needs to be judged in sustainability policies.

Analysing territorial development patterns and geographic concentration, we look again at Table 1 and Figure 2 as it illustrates a significant concentration of digital financial activity in capital-city innovation hubs (Warsaw, Bucharest, Vilnius, Tallinn). Rural or peripheral regions drop behind significantly, confirming that territorial disparities persist as a major challenge. Those states with higher DESI scores (Estonia 0.85, Lithuania 0.82) present higher adoption rates (80% and 78%), strengthening the relationship between digital infrastructure quality and FinTech penetration. Comparing the countries analysed, Poland and Romania have a significantly higher number of FinTech firms, but Estonia achieves a higher level of per capita adoption and digital readiness, stress once again that the level of quality and maturity of the ecosystem matters more than the number of firms themselves.

In terms of environmental implications due to FinTech systems implementation, the results show that digital enlargement increases energy consumption and advances sustainability trade-offs within regional digital transformation (see Table 3). Nevertheless, FinTech advancements facilitate the adoption of green investment platforms, lead to the adoption of climate finance instruments and

consider implementing viable development funding. Given that energy consumption is measured in absolute terms, there is a concern in cross-country comparisons, as larger economies may exhibit higher aggregate values. However, the analysis focuses on relative differences and patterns rather than absolute magnitudes.

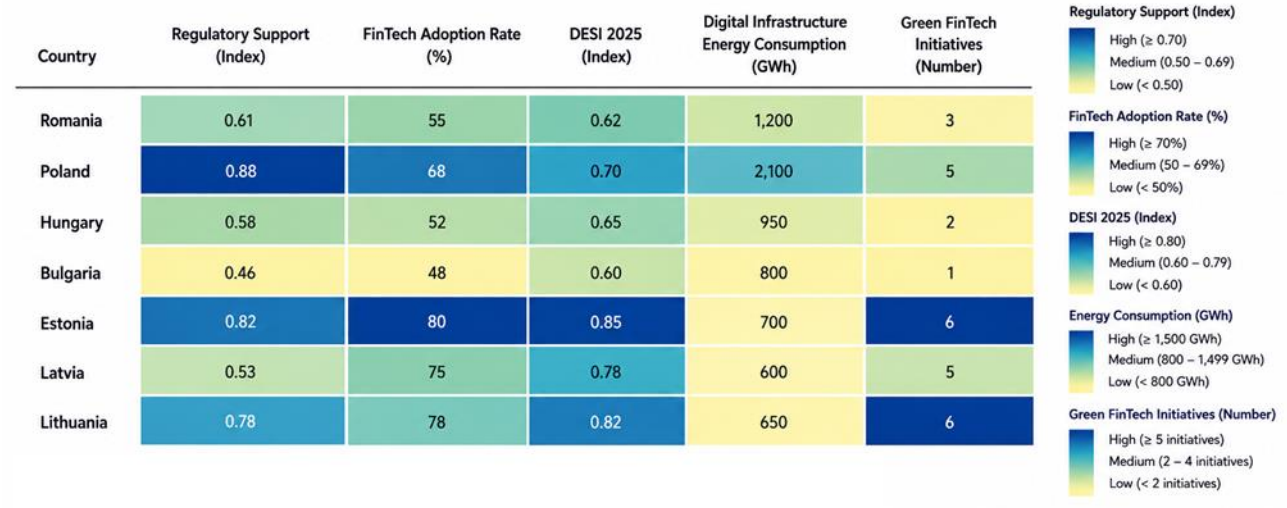
Table 3. Environmental Implications of Digital Financial Infrastructure

Country	DESI Score	FinTech Adoption (%)	Digital Infrastructure Energy Consumption (GWh)	Green FinTech Initiatives (No.)
Romania	0.62	55	1,200	3
Poland	0.70	68	2,100	5
Hungary	0.65	52	950	2
Bulgaria	0.60	48	800	1
Estonia	0.85	80	700	6
Latvia	0.78	75	600	5
Lithuania	0.82	78	650	6

Source: Author's elaboration based on World Bank (2024), OECD (2024), European Commission DESI (2025).

The analysis shows that higher digital maturity does not necessarily imply higher environmental costs. Larger economies such as Poland and Romania have higher energy demand due to scale effects and constraints related to legacy infrastructure. However, Estonia, Lithuania and Latvia, with greater FinTech integration, present a lower energy demand, having, at the same time, high green FinTech initiatives.

Figure 5. Heatmap of Regulatory support and FinTech adoption and Environmental Concentration



Source: Author's elaboration, based on data from Tables 1, 2, 3, and from ECB (2024), DESI (2025), WB Digital Economy data (2024), OECD Digital Economy Outlook and national FinTech association reports.

Figure 5 shows how institutional quality profiles digital financial development outcomes, graphically presenting the link between the support from legislation and the FinTech adoption within Eastern European states. Poland, Estonia and Lithuania lead the region in Regulatory support,

FinTech adoption and digital infrastructure development. Estonia and Lithuania also rank first in Green FinTech initiatives. They are closely followed by Poland and Latvia. This demonstrates the existence of sophisticated digital ecosystems supported by innovative policies and proactive governance. The intermediate positions of Romania and Hungary, across most indicators, indicate ongoing regulatory reform and growing digital finance adoption. Conversely, nations with less regulatory support (like Bulgaria) have slower adoption dynamics and emphasise the role of institutional capacity in promoting the spread of technology. Overall, the heatmap underlines a positive association between regulatory support and FinTech adoption, accompanied by higher digital development and stronger environmental engagement. In terms of environmental concentration, it has been noticed that Poland, followed by Romania, reports the highest energy consumption. This highlights the necessity of coordinating FinTech development with sustainable and energy-efficient policies. Here, Lithuania and Estonia lead in environmental engagement (with 6 initiatives each).

At this point, the analysis considers that the period under review also includes significant geopolitical disruptions. Therefore, the observed relationships between FinTech adoption and adaptive regional performance reflect not only structural development patterns but also adaptive responses to external shocks. The analysis reflects that the positive and statistically significant coefficients associated with the FinTech variables suggest that digital financial systems played a stabilising role in periods of increased uncertainty. Even though the research model does not isolate the causal effect of geopolitical shocks through explicit interaction terms, the consistency of the results over the period under review implicitly shows us indirect empirical support for the resilience-enhancing function of FinTech under stress.

4. Discussion

The paper demonstrates that FinTech plays a vital role in increasing economic flexibility to adjust and change during shock cycles. Digital payment systems and alternative lending platforms have contributed to reinforcing economic activity in times of crisis. Nevertheless, the spatial concentration of FinTech advancements in main cities emphasises territorial inequalities. Therefore, peripheral regions remain disadvantaged due to weaker digital infrastructure and restrained access to novel ecosystems. Indeed, it may be added that environmental issues are an evolving dimension of the digital revolution. As digital financial infrastructures open up, their energy consumption needs to be integrated into national sustainability strategies.

Emerging states in Eastern Europe with advanced digital architectures (Estonia, Lithuania) showed stronger stability of GDP and survival of SMEs during the crisis of recent military conflicts. This is the reason that advanced digital finance extends alternative payment channels, access to credit and stability of cross-border financial operations. This outcome is also underlined by the actual

literature suggesting that FinTech mitigates systemic economic shocks (Tamar and Lamara, 2021; Demertzis and Lipsky, 2023; Shah, 2026).

The present study emphasises that the general increase in development and deployment of FinTech firms in large cities, it deepens regional disparities between urban and peripheral areas (the case of Romania, Bulgaria and Hungary). Thus, the gathering of firms in capitals highlights territorial inequality, strengthening the conclusions of the OECD (2024) and the World Bank (2025). In these cases, the findings indicate that a review of investment policies is necessary to reduce the gaps between metropolitan and peripheral areas, including investments in digital infrastructure and regional financial literacy programs.

Regarding the influence of external disruptions, it is reflected in the dataset's temporal structure rather than through explicit model variables. The analysed period constitutes a de facto stress-testing environment for regional economies, especially in Eastern Europe. The persistence of positive relationships between FinTech adoption and economic performance indicators during this period suggests that digital financial ecosystems contribute to systemic resilience (digital finance played a crucial role during the lockdown period). However, the absence of a formal external instability variable or an interaction term limits the ability to quantify the magnitude of this effect. This will be a significant direction for future research.

5. Conclusion

This work paper investigated the role of digitalisation of financial technology in mapping regional growth, territorial development and environmental sustainability in Eastern Europe, under conditions of economic and geopolitical stress. The study focused on seven Eastern European states, Romania, Poland, Hungary, Bulgaria, Estonia, Latvia and Lithuania, blending a descriptive cross-country comparison, a panel regression analysis and a spatial assessment of FinTech ecosystems to detect how digital financial innovation interrelates with regional adaptability throughout times of systemic disruption, considering all current economic-geopolitical instability.

The current study's findings indicate that there is a significant statistical correlation between the use of digital finance and indicators of financial inclusion, SME survival rates, and regional GDP efficiency. According to the findings, areas with significant digital architecture and a higher spread of FinTech have shown themselves to be more resilient to economic and geopolitical shocks. These results demonstrate how these digital financial ecosystems serve as both institutional stabilisation infrastructures during times of crisis and innovation hubs.

The parallel research carried out in various nations establishes the diversity of Eastern Europe. Stable laws and interconnected digital governance systems underpin the high levels of digital maturity in Lithuania and Estonia. However, Hungary, Romania and Bulgaria are still working on their digital

systems. FinTech has grown significantly in these nations, but there are still disparities between rural and urban areas. With a combination of significant economic growth and regulatory adaptation, Poland is in the middle. FinTech is mostly found in big cities, which are centres of innovation according to a study of locations. Although digitalisation speeds up economic recovery, it can also increase regional disparities. This is because labour and infrastructure problems prevent less developed regions from reaping the same advantages from financial technology. Because of this, the advancement of digital finance does not necessarily result in more equitable regional development. The environmental impact was examined in another study. It was discovered that expanding digital infrastructure consumes more energy, demonstrating how environmental issues can arise as a result of digital advancement. Regulations that emphasise sustainability can lessen the detrimental effects of the expansion of financial technologies, as nations that employ green FinTech strategies may be more effective.

The findings of this paper put forward several relevant policy implications for East European countries policymakers to be considered, such as: pay increased attention to investments in digital infrastructure correspondingly outside the metropolitan regions, already well adapted to FinTech, which is essential to slow down or prevent spatial inequality triggered by digitalization; cohesion policies better to reflect that digital financial accessibility is a development objective; adopt clear and concrete legislation to support the development and implementation of FinTech, noting that countries with an openness to testing new financial advancements and with flexible governance systems to new progresses achieve better results in terms of innovation and inclusion of digital finance; enforce public regulations and facilities to strengthen digital ecosystems, as they help to reduce dependence on external financial infrastructures and increase systemic flexibility to economic and geopolitical shocks; find alternative for green or regenerable energy, to avoid bottlenecks related to energy supply in cases of military conflicts or other external stressors, which make access difficult or lead to significant price increases; lately, integrate sustainability as an essential component of digital transformation strategies, encouraging green FinTech innovation, energy-efficient data infrastructures and climate-friendly financial technologies, in order to align digital growth with European environmental goals.

In the end, it was observed that rather than only restricting economic activity, geopolitical unrest accelerates digital transformation. In today's world, financial systems rely more and more on digital platforms that can operate in disrupted institutional and physical environments. As a result, the rapid adoption of FinTech across Eastern Europe is seen as a flexible response to unpredictability, reflecting broader trends toward technologically enabled economic stability. In the end, digital transition emphasises FinTech as a crucial component linking environmental sustainability, geopolitical strength and regional economic growth.

The research also encountered key limitations in its treatment of geopolitical shocks. Although the analysis captures the effects of current major international disruptions on the time domain of the dataset, these shocks are not explicitly modelled using dedicated variables. Future research could address this limitation by incorporating geopolitical risk indices or "difference-in-differences" approaches to more precisely quantify the impact of external shocks on digital financial ecosystems.

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Appendix

Table A1: Variables Used in Econometric Analysis (Panel Regression)

Variable	Type	Definition (What it measures)	Measurement Unit	Data Source
Regional GDP Growth	Dependent	Annual growth rate of regional economic output, used as a proxy for economic performance and resilience	% (annual growth rate)	World Bank – World Development Indicators
FinTech Adoption Rate	Independent	The degree to which digital financial services (e.g., mobile payments, digital banking) are used within the economy	% of population or firms using FinTech services	World Bank Digital Economy Data
SME Survival Rate	Dependent	Share of small and medium-sized enterprises that continue operating over a given period, indicating business resilience	% of SMEs surviving	OECD SME and Entrepreneurship Data
Digital Infrastructure (DESI Score)	Independent	Composite index measuring digital development (connectivity, digital skills, integration of digital technology)	Index (0–1)	European Commission – DESI
Financial Inclusion Index	Dependent	The extent to which individuals and businesses have access to and use formal financial services	Index / %	World Bank Global Findex Database
Regulatory Support for FinTech	Independent	Degree of institutional and legislative support for FinTech development (e.g., digital finance regulation)	Index (constructed proxy)	European Central Bank Reports
Digital Infrastructure Energy Consumption	Dependent	Total energy consumption associated with digital financial infrastructure (data centres, digital platforms, etc.)	GWh	World Bank Energy Data; OECD Digital Economy Outlook

Appendix

Table A2: Variables Used in Descriptive and Comparative Analysis (Tables 1 & 3)

Variable	Definition (What it measures)	Measurement Unit	Data Source
Number of FinTech Firms	Total number of active FinTech companies in a country	Absolute number	OECD Digital Economy Outlook; national FinTech association reports
Digital Infrastructure Score (DESI)	Level of digital development across economies (connectivity, digital skills, integration of digital technology)	Index (0–1)	European Commission DESI
FinTech Adoption Rate	Share of population or firms using digital financial services	Percentage (%)	World Bank Digital Economy Data
Digital Infrastructure Energy Consumption	Total electricity consumption generated by digital infrastructure supporting FinTech ecosystems	GWh	World Bank (Energy Statistics); OECD
Green FinTech Initiatives	Number of initiatives/projects focused on environmentally sustainable financial technologies	Absolute number	OECD Reports; European Commission publications