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Middle Income Convergence Trap Phenomenon in CEE Countries

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Abstract: This study examines the Middle-Income Convergence Trap (MICT) in Central and Eastern European (CEE) countries by analysing their economic trajectories and the factors shaping their convergence with more advanced EU economies. Using data from 1995 to 2022 and an iterative Bayesian clustering approach, the analysis reveals heterogeneous convergence patterns. While countries like Bulgaria and Romania exhibit strong catch-up dynamics, others—such as Slovenia and the Czech Republic—show signs of stagnation, suggesting potential entrapment in the MICT. Further analysis using a dynamic fixed effects model identifies trade openness, human capital, and institutional quality as key drivers of convergence, whereas high public debt is associated with increased stagnation risk. The findings underscore the need for comprehensive policy strategies that promote innovation, enhance education systems, and improve governance. Addressing these structural challenges is essential for sustaining long-term convergence and avoiding the risks associated with the MICT in the CEE region.

Keywords: middle-income trap, convergence, economic growth, Central and Eastern Europe, Bayesian shrinkage estimator

JEL classification: F02, F15, O47

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1. Introduction and literature review

The concept of the MIT (middle income trap) has been extensively discussed in the academic literature, but evidence of its existence in Central and Eastern European (CEE) countries remains limited. Early work by Gill and Kharas (2007) defined the MIT as a general growth slowdown affecting middle-income economies that struggle to compete with low-cost producers or high-tech innovators. While this framework remains influential, more recent studies have refined the concept by exploring its relevance to specific regions.

Studies in Asian contexts have provided valuable insights into the causes and mechanisms of the MIT. Some scholars argue that the MIT aligns with fundamental growth theories, such as the Solow or Lewis models (Cai, 2012; Dalgıç et al., 2014), although methodological inconsistencies have led to mixed findings (see, e.g., Han & Wei, 2017). Various researchers have proposed their own definitions and interpretations of the MIT phenomenon. For instance, Ohno (2009) defines it as a barrier between stages of industrialization, where economies struggle to shift from growth driven by labour-intensive production to innovation-driven development. Similarly, Aoki (2011) conceptualizes economic development in five phases: Malthusian, government-led, Kuznets, human capital-based, and post-demographic transition. He argues that a country becomes trapped in the MIT if it fails to transition from the Kuznets phase to the human capital-based phase. While most scholars accept the concept of the MIT and explore strategies to overcome it (see, e.g., Cm et al., 2023; Glawe & Wagner, 2020; Lebdioui et al., 2021; Michalski, 2018; Naseemullah, 2022; Paus, 2020), some view it as vague or even deny its existence. For instance, Felipe et al. (2017) argue that differences among economies relate primarily to growth speed, highlighting that many high-income economies took decades to transition from middle-income status. Similarly, Lee (2020) finds no evidence that growth slowdowns occur more frequently in middle-income economies.

Beyond identifying the MIT, numerous authors investigate the factors that cause countries to fall into it. Naseemullah (2022) highlights the role of international institutions in perpetuating unequal development outcomes, while Lin and Wang (2020) emphasize the need for government intervention to prevent premature deindustrialization and promote industrial modernization. In contrast, Kalalang et al. (2022) argue that deregulation of government policies, combined with research support and labour force specialization, is essential for escaping the MIT. Human capital emerges as a critical factor in avoiding the MIT. Bulman et al. (2017), Cm et al. (2023), and Eichengreen et al. (2014) underscore the importance of education in enhancing labour productivity and supporting sustained growth. Cm et al. (2023) point out that middle-income countries often fail to fully leverage the potential of education, while Hu et al. (2023) confirm that human capital accumulation significantly reduces the risk of falling into the MIT.

Promoting domestic innovation and competitiveness is another key strategy. Michalski (2018) highlights the importance of balancing foreign investment with local innovation, particularly in high-tech sectors, while Liu (2016) demonstrates that patents drive innovation and economic growth. These findings suggest that fostering domestic innovation and leveraging unique skills are vital for avoiding stagnation and achieving sustainable growth.

While this concept has been widely studied, particularly in regions like Asia, research on this topic remains limited in the context of CEE. This gap underscores the growing relevance of the phenomenon for CEE, as the region faces distinctive challenges as post-communist economies striving to align with advanced EU member states. Begović (2018) introduced the concept of the **Middle-Income Convergence Trap**

(MICT), describing the stagnation or slow income growth of CEE countries relative to their wealthier EU counterparts. This framework is particularly relevant given the region's historical reliance on external drivers of growth, such as FDI, EU funding, and low labour costs, which may prove insufficient to ensure long-term economic convergence without significant structural and institutional reforms.

Following the fall of communism, CEE countries underwent profound transformations, transitioning from centrally planned economies to market-oriented systems. This period of transition was marked by substantial economic growth, driven by structural reforms, competitive labour costs, and significant inflows of foreign direct investment (FDI). The eleven CEE countries examined in this study have since integrated into the European Union, benefiting from enhanced market access, institutional reforms, and financial support through cohesion funds and structural assistance. Moreover, some of these countries have further deepened their integration by joining the Eurozone and adopting the common currency. This step has provided additional advantages, such as reduced transaction costs, increased trade and investment flows, and greater economic stability under a shared monetary framework.

Despite these benefits, challenges persist. Rising labour costs and structural limitations pose risks to their long-term growth potential. The threat of stagnation, akin to the middle-income convergence trap, highlights the urgency of understanding the factors shaping their economic trajectories and identifying strategies to foster sustainable development.

Beta convergence offers a theoretical framework for understanding the challenges posed by the MICT. It suggests that poorer economies should grow faster than wealthier ones, driven by their capacity to adopt existing technologies and capitalize on their lower starting points (R. J. Barro & Sala-i-Martin, 2004). However, for middle-income economies, this process often stalls as early advantages, such as low labour costs or external investments, begin to wane. The MICT can thus be seen as a specific disruption in the beta convergence process, where structural weaknesses and institutional inefficiencies hinder further economic catch-up.

In CEE countries, the early post-transition period was characterized by rapid growth, driven by competitive labour costs, FDI inflows, and structural reforms. EU integration and Eurozone membership provided significant advantages, including enhanced trade, financial stability, and access to structural funds. However, these benefits have not fully mitigated the risk of stagnation. As initial growth drivers lose momentum, structural barriers linked to the middle-income convergence trap—such as outdated industries and weak innovation systems—become increasingly apparent (Galgóczi & Drahokoupil, 2017).

The MICT in CEE countries is shaped by several structural and institutional factors. A critical barrier is the insufficient and ineffective investment in R&D, which hampers the region's ability to foster innovation and transition to high-value-added industries (Kravtsova & Radosevic, 2012). Technological advancement is a key driver of sustained economic growth, yet many CEE economies allocate limited resources to this area (Brodny & Tutak, 2024). Without robust innovation ecosystems, these countries remain reliant on external sources of growth, making it difficult to compete in advanced industries (Strelkov et al., 2024). Another challenge is the persistence of outdated industrial structures, a legacy of centrally planned economies (Correia et al., 2018). Many CEE countries continue to rely on low-value-added sectors, limiting their ability to diversify into more competitive and dynamic industries (Staehr, 2015). This reliance constrains their capacity for structural transformation, an essential component of overcoming the middle-income convergence trap.

Brain drains further exacerbate the region's challenges. Skilled professionals frequently migrate to wealthier EU member states in search of better opportunities and higher wages (Baláz et al., 2004). This depletion of local talent undermines human capital development, a cornerstone of innovation and productivity growth. Without targeted strategies to retain and develop skilled workers, CEE economies risk falling further behind in the convergence process (Atoyan et al., 2016; Roos, 2023).

Overcoming the MICT requires a multifaceted approach that addresses both structural and institutional weaknesses (Győrffy, 2022). Education and skills development are fundamental to building the human capital necessary for innovation and economic diversification (Akhvlediani & Cieślik, 2020; Antonia et al., 2023). Strengthening education systems and expanding access to technical and vocational training are essential for equipping the workforce with the skills needed for high-value-added industries.

Promoting domestic innovation through increased investment in R&D and fostering entrepreneurship is another critical strategy. Governments in the region must prioritize research initiatives and support public-private partnerships to drive technological advancements. Building a robust innovation ecosystem will enhance competitiveness and reduce dependence on external growth drivers. Economic diversification is essential for reducing vulnerability to external shocks and fostering resilience. Shifting resources toward high-tech and knowledge-intensive industries, such as information technology and renewable energy, can create new growth opportunities. Policies that support emerging industries and encourage local entrepreneurship will be crucial in this process (Zavarská et al., 2024).

Finally, strengthening institutions and improving governance are essential for creating a conducive environment for sustained growth. According to Shkolnykova et al.

(2024), transparent and efficient institutions can enhance market efficiency, reduce corruption, and attract investment. Institutional reforms should focus on streamlining regulatory frameworks, improving infrastructure, and fostering collaboration between the public and private sectors.

This study examines whether CEE countries are experiencing a MICT, leveraging the beta-convergence methodology to understand the region's economic trajectories and identify factors contributing to potential stagnation. The findings aim to inform policies that address the structural barriers to convergence, supporting a more cohesive and sustainable growth trajectory for all EU member states. In the next section, we describe the data, the models to estimate, and the methods to employ. In the third section, we present the results of our empirical analysis. Finally, the paper concludes with a discussion of the results and their policy implications.

2. Data, models and methods

In this paper, we focus on 11 CEE countries: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. These countries, classified as "Central Europe and the Baltics" in the WDI database, joined the EU in 2004, 2007, and 2013 and are often referred to as "new member states." They share key characteristics: i) low GDP per capita in 1995 compared to other EU members; ii) a transition from communist regimes to market economies; iii) significant industrial sectors, restructured through privatization and deregulation, attracting foreign investment, especially post-EU accession. Today, these countries play a key role in the EU, focusing on economic growth, social security, and improving citizens' quality of life. Their current challenge is to avoid the MICT: wages are no longer low enough to compete with less developed countries, yet innovation remains insufficient to rival advanced economies (Győrffy, 2022).

2.1 Models to estimate

As explained in the first section of the paper, the MIT issue in CEE countries is closely related to their economic catch-up dynamics and can therefore be analysed using β-convergence tools, referred to as the MICT. To identify the determinants of economic growth, we employ panel regressions.

Our approach begins with an assessment of **absolute *β*-convergence** in EU countries, focusing on whether poorer economies tend to grow faster than wealthier ones, thereby modelling the dynamics of economic catch-up. Barro and Sala-i-Martin (1995) specified the model of absolute convergence rewritten in dynamics for panel data by Islam (2003):

$$\log\left({y_{it}}/{y_{it-1}}\right) = \alpha_i - \left(1 - e^{-\beta_i}\right) log y_{it-1} + \varepsilon_{it} \tag{1}$$

where a is the intercept, and $-(1-e^{-\beta})$ the slope coefficient. Note that if the speed of convergence (i.e., parameter β) is positive, the annual growth rate, $\log(y_{i,t}/y_{i,t-1})$, is negatively correlated with $\log(y_{i,t-1})$, initial income per capita. Firstly, we propose estimating country-specific convergence speeds using iterative Bayesian estimators to assess whether Europe is indeed **converging at multiple speeds**. Secondly, we will explore **conditional convergence** by incorporating explanatory variables. Our focus will then shift to examining the relationship between key determinants and economic growth in CEE countries using panel data regression, aiming to identify factors that either facilitate or hinder their economic catch-up with more developed economies: [1]

$$\log\left({}^{y_{it}}/_{y_{it-1}}\right) = \alpha_i + \beta \log(y_{it-1}) + \gamma_k \log(X_{it}) + u_{it} \tag{2}$$

where log $\left({}^{y_{it}}/_{y_{it-1}}\right)$ as a dependent variable expresses growth of GDP per capita PPP (measured in constant 2021 international \$) in country i at time t, log (y_{it-1}) express the lagged GDP per capita PPP in country i at time $t-1$, which represents the conditional convergence. The X_{it} is matrix of k control variables, in which we introduce the following variables: PD_{it} (government consolidated gross debt, % of GDP), TO_{it} (trade openness, % of GDP), DWL_{it} (duration of working life, years), LP_{it} (labour productivity, index), $CORRUPTION_{it}$ (scale 0-15, it reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests). The annual data covers the period from 2002 to 2022. Data on GDP per capita PPP, corruption control, and trade openness

[1] We created a correlation matrix to find out whether any of the variables should be excluded from the model (if the correlation value was > 0.7) to avoid multicollinearity in these models.

comes from the World Development Indicators (2025), while data on government consolidated gross debt, duration of working life and labour productivity come from the Eurostat Database (2025). According to the conditional growth model, we expect a negative coefficient on log (y_{it-1}), indicating that poorer economies tend to grow faster than wealthier ones, conditional on structural characteristics. The empirical evidence on the impact of public debt on GDP per capita is mixed. However, based on the findings of Onofrei et al. (2022) we expect a negative correlation, suggesting that higher debt may lead to lower GDP per capita. High government debt can constrain fiscal flexibility and crowd out productive investments. For middle-income countries, effective debt management is essential to maintaining economic stability and avoiding stagnation, often associated with the MICT.

Greater trade openness facilitates access to international markets, enhances competition, and promotes efficiency through specialization. Additionally, it allows economies to benefit from technology transfers and foreign capital inflows. As a result,we expect a positive relationship between trade openness and GDP per capita growth, as supported by the literature on economic globalization and growth (Iyke, 2017). Higher labour productivity reflects improvements in technological advancement, efficiency, and overall economic performance. Productivity gains enable economies to produce more output with the same level of input, driving sustained growth (Martino, 2015; McMillan et al., 2014; Yılmaz, 2016). Consequently, we anticipate a strong positive correlation between labour productivity and GDP per capita growth.

A longer duration of working life increases labour supply and the accumulation of human capital, contributing to higher productivity and economic output. In aging societies, policies extending the working life can mitigate potential labour shortages and sustain economic growth. Therefore, we expect a positive effect of an extended working life on GDP per capita growth. Strong governance and transparency contribute to a more stable economic environment that fosters business development and growth. Hence, we expect a positive relationship between control of corruption and GDP per capita growth, aligning with previous findings emphasizing the role of institutions in economic performance (Ang & Dong, 2023; Cieślik & Goczek, 2018).

2.2 Methods

To explore the MICT hypothesis, we firstly estimate the convergence speeds of enlarged EU countries using a dynamic panel model (Eq. 1). To account for the heterogeneity of countries and their contrasting catch-up dynamics, we have chosen a model with variable coefficients. In panel data analysis (in general) and in the context of β-convergence (in particular), it is common to pool observations, either with or without individual-specific dummies. These dummies are assumed to be fixed (FE models) or random (RE models). In RE models, heterogeneity is modelled through random effects (individual and temporal). With panel data, one must decide whether to pool the data and obtain a single estimate for the entire sample or to estimate separate equations for each cross-section. Both the FE and RE models typically assume homogeneous slope coefficients across units, but this assumption is often unreasonable. Allowing for cross-sectional heterogeneity is particularly relevant in the context of convergence analysis. In the case of CEE countries, differences in convergence speeds challenge the idea of a uniform catch-up process in Eastern Europe.

The two standard estimation methods—pooling the data or estimating separate cross-sections—rely on extreme assumptions. Pooling assumes identical parameters across units, while separate estimation assumes completely different parameters for each cross-section. According to Maddala et al. (1997), the reality lies somewhere in between, as parameters are likely similar but not identical. To capture this, they propose treating parameters as drawn from a common distribution with a shared mean and a non-zero covariance matrix. The iterative Bayesian procedure (see the appendix for details) produces parameter estimates that are a weighted average of the pooled and individual cross-section estimates. These Bayesian shrinkage estimators, which "shrink" heterogeneous estimates toward the pooled estimator, are strongly recommended by Hsiao et al. (1999) when the model contains lagged endogenous variables, as is the case with our dynamic panel data convergence model.

Maddala and Hu (1996), Baltagi and Kao (2000), and Baltagi (2008) show that shrinkage estimators produce more stable, less dispersed coefficients and lead to better forecasts. Trapani and Urga (2009) further demonstrate, through a series of Monte Carlo simulations, that when the level of heterogeneity is high, shrinkage estimators should be preferred. Hsiao (2003) also confirms that, in the case of a panel data model with coefficient heterogeneity, the Bayesian approach performs well, even when the time dimension is small. Finally, according to Hsiao and Pesaran (2008) and Baltagi (2008), these estimators are not affected by non-stationarity bias. For all these reasons, we propose employing the iterative Bayesian procedure to obtain shrinkage estimators for the convergence speeds (i.e., the β coefficient) for each country in our sample.

To assess the conditional convergence in CEE countries, we employ a panel data approach. The Hausman test results favour a FE model, indicating that unobserved country characteristics are likely correlated with the explanatory variables. According to Hsiao and Pesaran (2008), adopting a FE approach helps mitigate bias arising from unobserved heterogeneity, particularly when cross-sectional units (i.e., countries) may differ systematically. Consequently, we include individual intercepts to control for these fixed differences across CEE countries.

Finally, panel datasets often exhibit cross-sectional dependence, heteroscedasticity, and serial correlation, which can invalidate standard inference if not addressed (Pesaran, 2004). To mitigate these issues, we follow the robust estimation approach suggested by Arellano (1987) and Hoechle (2007), adjusting the variance-covariance matrix to yield reliable standard errors. This ensures that our coefficient estimates, and corresponding statistical tests accurately reflect the underlying relationships, thereby shedding light on the key mechanisms driving economic growth and conditional convergence in the region.

3. Main results

Our results are presented in two subsections. First, we estimate the catch-up speeds for each country to establish their relative positions in terms of economic development (approximated by GDP per capita). Second, we present the results of the panel regression to determine which factors are significantly related to economic growth in CEE countries.

3.1 Speeds of convergence and MICT

The Figure 1 below illustrates the ongoing convergence among post-communist CEE countries, measured through GDP per capita in PPP as a percentage of the EU average. This metric, derived by dividing a country's GDP per capita in PPP by the EU average, underscores that despite three decades of transition, no CEE country has achieved parity with the EU average. Czechia emerged as a leader, surpassing the 90% threshold in 2017, reflecting its strong economic progress. Similarly, Slovenia, Lithuania, and Estonia have demonstrated significant progress, while Bulgaria lags significantly, achieving only 53.78% of the EU-27 average in 2020. The fact that no CEE country has reached the EU average after more than 25 years may signal the presence of a MICT, where countries face structural and policy barriers that slow growth as they approach higher income levels, posing challenges to sustaining long-term economic integration and development.

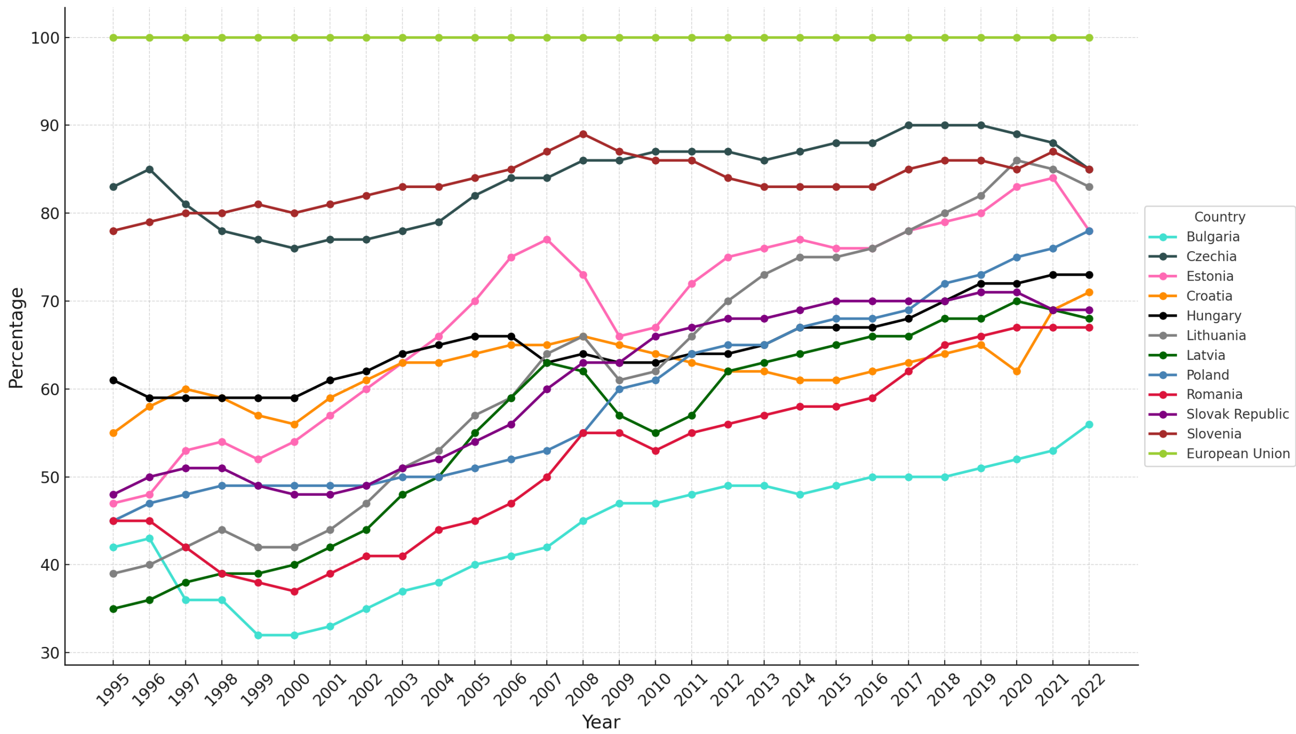


Figure 1. Convergence in CEE countries from 1995 to 2022
Own calculations based on data from WDI (2025).

When analysing the dynamics of EU integration, it is generally assumed that CEE countries, which joined the EU at different stages of development, should experience faster economic growth than the original European member states. This assumption is rooted in the theory of beta-convergence, which suggests that less developed economies tend to grow more rapidly than their more developed counterparts by adopting existing technologies and best practices. For poorer countries to catch up with wealthier ones, they must initially achieve higher convergence speeds. To test this hypothesis, we estimate these speeds using an iterative Bayesian procedure. The resulting "shrinkage" estimators of convergence speeds (parameters β) are calculated for the EU-27 over the period 1995-2022 (within the framework of Eq.1).

Table 1 contains the results of estimates: Bayesian shrinkage estimators for rates of convergence and the computed “half-life”, or the number of time periods necessary for the per capita income gap with EU to be halved. Note that economically less advanced countries like Romania and Bulgaria have higher rates of convergence than the richest countries of the EU. This result is in conformity with the theoretical conclusion: the rate of convergence decreases as the per capita income level increases.

Table 1. Bayesian Shrinkage Estimators of the Speeds of Absolute Convergence ($\hat{\beta}_i$) for EU-27 observed from 1995 to 2022

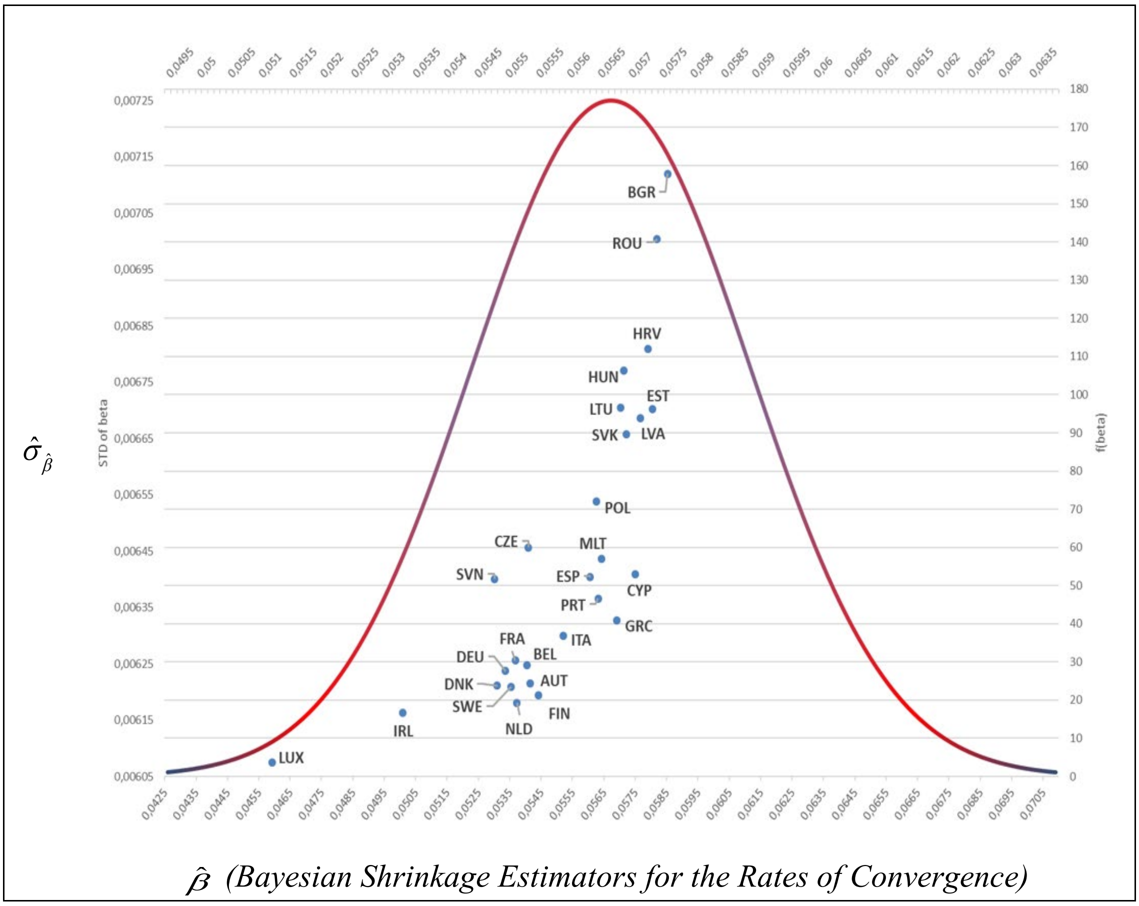
Beta-shrinkage country by country: number of iterations 6				
Country	Beta	Half-life	StdErrors of Beta	T-Stat of Beta
AUT	0.05415	5.55	0.00621	8.71369
BEL	0.05405	5.56	0.00624	8.65249
BGR	0.05853	5.14	0.00711	8.22099
CYP	0.05750	5.23	0.00640	8.97357
CZE	0.05409	5.56	0.00645	8.37895
DEU	0.05335	5.64	0.00623	8.55459
DNK	0.05309	5.66	0.00621	8.54855
ESP	0.05606	5.36	0.00640	8.75542
EST	0.05805	5.18	0.00670	8.66127
FIN	0.05442	5.53	0.00619	8.78580
FRA	0.05367	5.60	0.00625	8.58035
GRC	0.05692	5.28	0.00632	8.99703
HRV	0.05791	5.19	0.00680	8.50595
HUN	0.05714	5.26	0.00677	8.43952
IRL	0.05009	6.00	0.00616	8.12800
ITA	0.05520	5.45	0.00629	8.76348
LTU	0.05702	5.27	0.00670	8.50507
LUX	0.04592	6.55	0.00607	7.56031
LVA	0.05766	5.22	0.00668	8.62482
MLT	0.05642	5.33	0.00643	8.76624
NLD	0.05372	5.60	0.00618	8.69327
POL	0.05625	5.35	0.00653	8.60469
PRT	0.05631	5.34	0.00636	8.84642
ROU	0.05819	5.17	0.00700	8.30969
SVK	0.05721	5.26	0.00665	8.59530
SVN	0.05302	5.67	0.00640	8.28424
SWE	0.05354	5.62	0.00620	8.62378

Own calculations based on data from WDI (2025).

Figure 2 presents the convergence speed estimators as a function of their estimated standard deviations. The “core” of the distribution is represented by the high-income EU member states: Germany (DEU), France (FRA), Belgium (BEL), Finland (FIN), Italy (ITA), Austria (AUT), Netherlands (NLD), Sweden (SWE) and Denmark (DNK). Their catch-up speeds are very similar and relatively stable, around 5.3% per year. European countries such as Greece (GRC), Portugal (PRT), Spain (ESP), Malta (MLT), and Cyprus (CYP) have higher estimated catch-up speeds (around 5.6%), indicating that they are benefiting from economic convergence with the EU "core". The economic growth of high-income EU countries is in conformity with the absolute convergence hypothesis. These economies experienced significantly lower rates of economic growth during the examined period. For example, in 2023, the economic growth in Germany was 0,4 %, in France 0.5 %, while Greece, Portugal and Spain recorded more than 5 %. Among the oldest EU member states, two countries stand out from the "core": Ireland (IRL) and Luxembourg (LUX). These two countries have experienced a significant "economic take-off" — Luxembourg in the 1980s and Ireland in the 1990s. It is therefore consistent to find them on the left side of the distribution, as they are the most advanced along the path of beta-convergence in economic terms.

In CEE countries, there is an important heterogeneity. On one hand, Bulgaria (BLG) and Romania (ROU) exhibit the highest economic convergence speeds in the sample. While this positions them as "laggards", they are also experiencing a promising catch-up dynamic, thanks to their rapid GDP per capita growth. On the other hand, Slovenia (SVN), the Czech Republic (CZE) and Poland (POL) have catch-up speeds that are closer to the EU "core". This empirical result aligns with the trajectories presented in Figure 1. It suggests that these countries are the Eastern European "leaders" in terms of beta-convergence towards the EU. The Baltic States (LTU, LVA, EST), as well as Hungary (HUN), Slovakia (SVK), and Croatia (HRV), fall between the "laggards" and the "leaders" in CEE. Their estimated catch-up speeds are statistically similar to those of countries such as Cyprus, Malta, Spain, Portugal, and Greece.

Figure 2. Distribution of Convergence Rates for UE-27 over the period 1995-2022.



Own calculations based on data from WDI (2025).

In summary, the distribution of shrinkage estimators for the catch-up speeds of EU countries shows significant heterogeneity. The “leader” countries of CEE are converging towards the EU “core”. The “lagging” countries still have a considerable gap to close. However, their higher catch-up speeds allow for a certain degree of optimism regarding their convergence with the wealthier EU members. Nevertheless, according to the predictions of absolute convergence theory, the pace of catch-up will slow down as the wealth gap narrows. This slowdown raises concerns about the potential emergence of the MICT. Indeed, two Central and Eastern European countries stand out in this regard: Slovenia and the Czech Republic. These two countries share common characteristics. First, Fig. 1 shows that, while their levels of wealth are among the closest to the EU average, Slovenia and the Czech Republic still have some economic ground to cover.

Second, Fig. 2 indicates that their estimated catch-up speeds are similar to those of the EU core (5.3% for Slovenia and 5.4% for the Czech Republic). This raises concerns about a potential MICT: without a higher catch-up speed, Slovenia and the Czech Republic may struggle to close the gap with their wealthier European neighbours. To understand how this trap can be avoided, the next section will analyse the key factors driving convergence in Central and Eastern European countries.

3.2 Determinants of convergence in CEE countries

To understand the factors influencing economic convergence in 11 CEE countries between 2002 and 2022, it is essential to examine its key drivers. This section analyses macroeconomic determinants of convergence, focusing on government debt, trade openness, and human capital, represented by duration of working life and labour productivity, as well as institutional quality, measured by control of corruption. By employing panel regression analysis, we aim to examine which factors are significantly associated with economic convergence and assess their relative effects. The empirical findings contribute to the broader debate on whether CEE economies can sustain their catch-up momentum or face stagnation in the MICT due to structural barriers.

We estimated a fixed-effects (FE) model with individual country effects, which explains 70.56% of the variability in the dependent variable. To address rank correlation, cross-sectional dependence, and heteroscedasticity, we applied the Arellano variance-covariance matrix correction (Arellano, 1987) to ensure robust standard errors and reliable coefficient estimates. The regression results are presented in Table 2.

Table 2. Estimation results

	Dependent variable: growth of GDP per capita PPP					
	(I)	**(II)**	**(III)**	**(IV)**	**(V)**	**(VI)**
$\log(y_{it-1})$	-0.0682*** (0.0131)	-0.1143*** (0.0221)	-0.2131*** (0.0195)	-0.2047*** (0.0215)	-0.6535*** (0.0526)	-0.6484*** (0.0511)
log(DWL)		0.2578*** (0.0684)	0.1651** (0.0612)	0.2123** (0.0742)	0.5051*** (0.0483)	0.5358*** (0.0640)
log(TO)			0.1988*** (0.0302)	0.2313*** (0.0421)	0.0645* (0.0156)	0.0777* (0.0307)
log(PD)				-0.0416* (0.0166)	-0.0561*** (0.0103)	-0.0584*** (0.0101)
log(LP)					0.7061*** (0.0823)	0.6712*** (0.0732)
log(CORR)						0.0982* (0.0454)
R2	0.1035	0.1339	0.3300	0.4203	0.6928	0.7056
Adj. R2	0.0552 %	0.0862	0.2899	0.3827	0.6714	0.6836
Sample size: n = 11, T = 21, N = 231						

Note: ***=0.001, **=0.01, *=0.05 indicate 0.1%, 1%, 5% significance level; y_{it-1}: GDP per capita PPP in $t-1$; DWL: duration of working life; TO: trade openness; PD: government consolidated gross debt; LP: labour productivity; Corruption: control of corruption

Own calculations based on data from WDI (2025).and Eurostat Database (2025)

The coefficient on lagged GDP per capita provides strong evidence of conditional convergence, implying that countries with higher initial income levels exhibit slower growth. This suggests that CEE economies, despite initial rapid growth, may struggle to transition toward a high-income status without targeted structural reforms (Konya, 2023). Labour productivity emerges as the strongest determinant of growth. This finding underscores the role of technological progress, capital deepening, and efficiency improvements in sustaining economic expansion. The coefficient for duration of working life is positive and highly significant, suggesting that an increase in the number of years individuals spend in the labour force has a strong and positive effect on GDP growth. This reflects both demographic and labour market dynamics. A longer working life contributes to growth by increasing the labour supply, delaying retirement, and enhancing experience-based productivity (Scott, 2023). However, aging populations in CEE countries pose a long-term challenge, as extended working years must be supported by healthy aging policies, reskilling programs, and labour market flexibility.

The estimated coefficient for trade openness is significantly positive, suggesting that while global integration contributes to growth. Trade openness has a positive and significant effect on economic growth by increasing productivity, promoting technology transfer, and increasing efficiency through global competition (Arif et al., 2022; Keho, 2017). In CEE countries, EU integration and trade liberalization have driven rapid economic progress, enabling these nations to transition from low-cost manufacturing to more advanced industries. However, without complementary policies for human capital development and industrial upgrading, trade openness alone may not ensure sustained economic progress, which may lead to stagnation instead of convergence with high-income countries.

Government debt has a negative and highly significant effect on growth. This result signals potential risks associated with financial public sustainability. Many post-communist economies initially benefited from low debt levels but have recently experienced rising fiscal burdens due to demographic pressures, increased social spending, and economic shocks (e.g., the global financial crisis, COVID-19). High debt levels could crowd out productive investments and hinder long-term growth prospects. Institutional quality, measured through control of corruption, is found to be a positive and significant determinant of GDP growth. This aligns with economic theory suggesting that strong institutions promote investment, reduce transaction costs, and enhance economic efficiency.

4. Discussion of the results and policy implications

The empirical findings provide critical insights into the growth dynamics of post-communist CEE economies and their potential risk of falling into the MICT. The negative coefficient associated with lagged GDP per capita in the dynamic model suggests the existence of an economic catch-up dynamic. However, the heterogeneity in catch-up speeds found in the previous section raises concerns about a potential slowdown in this process (as observed in Slovenia and the Czech Republic). The central role of labour productivity in driving growth highlights the urgent need for a shift toward knowledge-based, innovation-driven economies. While early-stage growth in CEE countries was largely fuelled by FDI inflows, technology transfers, industrial restructuring, and cost advantages (Próchniak, 2011), economic catching-up now seems increasingly dependent on domestic innovation capacity and workforce skill development. Sustaining growth momentum will require strong investment in technological innovation, human capital, and high-value sectors.

Institutional quality plays a crucial role, suggesting that stronger governance and anti-corruption measures can help mitigate stagnation risks. Historically, post-communist economies inherited bureaucratic inefficiencies and governance weaknesses. While EU integration has driven institutional reforms, challenges persist in judicial independence, regulatory efficiency, and public sector transparency.

The negative effect of public debt raises concerns about the sustainability of fiscal policy. High debt burdens can restrict public investment in infrastructure, education, and research, thereby limiting the potential for long-term economic transformation. Without prudent fiscal management, these economies risk falling into a debt-growth spiral that could further exacerbate stagnation.

Trade openness has been a key driver of economic growth in CEE economies, facilitating productivity gains, technology transfer, and increased efficiency through global competition. EU integration and trade liberalization have enabled these countries to shift from low-cost manufacturing to more advanced industries. However, without complementary policies that enhance human capital, promote innovation, and support high-value-added production, economies risk remaining dependent on external demand and cost-based competitiveness, which may lead to stagnation rather than continued convergence. To maximize the benefits of trade openness, policymakers should focus on industrial upgrading, deeper integration into global value chains, and fostering a more innovative domestic business environment.

To sustain economic growth and avoid the MICT, policymakers in CEE economies must implement targeted structural reforms. Based on empirical findings, several key policy recommendations emerge. First, enhancing labour productivity through investment in human capital and innovation is crucial. Governments should prioritize education reforms, vocational training, and research and development incentives to foster technological diffusion and strengthen domestic innovation capacity. Transitioning to a knowledge-based economy is essential for long-term competitiveness.

Second, strengthening institutions remains a critical priority. Enhancing judicial independence, regulatory frameworks, and anti-corruption measures will foster a more transparent and investment-friendly business environment. Lessons from countries like Estonia show that digital governance and public sector efficiency reforms can significantly boost economic performance. Third, maintaining fiscal discipline is essential for long-term sustainability. Governments should focus on optimizing tax structures, improving expenditure efficiency, and reducing reliance on debt-financed public spending. Structural reforms in pensions and healthcare will also be necessary to address demographic-related fiscal pressures. Fourth, enhancing industrial competitiveness and moving up the value chain is crucial. Policies should support domestic entrepreneurship, technology clusters, and SME participation in global markets (Eriksson et al., 2023). Targeted incentives for high-tech industries and digital transformation will help economies reduce their dependence on low-cost, labour-intensive sectors (Zavarská et al., 2024).

Conclusion

The main objective of this study was to determine whether CEE countries are stuck in the MICT and to identify the factors related to this phenomenon. To address this question, we estimated dynamic panel models for the period 1995-2022. First, we estimated the convergence speeds using the iterative Bayesian procedure to account for the heterogeneity within the EU-27 sample. The initial results show: (1) that the EU converges at multiple rates; (2) that the CEE countries are indeed catching up with the EU's average wealth; (3) that countries such as Bulgaria and Romania have high convergence speeds, while Slovenia and the Czech Republic, after a successful start, seem to have fallen into the MICT. In the second step, we estimated the dynamic catch-up model in a panel using the Arellano method (period 2002-2022). We identified several factors contributing to economic growth. Thus, trade openness, control of corruption, and human capital are positively correlated with the economic catch-up dynamics in CEE countries, while government debt and lagged GDP per capita in PPP show a negative relation. In the first decade of the 21st-century economies of CEE countries experienced rapid growth, with the Slovak economy even being referred to as the 'Tatra Tiger' due to its impressive economic performance. This growth can be partly attributed to these countries' aspirations to join the EU and adopt the common European currency, which drove the implementation of systematic measures. However, in recent years, the lack of a similar vision has resulted in a loss of momentum for these countries to converge towards the more developed economies.

If the effort for both structural and institutional restructuring is not sustained by the respective governments, the CEE countries may fall into the MICT. In order to avoid it, now it is important to take more demanding steps towards convergence. According to our results, we suggest that the development strategy for countries should focus on human capital development, trade openness, and institutional quality, as highlighted by our results. Investing in human capital is crucial, as both labour productivity and extended working life have significant effects on growth. Policymakers should expand vocational training, digital education, and reskilling programs to ensure a competitive workforce. Additionally, pension system reforms and active aging policies can support longer workforce participation, sustaining productivity and economic growth.

While trade openness supports convergence, further benefits require shifting toward high-value-added exports. Governments should promote research and development, technology adoption, and deeper integration into global value chains while removing trade barriers and improving logistics infrastructure. Institutional quality, particularly control of corruption, remains essential for fostering a stable business environment. Reducing bureaucracy, enhancing transparency, and protecting investor rights will encourage entrepreneurship, ensuring long-term growth. A comprehensive innovation-driven strategy that strengthens human capital, trade competitiveness, and institutions is key to sustaining CEE economic convergence and avoiding stagnation.

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Declaration of interest statement

No potential conflict of interest was reported by the authors.

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Appendix: The Iterative Bayesian procedure

In the random-coefficient model, a single equation model in matrix notation for the i^{th} individual can be written as :

$$y_i = X_i \gamma_i + u_i \qquad \text{with} \qquad i=1,\ldots,N \tag{3}$$

where y_i is a $(T,1)$ vector, X_i is a (T,k) matrix of observations for the ith cross-section, and γ_i is a $(k,1)$ vector of parameters. Unlike pure cross-section data, panel data allow us to take the dynamic structure into account.

The model is thus assumed to be dynamic : X_i includes the lagged values of y_i . If all the parameters are treated as fixed and different for cross-sectional units and time periods, there are NTk parameters to estimate with only NT observations. Obviously, we cannot obtain any meaningful estimates of vector γ_i . Alternatively, each regression coefficient can be viewed as a random variable with a probability distribution. The random-coefficients specification substantially reduces the number of parameters to be estimated, while still allowing the coefficients to differ from unit to unit and/or from time to time.

In the Bayesian framework, the *prior* distribution of γ_i is given by : $\gamma_i \sim N(\mu,\Sigma)$. Since the parameters μ (average of γ_i), Σ (variance of γ_i) and σ_i^2 (residual variance) are unknown, some assumptions should be made on the *prior* specification of these parameters. One can then derive the *posterior* distribution for the γ_i parameters. If μ , Σ and σ_i^2 are known, the *posterior* distribution of γ_i is normal and given by :

$$\gamma_i^* = \left[\frac{1}{\sigma_i^{*2}} X_i' X_i + \Sigma^{*-1}\right]^{-1} \left[\frac{1}{\sigma_i^{*2}} X_i' X_i \hat{\gamma}_i + \Sigma^{*-1} \mu^*\right] \tag{4}$$

where $\hat{\gamma}_i$ is the OLS estimate of γ_i^*. The *posterior* distribution mean of γ_i and its variance are given by:

$$\mu^* = \frac{1}{N}\sum_{i=1}^{N} \gamma_i^* \tag{5}$$

$$V[\gamma_i^*] = \left[\frac{1}{\sigma_i^{*2}} X_i' X_i + \Sigma^{*-1}\right]^{-1} \tag{6}$$

Because in general Σ and σ_i^2 will not be known, one needs to specify priors for them. Smith (1973) took the conjugate Wishart distribution for Σ^{*-1} and the independent inverse χ^2 distributions for the σ_i^2 (Lindley and Smith, 1972). The author suggested using the mode of the *posterior* distribution :

$$\sigma^{*2}_i=\frac{1}{T+\varsigma_i+2}\left[\varsigma_i\lambda_i+(y_i-X_i\gamma_i^*)'(y_i-X_i\gamma_i^*)\right] \tag{7}$$

and $$\Sigma^*=\frac{1}{T-k-2+\delta}\left[R+\sum_{i=1}^{N}(\gamma_i^*-\mu^*)(\gamma_i^*-\mu^*)'\right] \tag{8}$$

where ς_i , λ_i , δ and *R* are parameters arising from the specification of the *prior* distributions. in the *prior* distributions. Smith (1973) proposed to approximate these parameters by setting $\varsigma_i=0$, $\delta=1$ and *R* to be a diagonal matrix with small positive entries (e.g., 0.001). The estimators are then :

$$\sigma^{*2}_i=\frac{1}{T+2}\left[(y_i-X_i\gamma_i^*)'(y_i-X_i\gamma_i^*)\right] \tag{9}$$

$$\Sigma^*=\frac{1}{T-k-1}\left[R+\sum_{i=1}^{N}(\gamma_i^*-\mu^*)(\gamma_i^*-\mu^*)'\right] \tag{10}$$

$$\gamma_i^*=\left[\frac{1}{\sigma^{*2}_i}X_i'X_i+\Sigma^{*-1}\right]^{-1}\left[\frac{1}{\sigma^{*2}_i}X_i'X_i\hat{\gamma}_i+\Sigma^{*-1}\mu^*\right] \tag{11}$$

and $$\mu^*=\frac{1}{N}\sum_{i=1}^{N}\gamma_i^* \tag{12}$$

The equations (6) to (9) have to be solved iteratively, with the initial iteration using the OLS estimator $\hat{\gamma}_i$ to compute μ^*, Σ^* and σ_i^2 . The second iteration is based on the empirical iterative Bayes' estimator γ_i^* . The third iteration and the next ones are identical to the second. The empirical Bayes' estimator was proposed by Maddala, Li, Trost, Joutz (1997). The only difference with Smith's estimator is in the computation of the parameters σ_i^2 and Σ^*:

$$\sigma^{*2}_i=\frac{1}{T-k}(y_i-X_i\gamma_i^*)'(y_i-X_i\gamma_i^*) \tag{13}$$

$$\Sigma^*=\frac{1}{N-1}\left[R+\sum_{i=1}^{N}(\gamma_i^*-\mu^*)(\gamma_i^*-\mu^*)'\right] \tag{14}$$

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