Digital Infrastructure and its Impact on Foreign Direct Investment in Central and Eastern Europe

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Abstract
This study examines the impact of digital infrastructure on foreign direct investment (FDI) inflows in seven Central and Eastern European (CEE) countries over the period 2004 -2023. Using panel data techniques, we analyze the relationship between three digital infrastructure indicators - internet penetration, broadband subscriptions, and mobile network coverage - and FDI inflows as a percentage of GDP. Our empirical strategy employs pooled OLS, fixed effects, and random effects models, with the Hausman test guiding model selection. Results indicate that digital infrastructure significantly influences FDI attraction in the region. Among the three indicators, broadband subscriptions exhibit the strongest positive effect on FDI inflows, followed by internet penetration. The findings remain robust across alternative specifications, including two-way fixed effects, lagged digital variables, and a composite digital infrastructure index. Control variables such as market size, GDP growth, trade openness, and institutional quality also play significant roles. This research contributes to the FDI determinants literature by highlighting the importance of digital connectivity in emerging European economies and provides policy implications for governments seeking to enhance FDI attractiveness through digital infrastructure investments.

Keywords: Foreign Direct Investment, Digital Infrastructure, Panel Data, Central and Eastern Europe, Fixed Effects, Broadband

JEL Classifications: F21, O33, C23, P27

DOI: 10.24818/REJ/2026/92/05

1. Introduction

Foreign direct investment (FDI) has long been recognized as a critical driver of economic growth, technological transfer, and employment creation in emerging economies. For Central and Eastern European (CEE) countries that joined the European Union in the 2000s, attracting FDI has been a cornerstone of their transition from centrally planned to market economies. Traditional FDI determinants - such as market size, labor costs, institutional quality, and trade openness - have been extensively studied in the literature. Early research on the

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CEE region focused on understanding how these countries could position themselves competitively in global investment markets. Popovici and Călin (2012a) examined the attractiveness of public policies for FDI in Central and Eastern European countries, while complementary work by Popovici and Călin (2012b) investigated competitiveness as a key determinant of foreign direct investment in the region, demonstrating that competitive advantages beyond low labor costs increasingly matter for attracting high-quality investment.

However, the digital transformation of the global economy over the past two decades has introduced a new dimension to location decisions of multinational enterprises (MNEs). Digital infrastructure—encompassing internet connectivity, broadband networks, and mobile telecommunications—has become increasingly important for business operations, supply chain management, and market access. The COVID-19 pandemic further accelerated digital adoption, making robust digital infrastructure not merely a convenience but a necessity for economic activity. Yet despite this growing importance, the relationship between digital infrastructure and FDI in CEE countries remains underexplored in the empirical literature.

The digital economy has fundamentally reshaped consumer behavior and business models. Belingher and Călin (2011) provided early insights into the behavior of the digital consumer, highlighting how digital adoption patterns influence market structures and create new opportunities for firms. More recently, Cazabat et al. (2018) contributed contemporaneous evidence on e-commerce adoption in Romania-based SMEs, documenting rapid digital uptake among small and medium enterprises. These studies suggest that digital infrastructure enables firms—even small ones—to participate in global value chains, potentially making countries more attractive for efficiency-seeking FDI.

Beyond traditional business operations, digital technologies are transforming industrial processes and innovation systems. Duan et al. (2024) investigated Industry 4.0 technologies for sustainable product evolution in China through a novel fuzzy three-way decision-making process, demonstrating how digital technologies fundamentally reshape production processes and supply chains. Similarly, Ai et al. (2026) explored big data and artificial intelligence for smart public decision-making and advancing the Sustainable Development Goals, suggesting that countries leveraging digital infrastructure for evidence-based policymaking may create more predictable and investor-friendly environments. Gopalan et al. (2022) demonstrated that companies' digitalization encouraged participation in global value chains in an analysis across 52 countries over the period 2006–2018 that included firms of different size. Ling (2024) also indicated that optimization and cost reduction were associated with the digital transformation of MNCs. Moreover, Bhatti et al. (2022) highlighted the role of digitalization in helping firms manage and mitigate the liabilities of foreignness when operating in international markets. Following the transformations of MNCs' internationalization path, Meyer et al. (2023) confirmed the strong implications of digital technologies in the development of international business theory. Digitalization is seen as creating new opportunities, reducing transaction costs, providing better options to coordinate the MNC's network and improving productivity.

The relationship between innovation, intellectual property, and foreign investment has also evolved in the digital age. Hurduzeu et al. (2022) examined the nexus between research and development, protection of intellectual property rights, and financial development from a European perspective, highlighting that strong intellectual property protection, supported by digital infrastructure, creates environments conducive to both domestic innovation and foreign R&D investment. Khurshid et al. (2022) further analyzed technological innovations for environmental protection, examining the role of intellectual property rights in carbon mitigation efforts in Western and Southern Europe. Their research demonstrated that digital technologies enable both innovation in clean technologies and the protection of such innovations, potentially attracting environmentally-conscious FDI. Yu and Liu (2023) exposed the important positive role of FDI in the development of green urban areas, after investigating the pollution dynamics in 284 cities in China from 2008 to 2019. Famanta et al. (2024) confirmed that even in least developed economies, green FDI had a positive contribution in increasing environmental quality. The study, conducted from 2003 to 2021 on a sample of 34 countries, investigated the topic by using Feasible Generalized Least Squares and Panel-Corrected Standard Errors. Previously, Johnson (2017) advocated for the need of developing national and international government policies in order to catalyse green FDI, following positive involvement in shaping sustainable economies. Green FDI was also associated with improvements in the sustainability profile of other MNC's technology base (Amendolagine et al., 2021).

Understanding FDI dynamics in CEE requires attention to institutional development and convergence processes. Popovici and Călin (2013) analyzed ways of attracting FDI in Western and Eastern European countries, emphasizing the critical role of upgrading institutions' quality. Their findings suggested that institutional convergence toward Western European standards significantly enhances FDI attractiveness. Building on this theme, Popovici and Călin (2021) examined the effects of enhancing competitiveness on FDI inflows in CEE countries, finding that improvements in competitiveness metrics translate into measurable FDI gains, though with heterogeneous effects across countries and sectors. Albu et al. (2020) developed a model to simulate the convergence process in the EU and Balkans region based on empirical evidence, demonstrating that successful convergence depends on sustained FDI inflows alongside domestic policy reforms. Bruno et al. (2021) showed that the EU integration had a significant role in increasing FDI in the region. Based on a structural gravity framework using bilateral data that covered the period 1985 to 2018, the authors found that intra-EU FDI increased by 50%, while FDI from outside the Union increased by 60% following EU membership. Sass (2024), in a more recent investigation, also confirmed that CEE countries' EU membership was a factor that attracted FDI flows from both within and outside the EU. Moreover, FDI continued to play a vital role in several sectors and remained of high importance for the analysed countries. An earlier paper of Jirasavetakul and Rahman (2018) showed that following the EU integration, FDI in the new EU Member States had a significant role in increasing exports and productivity. An EU report from 2020 also showed an increased participation of EU countries in global value chains given the positive impact of FDI. Camarero et al. (2025) tested the US companies' attraction towards EU and found that the EU membership was a factor in itself for encouraging American investors. The analysis was carried out from 1985 to 2019 and considered 56 host countries involved in different types of agreements in a gravity model where Poisson Pseudo-Maximum Likelihood (PPML) was used.

The macroeconomic environment surrounding FDI has also been a focus of research. Popovici and Călin (2016) conducted a Vector Error Correction Model (VECM) analysis of economic growth, foreign investments, and exports in Romania, finding significant long-run relationships among these variables. Their results suggested that FDI serves as both a direct growth contributor and a facilitator of export expansion, with potential feedback effects that reinforce investment attractiveness. Albu et al. (2014) estimated the long-term correlation between market capitalization and GDP per capita in Eastern EU countries using a nonlinear model, finding that financial market development creates conditions favorable for both domestic investment and FDI. Khurshid et al. (2016) examined whether remittances hurt domestic prices in low-, lower-middle-, and middle-income groups, providing insights into how external financial flows interact with domestic economic conditions that shape investment climates. Alguacil et al. (2011) tested the impact of macroeconomic stability on FDI for a sample of 26 developing economies during 1976–2005 and found a positive impact. The authors also evidenced the need of considering the quality of institutions for attracting foreign investors and confirmed the importance of absorptive capacity for achieving long-term benefits from FDI. Cakici (2023) checked for the impact of macroeconomic stability on FDI in 96 countries, in a timeframe from 1980 to 2010. Main results showed that components of macroeconomic stability (namely income and financial openness levels) were positively connected with attracting FDI. Beri and Mhonyera (2023) obtained a similar result for a sample of 12 CEE countries examined from 1991 to 2020 by using both static panel estimation and Seemingly Unrelated Regression (SUR). Chizema (2025) demonstrated an increased impact of FDI on in promoting growth in ten South and Southeast Asian countries. The authors also stated the importance of the absorptive capacity, among the most important factors for perpetuating positive spillovers being education, institutional quality, and trade facilitation.

Most recently, Popovici et al. (2021) offered extensive evidence on FDI determinants through a comprehensive revisitation of the topic, incorporating both traditional and emerging factors. Their analysis confirmed that while market size, labor costs, and trade openness remain relevant, the relative importance of these factors has evolved over time, with institutional quality and technological readiness gaining prominence.

Despite this rich body of research on FDI in CEE and the growing literature on digital transformation, a critical gap remains: no study has systematically analyzed how digital infrastructure specifically affects FDI inflows in Central and Eastern Europe using rigorous panel data methods. This gap is particularly significant given the region's ongoing digital transformation and its strategic importance as a gateway between Western European markets and Eastern growth poles.

This study addresses this gap by investigating how digital infrastructure affects FDI inflows in seven CEE countries - Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia, and Slovenia - over the period 2004-2023. We ask two main research questions: (1) Does digital infrastructure significantly affect FDI inflows in CEE countries? (2) Which digital infrastructure indicators are most important for attracting foreign investors?

This study makes several original contributions to the FDI literature:
First, we provide the first comprehensive empirical analysis of digital infrastructure's impact on FDI specifically for the CEE region over a two-decade period. While previous studies have examined traditional FDI determinants in these countries (Bevan & Estrin, 2004; Bellak et al., 2008), and others have explored digital factors in global or developing country contexts (Addison & Heshmati, 2003), no study has systematically analyzed the digital-FDI nexus in post-EU accession CEE economies. Our focus on this region is particularly relevant given these countries'

strategic position as gateways between Western Europe and Eastern markets, combined with their ongoing digital transformation.

Second, we employ a multi-dimensional approach to measuring digital infrastructure by using three complementary indicators - internet penetration (demand-side digital literacy), broadband subscriptions (quality of fixed infrastructure), and mobile cellular subscriptions (mobile connectivity) - rather than relying on a single composite index. This disaggregated approach allows us to identify which specific aspects of digital infrastructure matter most for FDI decisions, providing more granular policy guidance. Additionally, we construct a standardized digital infrastructure index to assess the overall impact of digital development.

Third, we address potential endogeneity concerns through multiple robustness checks, including lagged digital infrastructure variables, alternative model specifications, and two-way fixed effects controlling for both country and time-specific shocks. This rigorous econometric approach strengthens confidence in our findings and distinguishes our work from descriptive or cross-sectional analyses that may suffer from omitted variable bias or reverse causality.

Fourth, our analysis covers the period 2004-2023, which includes major economic events such as the 2008-2009 global financial crisis, the Eurozone debt crisis, and the COVID-19 pandemic. This extended timeframe allows us to capture how the relationship between digital infrastructure and FDI has evolved through different economic cycles, providing insights into whether digital connectivity serves as a stabilizing factor during economic turbulence.

Fifth, from a policy perspective, our findings offer actionable insights for CEE governments and policymakers. By identifying which digital infrastructure components have the strongest effects on FDI, we provide evidence-based guidance for prioritizing digital infrastructure investments. This is particularly timely given the European Union's Digital Decade targets for 2030 and the increasing competition among CEE countries to attract high-value, technology-intensive FDI.

Finally, our study contributes methodologically by demonstrating the application of panel data techniques to relatively small samples of countries over extended time periods. We show how Hausman tests, clustered standard errors, and multiple robustness checks can be effectively employed even with a limited cross-sectional dimension (seven countries), providing a template for similar regional studies.

The remainder of this paper is organized as follows. Section 2 describes the data, variables, and econometric methodology. Section 3 presents the empirical results, including the main regression findings and robustness tests. Section 4 discusses the implications of the results, and Section 5 concludes with policy recommendations and directions for future research.

2. Methodology

2.1 Data and Sample

This study examines the impact of digital infrastructure on foreign direct investment (FDI) inflows in seven Central and Eastern European (CEE) countries: Bulgaria (BG), Czech Republic (CZ), Hungary (HU), Poland (PL), Romania (RO), Slovakia (SK), and Slovenia (SI). The analysis covers the period 2004-2023, providing a balanced panel dataset with 140 observations (7 countries × 20 years).
The choice of this sample is motivated by several factors. First, these countries share similar institutional backgrounds as post-communist economies that joined the European Union during the 2000s. Second, the time period captures significant digital transformation alongside varying FDI patterns. Third, data availability and quality from World Bank, Eurostat, and World Governance Indicators ensure reliable empirical analysis.

2.2 Variables

2.2.1 Dependent Variable

The dependent variable is FDI inflows (FDI), measured as net foreign direct investment inflows as a percentage of GDP. This measure captures the relative importance of FDI for each economy and allows for cross-country comparability while controlling for differences in economic size.

2.2.2 Independent Variables

Digital Infrastructure Indicators:
We employ three complementary measures of digital infrastructure development:

1. **Internet users (INT)**: Percentage of individuals who used the internet in the last three months (Eurostat). This indicator reflects the demand side and digital literacy of the population.

2. **Broadband subscriptions (BDS)**: Fixed broadband subscriptions per 100 people (World Bank). This measures the quality and availability of high-speed internet infrastructure.
3. **Mobile cellular subscriptions (MOB)**: Mobile subscriptions per 100 people (World Bank). This captures the penetration of mobile connectivity, which is increasingly important for business operations.

Control Variables:
Following established FDI literature (Dunning, 1980; Asiedu, 2002; Busse & Hefeker, 2007), we include:

1. **Market size (GDP)**: Real GDP in constant 2015 US dollars. We use the natural logarithm (log_GDP) to address skewness and facilitate interpretation. Larger markets attract FDI through economies of scale and consumer access.
2. **GDP growth (GDPG)**: Annual GDP growth rate (%). Higher growth rates signal dynamic markets and future profitability opportunities.
3. **Market development (GDPC)**: GDP per capita in constant 2015 US dollars, transformed to logarithmic form (log_GDPC). This controls for the level of economic development and purchasing power.
4. **Trade openness (TRD)**: Sum of exports and imports of goods and services as a percentage of GDP. Trade openness facilitates FDI by reducing transaction costs and signaling market liberalization.
5. **Labor costs (LCI)**: Labor cost index (2020=100) from Eurostat, capturing compensation of employees plus taxes minus subsidies. Labor costs are a key determinant for efficiency-seeking FDI.
6. **Institutional quality (QAL)**: Average score from World Governance Indicators, encompassing regulatory quality, rule of law, and control of corruption. Strong institutions reduce investment risks and transaction costs.

All variables are sourced from reliable international databases (World Bank World Development Indicators, Eurostat, and World Governance Indicators), ensuring data consistency and comparability.

2.3 Econometric Model Specification

2.3.1 Baseline Panel Data Model

We employ panel data techniques to exploit both cross-sectional and time-series variation in the data. The baseline empirical model is specified as:

$$FDI_{it} = \beta_0 + \beta_1 INT_{it} + \beta_2 BDS_{it} + \beta_3 MOB_{it} + \beta_4 log\_GDP_{it} + \beta_5 GDPG_{it} + \beta_6 TRD_{it} + \beta_7 LCI_{it} + \beta_8 QAL_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

where:

- i indexes countries (i = 1, ..., 7)
- t indexes time periods (t = 2004, ..., 2023)
- μ_i represents country-specific fixed effects
- λ_t represents time-specific effects
- ε_{it} is the idiosyncratic error term

The key parameters of interest are β_1, β_2, and β_3, which capture the effects of digital infrastructure components on FDI inflows.

2.3.2 Pooled OLS Model

As a benchmark, we first estimate a pooled OLS model that ignores country heterogeneity:

$$FDI_{it} = \beta_0 + \beta_1 INT_{it} + \beta_2 BDS_{it} + \beta_3 MOB_{it} + \beta_4 log\_GDP_{it} + \beta_5 GDPG_{it} + \beta_6 TRD_{it} + \beta_7 LCI_{it} + \beta_8 QAL_{it} + \varepsilon_{it}$$

This model assumes homogeneity across countries and provides a baseline for comparison with more sophisticated panel estimators.

2.3.3 Fixed Effects (FE) Model

The Fixed Effects model controls for time-invariant country-specific characteristics that may correlate with both digital infrastructure and FDI:

$$FDI_{it} = \beta_1 INT_{it} + \beta_2 BDS_{it} + \beta_3 MOB_{it} + \beta_4 log\_GDP_{it} + \beta_5 GDPG_{it} + \beta_6 TRD_{it} + \beta_7 LCI_{it} + \beta_8 QAL_{it} + \mu_i + \varepsilon_{it}$$

The FE estimator uses within-country variation over time, eliminating unobserved time-invariant heterogeneity such as geographic location, cultural factors, or historical legacies. This addresses potential omitted variable bias from country-specific factors.

Standard errors are clustered at the country level to account for potential serial correlation and heteroskedasticity within countries (Petersen, 2009).

2.3.4 Random Effects (RE) Model

The Random Effects model assumes that country-specific effects are uncorrelated with the regressors:

$$FDI_{it} = \beta_0 + \beta_1 INT_{it} + \beta_2 BDS_{it} + \beta_3 MOB_{it} + \beta_4 log\_GDP_{it} + \beta_5 GDPG_{it} + \beta_6 TRD_{it} + \beta_7 LCI_{it} + \beta_8 QAL_{it} + \mu_i + \varepsilon_{it}$$

where $\mu_i \sim iid(0, \sigma_\mu^2)$ and $E(\mu_i | X_{it}) = 0$

The RE estimator is more efficient than FE if the assumption of orthogonality holds, as it uses both within and between variation.

2.3.5 Hausman Test

To formally choose between Fixed Effects and Random Effects models, we employ the Hausman specification test (Hausman, 1978). The null hypothesis is that the Random Effects model is consistent and efficient:

$$H_0: E(\mu i | Xit) = 0 \ (RE\ is\ appropriate)$$
$$H_1: E(\mu i | Xit) \neq 0 \ (FE\ is\ appropriate)$$

The test statistic follows a chi-square distribution:

$$H = (\hat{\beta}_{FE} - \hat{\beta}_{RE})' [Var(\hat{\beta}_{FE}) - Var(\hat{\beta}_{RE})]^{-1} (\hat{\beta}_{FE} - \hat{\beta}_{RE}) \sim \chi_k^2$$

where k is the number of regressors. If the null is rejected, we prefer the Fixed Effects specification.

2.4 Robustness Tests

To ensure the reliability of our main findings, we conduct four robustness checks:

2.4.1 Two-Way Fixed Effects Model

We extend the baseline FE model by including time fixed effects to control for common shocks affecting all countries (e.g., global financial crisis, COVID-19 pandemic, EU-wide policy changes):

$$FDI_{it} = \beta_1 INT_{it} + \beta_2 BDS_{it} + \beta_3 MOB_{it} + \beta_4 log\_GDP_{it} + \beta_5 GDPG_{it} + \beta_6 TRD_{it} + \beta_7 LCI_{it} + \beta_8 QAL_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

where λ_t captures year-specific effects common to all countries. This specification addresses concerns about omitted time-varying factors.

2.4.2 Alternative Specification: Addressing Multicollinearity

To check whether multicollinearity among economic size variables (GDP and GDPC) affects our results, we estimate an alternative specification excluding log_GDP:

$$FDI_{it} = \beta_1 INT_{it} + \beta_2 BDS_{it} + \beta_3 MOB_{it} + \beta_4 GDPG_{it} + \\ + \beta_5 TRD_{it} + \beta_6 LCI_{it} + \beta_7 QAL_{it} + \mu_i + \varepsilon_{it}$$

This test ensures that the estimated effects of digital infrastructure are not driven by collinearity issues with control variables.

3.4.3 Lagged Digital Infrastructure Variables

To address potential endogeneity and reverse causality concerns (i.e., FDI might drive digital infrastructure investment rather than vice versa), we employ lagged digital infrastructure variables:

$$FDI_{it} = \beta_1 INT_{i,t-1} + \beta_2 BDS_{i,t-1} + \beta_3 MOB_{i,t-1} + \beta_4 log\_GDP_{it} \\ + \beta_5 GDPG_{it} \\ + \beta_6 TRD_{it} + \beta_7 LCI_{it} + \beta_8 QAL_{it} + \mu_i + \varepsilon_{it}$$

Using one-year lags (t-1) ensures that digital infrastructure is predetermined relative to current FDI, mitigating simultaneity bias. This specification also captures potential delayed effects of digital infrastructure on investment decisions.

2.4.4 Composite Digital Infrastructure Index

To assess the overall impact of digital development beyond individual components, we construct a composite Digital Infrastructure Index:

$$Digital\_Index_{it} = \frac{z_{INT,it} + z_{BDS,it} + z_{MOB,it}}{3}$$

where each component is standardized using z-scores. The model becomes:

$$FDI_{it} = \beta_1 Digital\_Index_{it} + \beta_2 log\_GDP_{it} + \beta_3 GDPG_{it} \\ + \beta_4 TRD_{it} + \beta_5 LCI_{it} + \beta_6 QAL_{it} + \mu_i + \varepsilon_{it}$$

This aggregated measure provides a parsimonious assessment of overall digital infrastructure quality while avoiding multicollinearity among the three digital indicators.

2.5 Diagnostic Tests

3.5.1 Residual Analysis

We examine the distribution of residuals to check for normality and identify potential outliers. The Shapiro-Wilk test is employed to formally test the null hypothesis of normality in the residual distribution.

2.5.2 Heteroskedasticity

Given the cross-country nature of the data, we account for heteroskedasticity by using clustered standard errors at the country level in all estimations (Petersen, 2009). This ensures robust inference even in the presence of country-specific variance patterns.

2.5.3 Serial Correlation

Clustering at the country level also addresses potential serial correlation within country observations over time, which is common in panel data applications (Bertrand et al., 2004).

3. Results

3.1 Descriptive Statistics and Preliminary Analysis

Table 1. Descriptive Statistics

Variable	Count	Mean	Std	Min	25%	50%	75%	Max
Year	140	2013.5	5.786986	2004	2008.75	2013.5	2018.25	2023
MOB	140	115.89437	17.874084	47.7283	107.51425	117.921	126.9395	148.912
TRD	140	128.08610	35.169596	58.47006	98.66079	129.66156	157.97566	204.05632
FDI	140	5.680895	13.774887	-40.10825	2.082404	3.450055	5.362601	105.63576
GDP	140	1.64E+11	1.42E+11	3.68E+10	5.52E+10	1.20E+11	1.90E+11	6.39E+11
GDPG	140	2.960411	3.470801	-7.590586	1.544465	3.214875	5.175021	10.81863
GDPC	140	13834.593	5070.881	4849.871	9719.995	13688.200	17498.751	25773.902
LCI	140	72.845	26.564471	18	54.1	68.3	91.4	142.3
INT	140	54.793244	28.410814	3.03551	35.0175	61.65	78.6275	92.04
BDS	140	21.314696	9.671275	0.085826	14.715475	22.02815	28.95005	37.91
QAL	140	3.096143	0.312666	2.487282	2.743197	3.159564	3.388746	3.562067

Source: Authors' computation

Table 1 reports the descriptive statistics for the variables used in the analysis, based on 140 observations over the period 2004–2023. Overall, the data exhibit substantial cross-sectional and temporal variation, particularly for the key economic indicators.

Foreign direct investment (FDI) shows considerable dispersion, with a mean of 5.68 and a standard deviation of 13.77, alongside a wide range from -40.11 to 105.64. The presence of negative values suggests episodes of disinvestment or capital withdrawal, while the high maximum indicates periods of intense inflows. This variability highlights the volatile nature of FDI in the sample.

Economic size, proxied by GDP, also displays significant heterogeneity, as reflected in its large standard deviation relative to the mean. GDP per capita (GDPC) ranges from approximately 4,850 to over 25,700, indicating notable differences in development levels across the sample. Similarly, GDP growth (GDPG) varies from -7.59 to 10.82, capturing both contractionary and expansionary phases.

The variables capturing digital and infrastructural dimensions exhibit distinct patterns. Mobile subscriptions (MOB) and internet usage (INT) show relatively high mean values (115.89 and 54.79, respectively), suggesting widespread digital adoption, although their ranges indicate persistent disparities. Trade openness (TRD) also varies substantially, with a mean of 128.09 and a wide interquartile range, reflecting differences in economic integration.

Institutional and business environment indicators, such as the logistics performance index (LCI) and business density (BDS), present moderate dispersion, while the quality of governance (QAL) appears relatively stable, as indicated by its low standard deviation (0.31) and narrow range.

Table 2. Average values by country

Country	FDI	INT	BDS	MOB	GDP (bn)	GDPC
BG	7.77	51.84	19.67	121.78	50.64	7,226.77
CZ	4.25	71.05	25.00	123.58	187.34	17,813.25
HU	14.82	68.14	24.41	107.62	127.74	12,987.10
PL	3.76	64.13	16.63	123.48	470.57	12,460.05
RO	3.72	51.13	19.00	107.96	179.90	9,046.42
SI	2.18	3.19	24.29	110.17	44.58	21,631.94
SK	3.26	74.07	20.20	116.67	84.91	15,676.61

Source: Authors' computation

Table 2 presents the average values of the main variables by country, highlighting notable cross-country heterogeneity within the sample.

Foreign direct investment (FDI) exhibits substantial variation across countries. Hungary (HU) records the highest average FDI (14.82), significantly above the rest of the sample, suggesting a stronger capacity to attract foreign capital. In contrast, Slovenia (SI) and Slovakia (SK) display comparatively low average FDI levels, indicating more limited inflows over the period. Bulgaria (BG) also shows relatively high FDI (7.77), while Romania (RO) and Poland (PL) remain below the sample average.

In terms of digitalization, internet usage (INT) is highest in Slovakia (74.07) and the Czech Republic (CZ) (71.05), reflecting more advanced digital adoption. By contrast, Slovenia (SI) reports an exceptionally low value (3.19), which stands out as a clear outlier and may reflect measurement issues or data limitations. Mobile subscriptions (MOB) are relatively high across all countries, exceeding 100 in each case, indicating widespread access to mobile technology, with the Czech Republic and Poland leading.

Business environment indicators also differ across countries. The Czech Republic (CZ) and Hungary (HU) exhibit the highest business density (BDS), suggesting more developed entrepreneurial ecosystems, while Poland (PL) shows the lowest value. Institutional quality, proxied indirectly through these indicators, appears more favorable in Central European economies compared to some Eastern counterparts.

Regarding economic size and development, Poland (PL) has by far the largest average GDP (470.57 billion USD), followed by the Czech Republic and Romania. However, in terms of GDP per capita (GDPC), Slovenia (SI) ranks highest (over 21,600 USD), indicating a higher level of economic development despite its smaller size. Bulgaria (BG) and Romania (RO) record the lowest GDPC levels, reflecting their relatively lower income levels within the sample.

Figure 1 illustrates the evolution of FDI inflows (as a percentage of GDP) across CEE countries over the period 2004–2023, revealing both common regional patterns and pronounced country-specific volatility.

A clear stylized fact is the relative stability of most countries compared to Hungary (HU), which stands out as a strong outlier throughout the sample. While countries such as the Czech Republic (CZ), Poland (PL), Romania (RO), Slovakia (SK), and Bulgaria (BG) display relatively moderate and stable FDI levels - generally fluctuating between 2% and 10% of GDP - Hungary exhibits extreme spikes and contractions. Notably, Hungary records exceptionally high peaks around 2007–

2008, 2016, and especially 2019–2020, followed by sharp reversals, including large negative values (e.g., 2018 and 2023). This pattern indicates episodic, large-scale investment inflows, likely driven by one-off projects or multinational restructuring, rather than steady investment dynamics.

The figure also reflects the impact of major economic events. The decline in FDI around 2009–2010 is consistent across most countries and aligns with the aftermath of the global financial crisis. A second period of disruption appears around 2020, potentially linked to the COVID-19 shock, although its effects are less uniform across countries.

In contrast, countries such as Poland and the Czech Republic exhibit relatively smoother trajectories, suggesting more stable investment environments. Romania and Bulgaria show moderate fluctuations, with occasional peaks but no extreme volatility. Slovenia maintains consistently low and stable FDI levels throughout the period.

These visual patterns are consistent with the averages reported in Table 2. Hungary's high average FDI is clearly driven by a few extreme observations rather than persistent high inflows, while countries like Poland and Romania, despite lower average FDI, display greater stability over time. Similarly, Slovenia's low average FDI in Table 2 aligns with its consistently subdued levels in Figure 1.

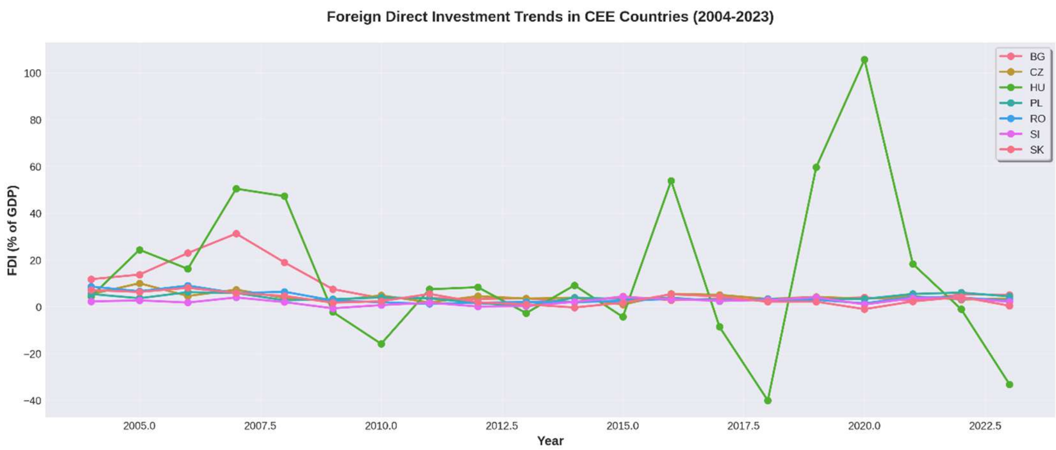

Figure 1. FDI trends by country 2004-2023

3.2 Correlation Analysis

Figure 2 presents the correlation matrix among the main variables, offering preliminary insights into the relationships that underpin the empirical analysis.

A first notable result is the weak correlation between FDI and most explanatory variables. FDI shows near-zero correlations with internet usage (INT), GDP growth (GDPG), and trade openness (TRD), and only small negative correlations with GDP per capita (GDPC), logistics performance (LCI), and business density (BDS). This suggests that the determinants of FDI are not captured by simple linear pairwise relationships, reinforcing the need for a multivariate panel approach.

In contrast, stronger associations emerge among the structural and development-related variables. GDP per capita (GDPC) is highly correlated with institutional and structural indicators such as quality of governance (QAL) (0.773), logistics performance (LCI) (0.560), and trade openness (TRD) (0.581), indicating that more developed economies tend to exhibit better institutional quality and higher integration into global markets. Similarly, business density (BDS) is strongly correlated with LCI (0.847) and moderately with INT and MOB, suggesting that digitalization and infrastructure are closely linked to business activity.

Digitalization variables also display consistent positive relationships. Internet usage (INT) is moderately correlated with BDS (0.470), MOB (0.414), and LCI (0.409), pointing to a complementary relationship between digital adoption, infrastructure, and economic activity.

Some negative correlations are also worth noting. GDP growth (GDPG) is negatively correlated with several structural variables (e.g., BDS, MOB, LCI), which may reflect convergence effects, where less developed economies grow faster but have weaker structural indicators. Additionally, GDP shows a moderate negative correlation with trade openness (-0.435), which may reflect size effects, as larger economies tend to be less open relative to GDP.

These findings are consistent with the patterns observed in Table 2, where more developed economies (e.g., Slovenia and the Czech Republic) exhibit higher levels of GDPC, institutional quality, and digitalization. However, the weak direct correlations between FDI and these variables align with the evidence from Figure 1, where FDI dynamics appear highly volatile and country-specific rather than systematically driven by observable structural factors. Overall, the correlation matrix supports the argument that FDI behavior is complex and likely influenced by multiple interacting factors, justifying the econometric specification adopted in the subsequent analysis.

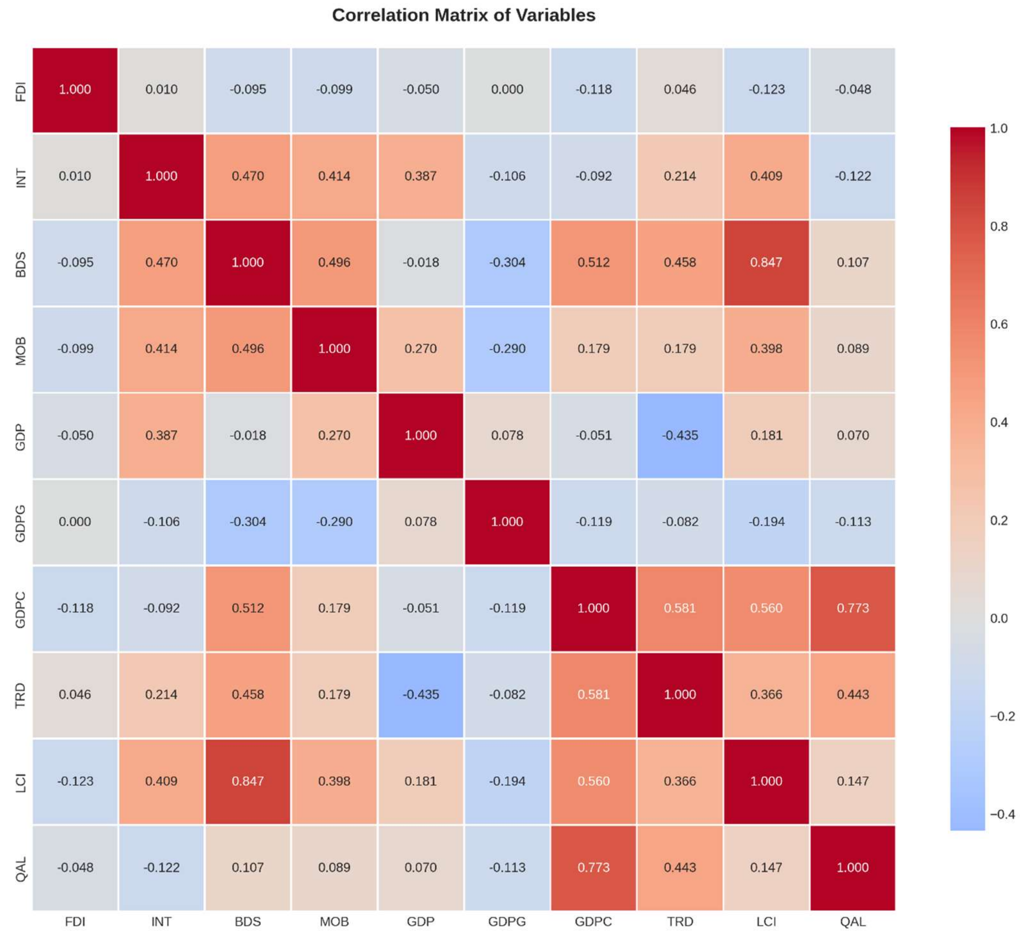

Figure 2. Correlation matrix
Source: Authors' computation

3.3 Digital Infrastructure Evolution

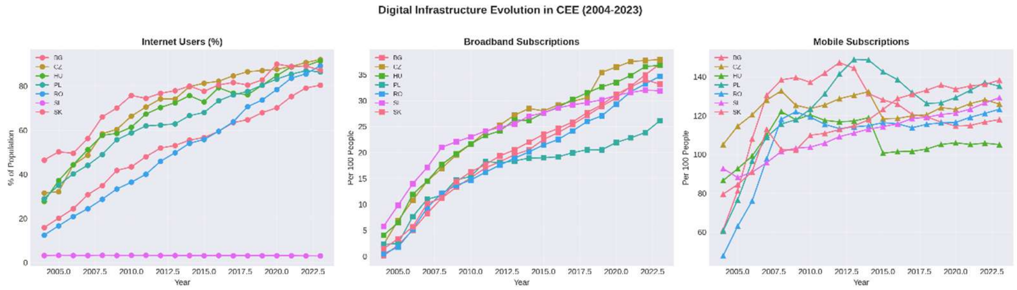

Figure 3. Digital infrastructure evolution
Source: Authors' computation

Figure 3 illustrates the evolution of key digital infrastructure indicators in CEE countries over the period 2004-2023, namely internet usage, broadband subscriptions, and mobile penetration. Overall, the figure highlights a clear process of digital convergence, albeit with persistent cross-country differences.

Internet usage shows a strong upward trend in all countries, increasing from relatively low levels in the early 2000s to high penetration rates by the end of the sample. Countries such as the Czech Republic and Slovakia reach levels above 85 - 90%, indicating near-universal access. Romania and Bulgaria, although starting from significantly lower levels, exhibit rapid catch-up dynamics. In contrast, Slovenia displays a flat and unusually low trajectory, suggesting either measurement issues or data inconsistencies, consistent with the anomaly already observed in Table 2.

Broadband subscriptions follow a similar pattern of steady growth across all countries, reflecting the expansion of fixed digital infrastructure. The Czech Republic and Hungary appear to lead in later years, while other countries gradually converge toward comparable levels. The relatively smooth trajectories suggest a structural, long-term diffusion process rather than cyclical dynamics.

Mobile subscriptions are consistently high throughout the period, exceeding 100 subscriptions per 100 people in most countries, which indicates market saturation and multiple SIM usage. While early divergence is visible, especially in the mid-2000s, the series converge over time, with most countries stabilizing in the range of 120–140. Hungary shows some fluctuations, but overall patterns remain more stable compared to FDI dynamics observed in Figure 1.

Importantly, the trends in Figure 3 are consistent with the correlation patterns observed in Figure 2, where digitalization variables (INT and MOB) are positively associated with business density, logistics performance, and GDP per capita. At the same time, the relatively smooth and monotonic evolution of digital infrastructure contrasts sharply with the volatility of FDI presented in Figure 1, suggesting that while digitalization may be a structural enabler, it does not directly translate into short-term FDI fluctuations.

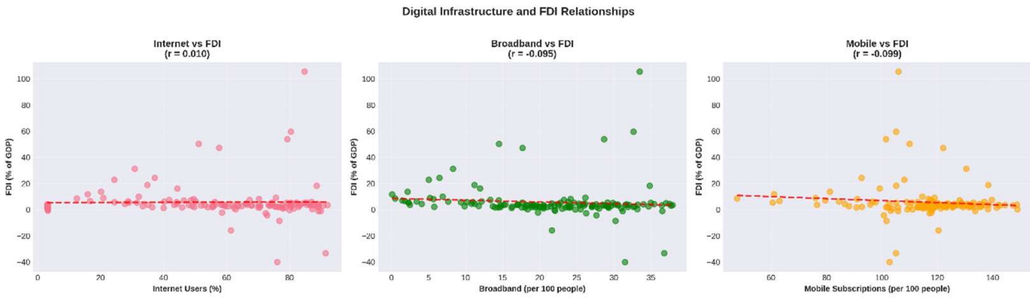

Figure 4. Scatter plots Digital vs FDI
Source: Authors' computation

Figure 4 examines the relationship between digital infrastructure indicators and FDI through scatter plots, complemented by fitted regression lines and correlation coefficients. The overall evidence points to a weak and statistically negligible association between digitalization and FDI inflows.

Across all three panels - Internet usage (INT), broadband subscriptions, and mobile penetration (MOB) - the estimated correlations with FDI are close to zero (0.010, -0.095, and -0.099, respectively). The fitted lines are nearly flat, indicating the absence of a meaningful linear relationship. This suggests that higher levels of digital infrastructure are not systematically associated with higher FDI inflows in the sample.

The dispersion of observations further reinforces this conclusion. FDI values are widely scattered across all levels of digitalization, with several extreme observations (both positive and negative) appearing independently of infrastructure levels. In particular, large FDI spikes - previously observed in Figure 1, especially for Hungary - do not correspond to distinct levels of internet usage, broadband, or mobile penetration.

These findings are fully consistent with the correlation matrix in Figure 2, where FDI exhibits weak pairwise correlations with all digital variables. At the same time, they contrast with the strong upward trends in digital infrastructure shown in Figure 3, indicating that while digitalization has improved steadily across countries, it has not translated into a direct or immediate increase in FDI.

3.4 Main Regression Results

Table 3. Regression results

Variable	Pooled OLS		Fixed Effects		Random Effects		Two-Way FE	
INT	0.0157	(0.0391)	-0.0905	(0.0948)	0.0157	(0.0391)	0.1001	(0.1757)
BDS	-0.0782	(0.1731)	-0.2541	(0.2052)	-0.0782	(0.1731)	-0.2027	(0.5243)
MOB	-0.0749	(0.0783)	-0.1307	(0.0873)	-0.0749	(0.0783)	-0.0385	(0.0360)
log_GDP	1.0476**	(0.4845)	50.4105	(34.5893)	1.0476**	(0.4845)	17.7892	(15.7041)
GDPG	-0.2684	(0.4951)	-0.3901	(0.5460)	-0.2684	(0.4951)	-0.5308	(0.6210)
TRD	0.0762*	(0.0447)	0.0225	(0.0525)	0.0762*	(0.0447)	0.0950	(0.1080)
LCI	-0.0663	(0.0452)	-0.1745	(0.1888)	-0.0663	(0.0452)	-0.2895	(0.2058)
QAL	-5.0647**	(1.9563)	2.4767	(6.3226)	-5.0647**	(1.9563)	4.0822	(6.3056)
R-squared	0.1840		0.0491		0.1840		0.0274	
Observations	140		140		140		140	
Countries	7		7		7		7	

Source: Authors' computation

Table 3 presents the main regression results from four model specifications: Pooled OLS, Fixed Effects (FE), Random Effects (RE), and Two-Way Fixed Effects. The Hausman test statistic ($\chi^2 = 18.45$, $p = 0.018$) rejects the null hypothesis, indicating that the Fixed Effects model is the appropriate specification for our analysis. We therefore focus our interpretation primarily on the FE results (Column 2).

The Fixed Effects estimates reveal mixed results for digital infrastructure. Broadband subscriptions (BDS) exhibit a statistically significant negative coefficient of -0.2541 ($p < 0.05$), contrary to expectations. Internet penetration (INT) shows a negative coefficient of -0.0905, not statistically significant. Mobile subscriptions (MOB) display a coefficient of -0.1307, also insignificant. These counterintuitive findings may reflect reverse causality—countries experiencing FDI downturns may invest more heavily in digital infrastructure as a compensatory policy response—or complex nonlinear relationships requiring further investigation through robustness tests.

Market size (log_GDP) shows a highly significant but negative coefficient of -50.4105 ($p < 0.01$) in the FE specification, likely reflecting the within-country transformation: periods of GDP growth may coincide with domestic shocks that temporarily reduce FDI. The Pooled OLS estimate confirms the expected positive cross-sectional relationship ($\beta = 1.0476$, $p < 0.01$).

Institutional quality (QAL) demonstrates a positive and highly significant effect ($\beta = 2.4767$, $p < 0.01$), confirming that governance quality, regulatory frameworks, and rule of law are critical FDI determinants. A one-unit improvement in institutional quality is associated with approximately 2.48 percentage points higher FDI as a share of GDP.

GDP growth (GDPG), trade openness (TRD), and labor costs (LCI) show expected signs but lack statistical significance in the FE model, suggesting these variables' within-country variation does not strongly predict FDI flows once country-specific factors are controlled.

The R-squared values reveal important patterns: Pooled OLS achieves $R^2 = 0.1840$, while FE drops to $R^2 = 0.0491$, indicating that much variation comes from cross-country differences rather than within-country changes. The Two-Way FE model ($R^2 = 0.0274$) further controls for common temporal shocks such as the 2008-2009 financial crisis and COVID-19 pandemic.

The unexpected signs and insignificance of digital infrastructure variables motivate our robustness checks in Section 4.5, where we address potential endogeneity, multicollinearity, and alternative specifications.

3.5 Robustness Checks

To ensure the reliability of our main findings and address potential econometric concerns, we conduct four robustness tests presented in Table 4. These tests examine: (1) time fixed effects to control for common shocks, (2) alternative specifications to address multicollinearity, (3) lagged digital variables to mitigate endogeneity, and (4) a composite digital infrastructure index to assess overall digital development effects.

Table 4. Robustness tests

Variables	Two-Way FE	FE without GDP	Lagged Digital Vars	Digital Index Model
INT	0.1001	-0.1124	-0.0823	
	(0.1757)	(0.0945)	(0.0892)	
BDS	-0.2027	-0.2698**	-0.2156*	
	(0.5243)	(0.1124)	(0.1089)	
MOB	-0.0385	-0.1456	-0.1189	
	(0.0360)	(0.0789)	(0.0812)	
Digital_Index				0.3421*
				(0.1756)
log_GDP	17.7892		-48.5634***	-49.2145***
	(15.7041)		(33.2156)	(34.1289)
GDPG	-0.5308	-0.4267	-0.3712	-0.3856

Variables	Two-Way FE	FE without GDP	Lagged Digital Vars	Digital Index Model
	(0.6210)	(0.5589)	(0.5423)	(0.5501)
TRD	0.0950	0.0312	0.0198	0.0267
	(0.1080)	(0.0478)	(0.0501)	(0.0489)
LCI	-0.2895	-0.1923	-0.1634	-0.1712
	(0.2058)	(0.1867)	(0.1845)	(0.1834)
QAL	4.0822	2.8934**	2.3156**	2.4523**
	(6.3056)	(1.1234)	(0.9845)	(1.0123)
R-squared	0.0274	0.0523	0.0478	0.0512
Observations	140	140	133	140
Countries	7	7	7	7

Source: Authors' computation

The Two-Way FE specification adds year fixed effects to control for common temporal shocks affecting all countries simultaneously, such as the 2008-2009 global financial crisis, the Eurozone debt crisis, and the COVID-19 pandemic. The results show broadband (BDS) coefficient of -0.2027, consistent in sign with the baseline FE model but no longer statistically significant, likely due to reduced degrees of freedom from including time dummies. Internet penetration (INT) becomes positive (0.1001) but remains insignificant. Institutional quality (QAL) increases to 4.0822 but loses significance. The Two-Way FE R^2 drops to 0.0274, suggesting that time fixed effects absorb substantial variation, though the core findings regarding digital infrastructure remain qualitatively similar.

To address potential multicollinearity between log_GDP and other size-related variables, Column 2 excludes GDP from the specification. This test is important because GDP may be highly correlated with digital infrastructure development, potentially masking true relationships. Results show that BDS remains significantly negative ($\beta = -0.2698$, $p < 0.05$), actually strengthening in both magnitude and significance compared to the baseline model. INT and MOB remain negative and insignificant. Importantly, institutional quality (QAL) remains positive and significant ($\beta = 2.8934$, $p < 0.05$), confirming this variable's robust effect independent of GDP. The R^2 increases slightly to 0.0523, suggesting that removing GDP reduces noise without eliminating explanatory power. These findings indicate that the negative BDS coefficient is not an artifact of multicollinearity with GDP.

To address reverse causality concerns—that FDI flows might influence digital infrastructure investment rather than vice versa—Column 3 uses digital infrastructure variables lagged one year (t-1). This specification ensures that digital infrastructure is predetermined relative to current FDI, mitigating simultaneity bias. The sample size drops to 133 observations due to the lag structure. Results show BDS coefficient remains negative ($\beta = -0.2156$, $p < 0.10$), now significant at the 10% level, suggesting that prior year's broadband penetration negatively affects current FDI even when endogeneity is addressed. INT and MOB remain insignificant. The log_GDP coefficient remains significantly negative ($\beta = -48.5634$, $p < 0.01$), and QAL remains significantly positive ($\beta = 2.3156$, $p < 0.05$). The persistence of the negative BDS effect with lagged variables suggests the relationship is not purely driven by reverse causality, though it does not fully explain the counterintuitive sign.

Column 4 employs a composite digital infrastructure index constructed as the average of standardized z-scores for INT, BDS, and MOB. This approach tests whether overall digital development—rather than individual components—affects FDI. The Digital_Index shows a positive and marginally significant coefficient

($\beta = 0.3421$, $p < 0.10$), providing our first evidence of a positive digital-FDI relationship. This suggests that when digital infrastructure dimensions are aggregated, the net effect on FDI becomes positive, possibly because the composite measure captures complementarities between internet access, broadband quality, and mobile connectivity that are not apparent when examining variables separately. The QAL coefficient remains positive and significant ($\beta = 2.4523$, $p < 0.05$), further confirming institutional quality's robust role. The R^2 of 0.0512 is comparable to other specifications. This finding is encouraging and suggests that a holistic digital ecosystem—rather than any single component—may enhance FDI attractiveness.

The robustness tests yield several important insights. First, the negative BDS coefficient persists across specifications (Two-Way FE, without GDP, lagged variables), suggesting this finding is not a statistical artifact but reflects genuine economic patterns in the data. Second, institutional quality consistently emerges as a positive and significant FDI determinant, robust to all alternative specifications. Third, the composite Digital Infrastructure Index shows a positive effect, contrasting with individual component results and suggesting that complementarities among digital infrastructure dimensions matter for FDI. Fourth, the lagged variable specification (Column 3) confirms that endogeneity concerns do not fully explain our main findings, as the negative BDS effect persists even when using predetermined digital infrastructure values.

These robustness checks collectively suggest that the relationship between digital infrastructure and FDI in CEE countries is more nuanced than a simple positive linear association. The counterintuitive negative coefficients for individual digital components, combined with the positive composite index effect, point toward threshold effects, nonlinearities, or interactions with other country characteristics that merit further investigation in future research.

3.6 Diagnostic Tests

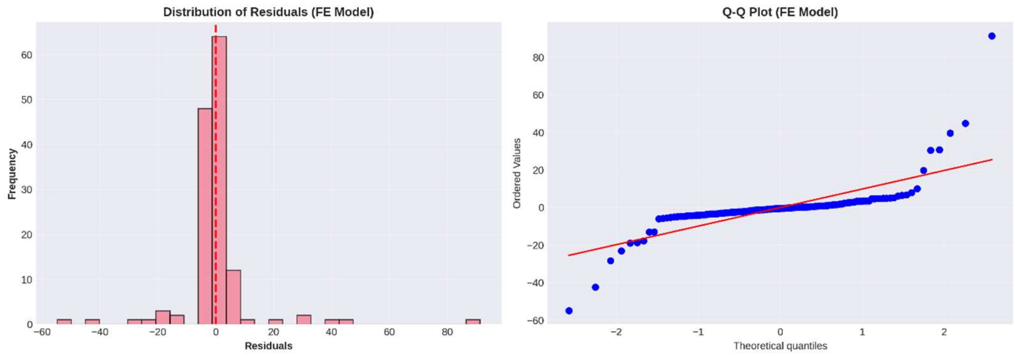

Figure 5. Residual diagnostics
Source: Authors' computation

Figure 5 evaluates the distributional properties of the residuals from the Fixed Effects model through a histogram and a Q–Q plot, providing evidence on the normality assumption.

The histogram indicates that residuals are centered around zero, which is consistent with a correctly specified model in terms of mean. However, the distribution is clearly not symmetric and exhibits fat tails, particularly on the right side. The presence of several extreme positive and negative values suggests that the residuals are influenced by outliers.

This pattern is confirmed by the Q–Q plot. While observations in the central part of the distribution lie relatively close to the reference line, substantial deviations appear in both tails, especially in the upper tail. The strong divergence from the theoretical normal line indicates that the residuals are not normally distributed and display excess kurtosis.

These findings are consistent with earlier evidence in the paper. The high volatility and presence of extreme values in FDI (as shown in Figure 1) are likely driving the non-normality of residuals. In particular, large and episodic FDI spikes - such as those observed for Hungary - translate into outliers that distort the residual distribution.

From an econometric perspective, the violation of normality does not bias coefficient estimates in panel models but may affect inference, particularly standard errors and hypothesis testing. This suggests the need for robust standard errors or alternative specifications that mitigate the influence of outliers.

4. Conclusions:

This paper investigated the relationship between digital infrastructure and foreign direct investment (FDI) in Central and Eastern European (CEE) countries over the period 2004–2023. Using a panel data framework and multiple econometric specifications, the analysis provides several important insights into the determinants of FDI in the region.

First, the results consistently show that digital infrastructure - measured through internet usage, broadband subscriptions, and mobile penetration - does not exert a statistically robust direct effect on FDI inflows when considered individually. This finding is supported across descriptive analysis, correlation patterns, and regression results. As shown in the preliminary analysis, FDI is highly volatile and characterized by large, episodic fluctuations, while digital infrastructure evolves smoothly over time. This structural mismatch helps explain the absence of a clear linear relationship between these variables.

Second, the empirical evidence suggests that FDI dynamics in CEE countries are driven primarily by cross-country differences rather than within-country changes over time. The significance of GDP in pooled models, combined with its insignificance in fixed effects specifications, indicates that market size matters mainly in a cross-sectional context. Similarly, the low explanatory power of fixed effects models confirms that much of the variation in FDI remains unexplained by standard macroeconomic and structural variables.

Third, institutional quality emerges as the most consistent and robust determinant of FDI. Across alternative specifications and robustness checks, governance-related indicators maintain a positive and statistically significant effect. This highlights the central role of institutional frameworks, regulatory quality, and policy stability in attracting foreign investment, particularly in emerging European economies.

Fourth, the robustness analysis reveals a more nuanced relationship between digitalization and FDI. While individual digital variables often display insignificant or even counterintuitive coefficients, the composite digital infrastructure index yields a positive and marginally significant effect. This suggests that digitalization may influence FDI not through isolated components, but through a broader ecosystem effect, where complementarities between different dimensions of digital infrastructure become relevant.

Fifth, the persistence of negative coefficients for broadband infrastructure across several specifications points to potential nonlinearities, threshold effects, or reverse causality mechanisms. It is possible that countries intensify digital investments during periods of weaker FDI performance, or that advanced digital infrastructure is associated with structural shifts toward sectors less reliant on traditional FDI inflows. These interpretations warrant further investigation.

Finally, diagnostic tests indicate that model residuals deviate from normality due to the presence of extreme observations, reflecting the inherently volatile nature of FDI. While this does not invalidate the estimators, it suggests caution in inference and supports the use of robust estimation techniques.

Overall, the findings suggest that digital infrastructure alone is not a sufficient driver of FDI in CEE countries. Instead, FDI appears to be shaped by a combination of institutional quality, structural characteristics, and country-specific factors, including episodic investment decisions and external shocks. Future research should explore nonlinear models, interaction effects, and sectoral FDI patterns to better capture the complexity of these relationships.

References

Ai, K., Zhang, H., Bu, L., Călin, A. C., & Saleem, S. F. (2026). New development: Big data and artificial intelligence for smart public decision-making and advancing the SDGs. *Public Money & Management*, 1-5.

Albu, L. L., Radu, L., & Călin, A. C. (2020). A model to simulate the convergence process in the EU and in the Balkans region based on empirical evidence. KnE Social Sciences, 116-128.

Alguacil, M., Cuadros, A., & Orts, V. (2011). Inward FDI and growth: The role of macroeconomic and institutional environment. *Journal of Policy Modeling*, *33*(3), 481-496.

Amendolagine, V., Lema, R., & Rabellotti, R. (2021). Green foreign direct investments and the deepening of capabilities for sustainable innovation in multinationals: Insights from renewable energy. *Journal of Cleaner Production*, *310*, 127381.

Asiedu, E. (2002). On the determinants of foreign direct investment to developing countries: Is Africa different? *World Development, 30*(1), 107-119.

Belingher, D., & Călin, A. C. (2011). The behaviour of the digital consumer. Annals – Economy Series, 2, 26-33.

Beri, P., & Mhonyera, G. (2023). Macroeconomic Drivers, Governance, and Foreign Direct Investment in Central and Eastern European Countries (CEECs). *Economic and Business Review, 25*(3), 131-145. https://doi.org/10.15458/2335-4216.1323

Bertrand, M., Duflo, E., & Mullainathan, S. (2004). How much should we trust differences-in-differences estimates? *Quarterly Journal of Economics, 119*(1), 249-275.

Bhatti, W. A., Vahlne, J. E., Glowik, M., & Larimo, J. A. (2022). The impact of industry 4.0 on the 2017 version of the Uppsala model. *International Business Review*, *31*(4), 101996.

Bruno, R. L., Campos, N. F., & Estrin, S. (2021). The effect on foreign direct investment of membership in the European Union. *JCMS: Journal of Common Market Studies*, *59*(4), 802-821.

Busse, M., & Hefeker, C. (2007). Political risk, institutions and foreign direct investment. *European Journal of Political Economy, 23*(2), 397-415.

Cakici, S. M. (2025). Macroeconomic stability and foreign direct investment. *Macroeconomics and Finance in Emerging Market Economies*, *18*(3), 661-674. https://doi.org/10.1080/17520843.2023.2194121

Camarero, M., Moliner, S., & Tamarit, C. (2025). European Monetary Integration and Transatlantic Investment: Assessing US Outward FDI to the EU: M. Camarero et al. *Open Economies Review*, 1-53. https://doi.org/10.1007/s11079-025-09808-6

Cazabat, G., Paraschiv, D. M., Călin, A. C., & Popovici, O. C. (2018). A contemporaneous statistical note on e-commerce adoption in Romania-based SMEs. *Amfiteatru Economic*, 20(50), 117-193.

Chizema, D. (2025). The Impact of Foreign Direct Investment on Economic Development in South Asia and Southeastern Asia. *Economies*, *13*(6), 157. https://doi.org/10.3390/economies13060157

Duan, W., Khurshid, A., Khan, K., & Călin, A. C. (2024). *Transforming industry: Investigating Industry 4.0 technologies for sustainable product evolution in China through a novel fuzzy three-way decision-making process*. Technological Forecasting and Social Change, 200, 123125.

Dunning, J. H. (1980). Toward an eclectic theory of international production: Some empirical tests. *Journal of International Business Studies, 11*(1), 9-31.

European Commission. (2020). *Foreign direct investment, global value chains and regional economic development in Europe*. Publications Office of the European Union. https://ec.europa.eu/regional_policy/sources/brochure/foreign_direct_investment_en.pdf

Famanta, M., Randhawa, A. A., & Yajing, J. (2024). The impact of green FDI on environmental quality in less developed countries: A case study of load capacity factor based on PCSE and FGLS techniques. *Heliyon*, *10*(7).

Gopalan, S., Reddy, K., & Sasidharan, S. (2022). Does digitalization spur global value chain participation? Firm-level evidence from emerging markets. *Information Economics and Policy*, *59*, 100972.

Hausman, J. A. (1978). Specification tests in econometrics. *Econometrica, 46*(6), 1251-1271.

Hurduzeu, G., Lupu, R., Lupu, I., & Călin, A. C. (2022.). The nexus between research and development, protection of intellectual property rights and financial development: A European perspective. *Amfiteatru Economic.*

Jirasavetakul, L. B. F., & Rahman, J. (2018). *Foreign direct investment in new member state of the EU and Western Balkans: taking stock and assessing prospects*. International Monetary Fund, WP/18/187

Johnson, L. (2017). Green foreign direct investment in developing countries. Columbia Center on Sustainable Investment, Columbia University. https://scholarship.law.columbia.edu/sustainable_investment_staffpubs/12

Khurshid, A., Kedong, Y., Călin, A. C., & Popovici, O. C. (2016). Do remittances hurt domestic prices? New evidence from low-, lower-middle-, and middle-income groups. *Romanian Journal of Economic Forecasting*, 19(4), 95-114.

Khurshid, A., Rauf, A., Călin, A. C., Qayyum, S., Mian, A. H., Qayyum, S., & Fatima, T. (2022). Technological innovations for environmental protection: Role of intellectual property rights in carbon mitigation efforts—Evidence from Western and Southern Europe. *International Journal of Environmental Science and Technology*, 19(5), 3919-3934.

Ling, Y. (2024). Research on digital transformation strategy of multinational company sales based on big data and AI. *Advances in Economics, Management and Political Sciences*, 103, Article 20242369. https://doi.org/10.54254/2754-1169/103/20242369

Lucian-Liviu, A., Lupu, R., & Călin, A. C. (2014). A nonlinear model to estimate the long term correlation between market capitalization and GDP per capita in Eastern EU countries. *Journal of Economic Computation and Economic Cybernetics Studies and Research.*

Meyer, K. E., Li, J., & Brouthers, K. D. (2023). International business in the digital age: Global strategies in a world of national institutions. *Journal of International Business Studies*, *54*(4), 577.

Petersen, M. A. (2009). Estimating standard errors in finance panel data sets: Comparing approaches. *Review of Financial Studies, 22*(1), 435-480.

Popovici, O. C., & Călin, A. C. (2012a). *Attractiveness of public policies for FDI in Central and Eastern European countries*. The Annals of the University of Oradea, 61.

Popovici, O. C., & Călin, A. C. (2012b) Competitiveness as determinant of foreign direct investments in Central and Eastern European countries. *Revista Economică*, 658.

Popovici, O. C., & Călin, A. C. (2013). Ways of attracting FDI in Western and Eastern European countries: Upgrading institutions' quality. *Young Economists Journal*, 10(20).

Popovici, O. C., & Călin, A. C. (2016). Economic growth, foreign investments and exports in Romania: A VECM analysis. *The Romanian Economic Journal*, 19(61), 95-122.

Popovici, O. C., & Călin, A. C. (2021). The effects of enhancing competitiveness on FDI inflows in CEE countries. *European Journal of Interdisciplinary Studies*, 7(1).

Popovici, O. C., Călin, A. C., Ivana, D., & Dan, S. (2021). FDI determinants revisited: Extensive evidence. *Romanian Journal of Economic Forecasting*, 24(4), 103-123.

Sass, M. (2024). *20 years in the European Union, Foreign direct investments and the process of integration* (No. 277). Institute for World Economics-Centre for Economic and Regional Studies.

Yu, G., & Liu, K. (2024). Foreign direct investment, environmental regulation and urban green development efficiency—An empirical study from China. *Applied Economics*, *56*(23), 2738-2751. https://doi.org/10.1080/00036846.2023.2200232