A composite indicator to evaluate EU membership: The case of Central and Eastern European member states, 2004–2021

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The European Union (EU) experienced its largest expansion in 2004, when ten countries from Central and Eastern Europe (CEE) joined. This was followed by the accession of Bulgaria and Romania in 2007 and Croatia in 2013. The purpose of this study is to demonstrate how these countries have been able to benefit from EU membership. The topic's relevance is emerging because of discussions with candidate countries for EU membership. Before a new round of accessions, it is important to assess how previously admitted states have been able to benefit from their membership and what lessons can be learned from their cases. The paper covers the period between 2004 and 2021. The main questions concern the evolution of select CEE countries in recent years, the results that have already been achieved, and the weakest features of their integration. The paper suggests that although these countries have been able to benefit from membership, they still face significant challenges as members of the EU. To endorse this suggestion, the paper applies Tibor Palánkai's integration maturity and profile theories. The research builds on two hypotheses: first, the CEE countries in the analysis could improve their integration profile if they developed deeper economic ties with other EU members; second, countries that are located closer to the core countries of the EU (such as Austria and Germany) could exploit most of the benefits as a result of higher foreign direct investment (FDI) attractiveness. The paper designs a new composite indicator to provide a comprehensive understanding of the costs and benefits of EU membership. The findings support the hypotheses: countries

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such as the Czech Republic, Poland and Slovenia, which have formed deeper economic (trade and investment) relations with the EU's core countries, could significantly improve their composite indicator values. The results can contribute to integration theory and enlargement decision-making.

Introduction

Apart from Cyprus and Malta, CEE countries submitted their applications for membership to the European Union (EU) in the mid-1990s and gained membership within 10-15 years after three rounds of evaluation based on their preparedness. They were admitted into the EU if they fulfilled the specific economic, political, and institutional accession criteria established by the European Community/European Union in 1991 and 1993.

The first accession criteria were introduced by the Treaty of Rome, which stated that the candidate country should be European and democratic (Baldwin–Wyplosz 2004). As the enlargement and deepening of the integration went ahead, candidates' integration preparedness became increasingly relevant. CEE countries had to fulfil the so-called Copenhagen criteria (functioning market economy and competitiveness, implementation of the acquis communautaire) while also committing themselves to fulfil the Maastricht criteria in the future and join the eurozone. However, as pointed out by previous research (such as Daviddi–Ilzkovitz 1997 or Palánkai 2014), these criteria have been drawn in a very general way, setting only a minimum of requirements for accession without prescribing any explicit measurements and benchmarks.

The general impact of accession and the ability of CEE countries to benefit from EU membership have been less examined in the literature. Some aspects have come to the fore, such as the impact on agricultural trade or tourism (Kiss 2007 or Hughes–Allen 2009), but no study has examined the question in a broader and quantified way. The aim of this paper is to evaluate the performance of the CEE member states in regard to the economic criteria and the development they have achieved in these areas between 2004 and 2021. The paper is built on Tibor Palánkai's integration maturity and profile theories (2010, 2014, Palánkai–Miklós 2017) that establish clear criteria to determine whether and to what extent a country benefits from membership. The countries examined in this paper are Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Slovakia, and Slovenia. We excluded Cyprus, Malta, and the Baltic countries, as their economic structures and characteristics differ significantly from those of the other CEE countries whose geographic location and proximity to the core countries helped them achieve rapid development. This paper proposes two

hypotheses. First, *the examined CEE countries were able to improve their integration profile if they developed deeper economic relations with other EU members. Second, countries that are located closer to the core countries (such as Austria and Germany) could exploit most of the benefits as a result of higher foreign direct investment (FDI) attractiveness.*

The economic performance of the abovementioned countries will be compared based on a newly created composite indicator. The paper first provides an overview of the relevant academic literature; then, we verify the hypotheses through the introduction of a composite indicator based on indices that cover most of the economic criteria suggested by Tibor Palánkai's (2010) economic integration maturity and profile theories. After data collection and standardization, a principal component analysis is carried out to define specific factors and dimensions of the newly created composite indicator. Following these calculations, we introduce results that help us determine whether and to what extent these countries benefitted from EU membership from an economic perspective. The results can contribute to enlargement theory and decision-making and suggest that member states can benefit from the internal market from an economic point of view. This is even more important in the present situation marked by the pandemic, the Russia–Ukraine war, and a recession when countries' economic performance and convergence usually deteriorates.

Literature review

Economic cooperation is the form of international collaboration that is characterized by the exchange of industrial, financial, commercial, and technological resources, which results in economic development and gain for every participating actor (Snidal 1991). In a customs union, the possible sources of economic gain are drawn from more efficient and higher-quality production, as well as improved international bargaining position due to the larger size, which results in better terms of trade, intensified internal competition, and technological advances due to the spillover effect. Economic integrations provide a framework to reach these goals. Economic integrations also have political dimensions, as these forms of cooperation are mostly created for political reasons, but irrespective of these motives, the economic outputs are always significant (Viner 2014). In the case of a common market such as the European Union, additional sources of economic gain are manifested in the form of labor mobility, coordination of fiscal and monetary policies, and better income distribution (El-Agraa 1989, Jovanović 2007). On the other hand, these positive impacts are not evident. As Gabrisch–Werner (1998) pointed out, if transitional economies – such as CEE countries – do not carry out structural reforms, they can be easily harmed by diverging economic structures and cannot catch up to developed Western European countries. The reason behind this is increased intraindustry trade, which can lead to specialization, which in turn is based on low value-added

production. In this case, the income distribution is less favorable for these countries and creates a technology gap for CEE countries.

In what follows, the theory of integration maturity as the measurement of impacts of accession is introduced and an overview of the already existing literature in the field is given.

Integration maturity for measuring the impact of accession

Integration maturity theory gives a complex approach to define one country's capability to benefit from an integration to the maximum, while the costs and drawbacks are minimized (Palánkai 2010). The theory was created for measuring CEE countries' readiness to join the European Union, and it can be applied both before and after accession. Tibor Palánkai distinguished four aspects of integration maturity: economic, political, institutional, and social. In this study, we focus on the economic dimension since it is the most objective and quantifiable dimension.

Economic integration maturity can be defined by the following basic criteria: functioning market economy, competitiveness, macroeconomic stability, convergence, and financing ability. The functioning market economy is one of the Copenhagen criteria. It assumes the existence of free movement of market participants and prices that are determined by market conditions (Palánkai 2014). At the time of accession, CEE countries fulfilled this criterion, but it is worth measuring whether these countries could develop it further and benefit more from it compared to their time of accession. Competitiveness also appears among the accession criteria; it expresses candidates' ability to cope with the competitive pressures of EU markets and their businesses' ability to compete against other European enterprises. In a broader approach, it means that countries also compete against their social, economic, and institutional systems to create a favorable business environment. This aspect is more important in the case of CEE countries, as most of them are dependent on multinational companies, and their small and medium-sized enterprises (SMEs) are less competitive than similar enterprises in Western Europe. The role of macroeconomic stability has gained importance since the 2008–2009 crisis, and it is crucial to benefit from integration itself in the long term. Convergence is necessary to catch up and avoid the negative consequences of joining an integration. Joining an integration form can have a more negative impact on less developed countries than on more developed countries. If competition sharpens, most producers lose markets, which might result in a severe deterioration in the current account and balance of payments of underdeveloped countries. This can cause serious problems in terms of employment, budget, and economic growth. In addition, a more developed state can better adjust to the changed competitive conditions, mobilize its capital resources, and convert to more modern technologies. Financing ability implies the availability of domestic capital resources, the ability of an economy to produce the resources for its

own development, and the way a country operates on capital markets; it shows the ability of a particular country to absorb capital, both in terms of external investments of private capital (for instance foreign direct investments) and the intake of budgetary transfers (Palánkai 2014, Tankovsky–Endrődi-Kovács 2021).

After accession, a so-called integration profile can be formed for new member states. Palánkai–Miklós (2017) designed three pillars for its measurement: integration of the real economy (integratedness), comparative performance, and convergence and divergence. Real-economic integration focuses on the trade flows of member states, their structure of trade, and the transnationalization of their company sector (Outward Foreign Direct Investments – OFDIs). Comparative performance indices contain indices related to competitiveness and macroeconomic stability. Using these indices, the most important competitiveness and macroeconomic indices can be compared to each other. They also include the main characteristics of socioeconomic development. The aim of this pillar is to provide realistic and relevant information about the ongoing processes and the state of integration. The convergence and divergence pillar examines the levels of development and structures (Palánkai–Miklós 2017).

The main pillars of our analysis matrix have been selected in accordance with Tibor Palánkai's integration maturity and profile theories. Due to overlaps in indicators, five pillars are identified for the purposes of creating composite indicators (Table 1): 1. functioning market economy, 2. comparative performances (including indices related to competitiveness and macroeconomic stability), 3. real-economic integration, 4. financing ability, and 5. convergence.

Economic impact of EU accession on the economies of CEE countries

To date, only a few studies have quantified the economic results of EU membership in new member states. Even less examine this from several economic dimensions, such as those established by Tibor Palánkai. With this paper, we would like to contribute to filling this research gap.

Tibor Palánkai (2010) examined Hungary's integration profile through data analysis after 5 years of accession. Among the results, rapid export-led growth, high global integration, and investments by foreign companies can be highlighted. The same results also indicate that there is a need for further reforms in public services and the fight against corruption. Overall, EU membership is a positive-sum game for the country, but further investments in infrastructure, agriculture and SMEs are necessary to increase competitiveness and to benefit more from integration. Tankovsky–Endrődi-Kovács (2021) examined Romania's and Bulgaria's economic maturity. They concluded that these countries were not ready to join the EU in 2007, but they could benefit from membership in terms of economic development and macroeconomic stability. Nevertheless, further development is necessary, mainly in the fields of financing ability and infrastructure.

No study has been published thus far that examines CEE countries' integration maturity and profile by applying a composite indicator approach. However, there are studies that focus on each aspect of integration maturity and profile. Capello–Perucca (2014) found that CEE countries that carried out deep institutional reforms before accession and had a relatively high openness to globalization were able to achieve higher economic growth after joining the EU. Rapacki–Prochniak (2019) proved that variables associated with EU membership (economic freedom, improving quality of governance, progress in market reforms, improved institutional environment, inflow of EU funds and the rising volume of international trade and foreign direct investments) are important drivers of gross domestic product (GDP) growth in CEE countries. By examining trade flows as a source of competitiveness, Allard (2009) found that CEE (Visegrad) countries could increase their competitiveness, with rapid inward FDI playing more of a role than price competitiveness. Nevertheless, the 2008-2009 crisis revealed these countries' vulnerability to a sudden trade shock due to their heavy reliance on global demand. Rusu–Roman (2018) examined ten CEE countries' competitiveness between 2004 and 2016. They used the Global Competitiveness Index as a composite indicator and identified GDP growth and inflation rate as common sources of competitiveness. Nagy–Siljak (2018) examined the Eastern Partnership and 13 CEE countries' convergence between 2004 and 2016, differentiating the periods before and after the 2008–2009 crisis. They found that Estonia, Lithuania, Poland, and the Slovakia diverged from these countries due to higher growth rates between 2004 and 2016. They concluded that fixed capital formation played a significant role in the convergence process. Furthermore, while government debt had a negative impact on per capita growth, economic openness, inflation rate and unemployment rate were not statistically significant variables in the analyzed periods. Grela et al. (2017) examined CEE countries' convergence toward old member states between 1997 and 2014. They concluded that convergence was mainly driven by FDI flows (and related technology spill-overs) and trade, but these reached their limits by 2014. Further convergence is based on how these countries develop their innovation activities. Grančay et al. (2015) examined sigma convergence among new member states and found convergence of exports and imports per capita as well as of productivity levels associated with the member states' export baskets. However, there was no evidence for convergence of territorial and commodity structures of trade, which implied that multinational corporations had organized their global value chains across the EU in a way to maximize economies of scale. Findings by the Organisation for Economic Co-operation and Development (OECD) (Pina–Sicari 2021) are in line with this: the main source of regional convergence of CEE is German FDI and the region's consequent embeddedness in Germany's supply chains. The OECD recommends that limited EU funds should be spent more effectively to enhance productive upgrading. Moreover, more emphasis should be placed on innovation performance and the possibilities of urban agglomerations in the future.

The novelty of this paper is that it takes all elements of integration maturity and profile theories and evaluates EU membership in a quantified and complex way. To date, no paper examining this topic by building a composite indicator has been published. The composite indicator approach, on the other hand, has been widely accepted as a useful tool for assessing system performance at the macro level (Zhou et al. 2014) and for policy analysis related to competitiveness, sustainable development, or quality of life assessment. Giambona–Vassallo (2014) built a composite indicator for European countries to measure social inclusion, while Reig-Martínez (2013) calculated a wellbeing composite index to measure socioeconomic development in various European, Middle Eastern and North African countries. Gitelman et al. (2010) designed a composite indicator for European road safety. Groh et al. (2010) calculated composite indices to compare the attractiveness of 27 European countries for institutional investments in venture capital and private equity assets. Several studies (Edmonds et al. 2020, Magrini–Giambona 2022, Bonnet et al. 2021) have applied this methodology for measuring climate change vulnerability or sustainable development.

The composite indicator for competitiveness by Karl et al. (2013) is the most similar to our approach. The research measures the competitiveness of EU member states by identifying costs (relative to productivity), economic structure, countries' capabilities regarding exports, and innovation as driving forces. Karl et al. also measured several aspects of competitiveness by including the social and ecological dimensions. They have found that new member states fall behind on outcome measures and capabilities due to different economic structures. However, the research neither examined the differences among the new member states nor explained the differences in economic structures. This is the research gap we would like to cover with this paper by applying a new approach.

Research method

The paper builds on the theoretical underpinnings of economic integration maturity when designing a composite indicator. The purpose of the article is to gain a clearer understanding of the potential advantages of EU membership for CEE countries. We developed a new composite indicator that compresses relevant indices to measure integration maturity and, consequently, integration profile because it cannot be adequately described by a single component.

The statistical approach we employed is based on the OECD's Handbook on Constructing Composite Indicators (2008). The development of a composite indicator allows for the comparison and scalability of countries while maintaining a comprehensive and intricate overall image. Most of the time, working with a single variable is simpler than trying to find comparable trends across numerous separate indicators (OECD 2008). The newly constructed indicator proposes results along

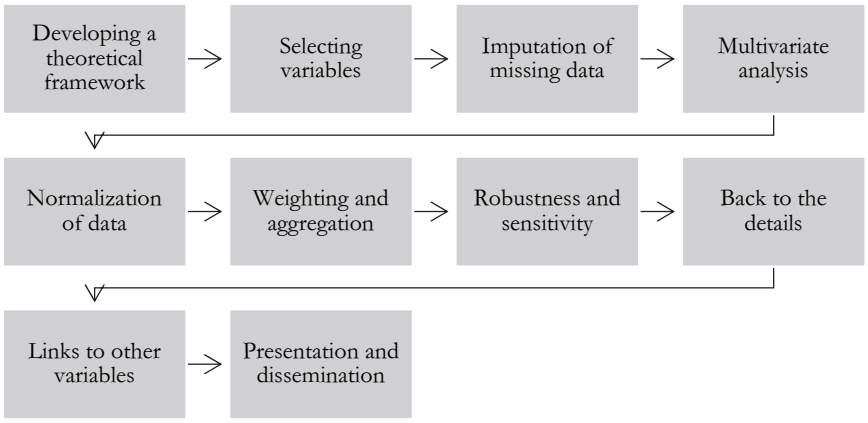
each of Palánkai's factors based on the aforementioned elements. The specific factors and variables analyzed in this study are presented in Table 1.

The variables were selected based on the literature and available statistics. The time scale of the analysis was determined with a view to the accession dates and the availability of a balanced dataset. Therefore, the time period under analysis spans from 2004 through 2021. Due to COVID restrictions, economic data were not always fully available for 2021. In these cases, we used estimates.

The creation of a statistically stable and reliable indicator can be accomplished in 10 phases, according to the OECD (2008) guidelines (see Figure 1).

Figure 1

The methodological framework of the composite indicator



Source: Constructed by the authors based on OECD (2008).

Based on the selected 16 indices, our composite indicator is suitable to assess the readiness of these nations to join the EU in terms of their total economic integration. Although the selection of the variables is debatable, they were chosen in accordance with the literature, from dependable sources, and proportionately for each criterion. This methodology is unique in that it assesses whether countries that are already members of the European Union have been able to develop economically and profit from EU membership. The disadvantage of the approach is that it evaluates the economic elements of integration in an exclusively quantitative fashion.

Analysis

In what follows, the contributions of each variable will be described in depth along with our conclusions in the sections that follow, based on the methods for developing a composite indicator.

Selection of variables

The objective of this step is to endorse the previously outlined theoretical definition. The availability and quality of the data have a significant impact on this process, so it is important to analyze the advantages and disadvantages of the chosen subindicators. Based on Palánkai (2010) and Palánkai–Miklós (2017), variables have been selected in accordance with the five main pillars.

Table 1

Variable selection based on the theoretical framework

Pillar (basic criteria)	Indicators defined	Data source(s)
Functioning market economy	BTI	[1]
Comparative performances (competitiveness and macroeconomic stability indices)	Global competitiveness index	[2]
	Doing business index	[3]
	Productivity/Unit labor cost	[4]
	GDP growth (annual %)	[5]
	Inflation, consumer prices (annual %)	[6]
	Unemployment rate, total (% of total labor force)	[7]
Real-economic integration	Medium and high-tech export (% manufactured goods)	[8]
	Trade balance	[9]
	OFDI (stock, m US)	[10]
Financing ability	Nonperforming loans to total gross loans (%)	[11]
	IFDI (stock, m US)	[10]
	Use of IMF credit (DOD, current US)	[12]
Convergence	Real GDP per capita (Chain linked volumes (2010), EUR per capita)	[13]
	Government net lending/ borrowing (% of GDP)	[14]
	Government debt to GDP (% of GDP)	[14]

The first variable is the transformation index from the Bertelsmann Stiftung (BTI), which was selected because it examines and assesses how developing and transitional nations are guiding societal transformation toward democracy and the market economy. The index evaluates 129 countries using 17 different criteria. The status index and the governance index are two indices created by the BTI by combining the outcomes of transformation processes and political management. The status index identifies where each of the 129 nations stand on its path toward democracy under the rule of law and a social market economy through its two analytic dimensions of

political and economic development. In our computations, the status index was applied.

The "Comparative performances" pillar contains indices related to competitiveness and macroeconomic stability. In the case of competitiveness, the EU only provides guidelines and patterns rather than a specific methodology (EC 2018). For instance, a country seeking full membership needs to implement the competition law of the EU and fulfil all its criteria. Since the EU does not have a complex competitiveness index, we used the World Economic Forum's calculations [2]. Two other competitiveness indices are also included in this section: one assesses how a country can form a favorable business environment for companies (Doing business indicator) (Siljak–Nielsen 2022), and the other is an indicator that measures firms' competitiveness (productivity/unit labor cost [ULC]) (Szentes 2011). In line with suggestions in Palánkai (2014), the most important macroeconomic indicators (GDP growth, inflation rate and unemployment rates) are counted in this pillar as well.

In the "Real-economic integration" pillar, following Palánkai–Miklós (2017), indices related to trade and transnationalization were included, such as trade balance, medium- and high-tech exports, and the level of OFDI.

Related to financing ability, the most important (and available) indicators (nonperforming loans [NPLs], IFDI and use of International Monetary Fund [IMF] credit) were selected to examine the available domestic and foreign capital resources, the ability of an economy to produce the resources for its own development, and the way a country operates on capital markets. This variable selection is in line with Palánkai's (2010) analysis.

In measuring convergence, we follow Palánkai's (2014) approach, which, in addition to GDP per capita, focuses on development and convergence in monetary and fiscal terms. Thus, we have included two of the Maastricht criteria as well. The selection of these variables is supported by the fact that the CEE countries made a promise at the time of their accessions that they would eventually join the eurozone.

Results of the multivariate analysis

To assess the applicability of the complex indicator and manage any future methodological developments, it is necessary to look at how indicators move together. In line with the selection of variables, five separate factors were developed to produce the most thorough outcome following the correlation analysis (see Table 2).

One drawback of complex indicators is that they tend to display only the overall picture, whereas minor issues can only be observed on a more in-depth level of study. That is why we will draw attention to measurements and fundamental characteristics that exhibit extreme values or have a substantial bearing on our research.

Table 2

Factor loadings

Number	Variable	F1	F2	F3	F4	F5
1	BTI	0.482	0.152	–0.407	–0.161	–0.452
2	Competitiveness index	0.675	0.455	0.043	0.124	–0.194
3	Doing business index	0.204	–0.355	0.616	0.292	0.066
4	Productivity/ULC	–0.326	0.466	–0.199	0.307	0.146
5	Medium and high-tech export	0.784	–0.141	–0.176	–0.150	0.084
6	GDP growth	–0.170	0.649	–0.166	0.205	0.415
7	Inflation (consumer prices)	–0.355	0.467	0.134	–0.506	0.128
8	Government net lending/borrowing	–0.064	0.621	0.089	0.667	–0.024
9	Government debt to GDP	0.407	–0.585	–0.189	0.138	0.475
10	Unemployment rate	–0.455	–0.412	–0.502	0.122	0.117
11	Trade balance	0.724	0.033	0.006	0.328	–0.247
12	GDP per capita (PPP[a])	0.784	–0.001	–0.388	0.050	–0.148
13	IFDI (%GDP)	0.516	0.148	0.522	–0.193	0.202
14	OFDI (%GDP)	0.743	–0.013	0.375	0.011	0.273
15	Nonperforming loans to total gross loans (%)	–0.345	–0.612	0.085	0.416	–0.162
16	Use of IMF credit (% of GNI[b])	–0.484	–0.042	0.477	–0.016	–0.461

a) Purchasing power parity.
b) Gross national income.
Source: Constructed by the authors based on the results of composite indicator analysis.

Normalization of data

This process is carried out to standardize the data and solve the issue of disparate measuring systems. Only when converted to a common unit of measurement can they be combined. As such, the values of the variables needed to be harmonized. Indicator values are transformed into simple numbers by this method, and the standardized value displays the standard deviation of the variable's value from the sample average. The calculation method for the standardized value is:

$$z = (x - \mu)/\sigma \quad (1)$$

where z is the standardized value, x is the variable's normal value, μ is the variable's average, and σ is the variable's standard deviation.

When the standardized value is negative, the variable's value is below average; when it is positive, it is above average. This process renders the composite indication unitless and enables it to be freely aggregated (OECD 2008: pp. 27).

Weighting and aggregation

This step increases the reliability of the composite indicator. It should be noted that after grouping the indicators, the aggregate weights of the groups differ because of the weighting method. A linear or geometric strategy can be applied in this situation (OECD 2008: pp. 31). The weight of each new group was established by factor

analysis (OECD 2008: pp. 32), which in turn was established by the sum of the squares of variance of the variables within the group as a result of the correlation of subindicators (see results in Table 3).

Table 3

Factor analysis and weighting

Variable	F1	F2	F3
BTI	0.232	0.023	0.165
Competitiveness	0.456	0.207	0.002
Medium and high-tech export	0.615	0.020	0.031
Trade balance	0.524	0.001	0.000
GDP per capita	0.615	0.000	0.151
OFDI	0.552	0.000	0.141
IMF Loans/GNI (%)	0.234	0.002	0.228
Productivity/ULC	0.106	0.217	0.040
GDP growth	0.029	0.421	0.028
Inflation	0.126	0.218	0.018
Budget deficit	0.004	0.386	0.008
Gov debt (gross)	0.166	0.343	0.036
NPLs	0.119	0.375	0.007
Doing business	0.042	0.126	0.379
Unemployment	0.207	0.170	0.252
IFDI	0.266	0.022	0.273

Note: Light grey represents factor loadings of F1 ("Comparative performances") principle component; medium grey represents F2 ("Real-economic integration") and dark grey represents F3 ("Business environment") loadings.

Source: Constructed by the authors based on the results of composite indicator analysis.

The squared cosines of the variables are displayed in Table 4. Based on these findings, weighting was established, as shown in Table 3. It is important to give each of the components a name when developing a composite indicator (Gitelman et al. 2010: p. 1216); in the section that follows, we will further elaborate the reasoning behind our naming scheme.

The results in Table 3 show us that instead of five pillars, it is worth establishing only three. The new pillars highly correlate with the previously defined pillars based on the theories in Palánkai (2014) and Palánkai–Miklós (2017), but minor modifications should have been carried out since each index can be grouped into different pillars.

Table 4

Squared cosines of the variables (values in bold correspond for each variable to the factor for which the squared cosine is the largest)
Factor loadings

Number	Variable	F1	F2	F3	F4	F5
1	BTI	0.232	0.023	0.165	0.026	0.204
2	Competitiveness index	0.456	0.207	0.002	0.015	0.038
3	Doing business index	0.042	0.126	0.379	0.085	0.004
4	Productivity/ULC	0.106	0.217	0.040	0.094	0.021
5	Medium and high-tech export	0.615	0.020	0.031	0.023	0.007
6	GDP growth	0.029	0.421	0.028	0.042	0.172
7	Inflation (consumer prices)	0.126	0.218	0.018	0.256	0.016
8	Government net lending/borrowing	0.004	0.386	0.008	0.444	0.001
9	Government debt to GDP	0.166	0.343	0.036	0.019	0.226
10	Unemployment rate	0.207	0.170	0.252	0.015	0.014
11	Trade balance	0.524	0.001	0.000	0.108	0.061
12	GDP per capita (PPP[a)])	0.615	0.000	0.151	0.003	0.022
13	IFDI (%GDP)	0.266	0.022	0.273	0.037	0.041
14	OFDI (%GDP)	0.552	0.000	0.141	0.000	0.075
15	Nonperforming loans to total gross loans (%)	0.119	0.375	0.007	0.173	0.026
16	Use of IMF credit (% of GNI[b)])	0.234	0.002	0.228	0.000	0.212

Source: Constructed by the authors based on the results of composite indicator analysis.

In the first group, BTI, Word Economic Forum (WEF) competitiveness, medium- and high-tech exports, trade balance, GDP per capita, OFDI and the usage of IMF credits have the strongest contribution. Based on these findings, we named the first group "Comparative performance", which represents the most significant part of our composite indicator (63.3%). The second group includes labor productivity, GDP growth, inflation, government net lending/borrowing, rate of government debt and the rate of nonperforming loans. In line with the theories, this group is called "real-economic integration". Its overall contribution is 26%. There was one major deviation from the results. Inflation and budget deficit data were supposed to create another factor. However, the contributions of these variables to the second factor were 0.218 and 0.386 and to the fourth factor were 0.256 and 0.444. There was no significant difference between the numbers, but it is more logical to pair them to the second large group. Thus, the third group contains the doing business index, unemployment ratio and IFDI. These variables showed such different results and no significant correlation with the other variables that we had to create a separate group for them. Based on previous research (Siljak–Nielsen 2022, Ármás 2022), this factor was named "Business environment". Its final contribution to the composite indicator is 10.8%, as it represented the least number of comovements.

Table 5

Results and formulated criteria after weighting and aggregation

Comparative performances	Real-economic integration	Business environment
BTI Global competitiveness index Medium and high-tech export (% manufactured goods) Trade balance Real GDP per capita (Chain linked volumes (2010), EUR per capita) OFDI (stock, m US) Use of IMF credit (DOD, current US)	Productivity/Unit labor cost GDP growth (annual %) Inflation, consumer prices (annual %) Government net lending/borrowing (% of GDP) Government debt to GDP (% of GDP) Nonperforming loans to total gross loans (%)	Doing business index Unemployment rate, total (% of total labor force) IFDI (stock, m US)

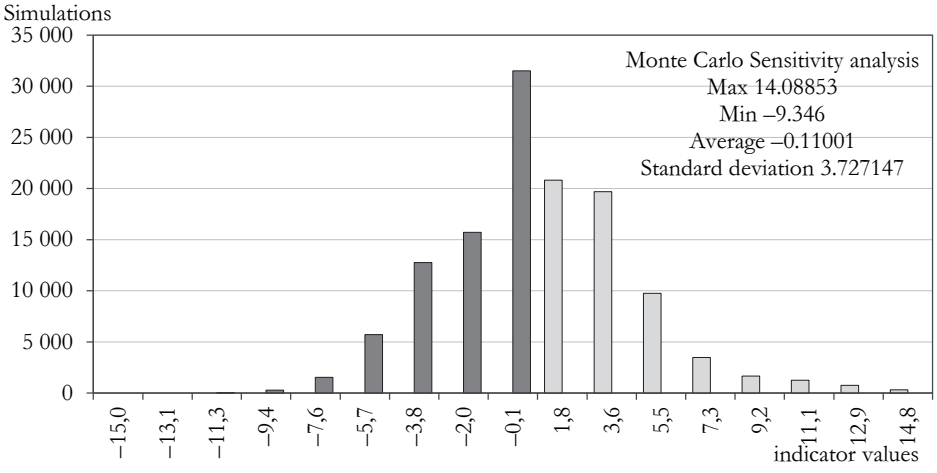
Source: Constructed by the authors based on the results of composite indicator analysis.

Robustness and sensitivity analysis

Robustness analysis must precede the validation of the data. To prove this, we used a Monte Carlo simulation: we created alternative economic conditions in which every indicator's value would be multiplied by 0.7 and 1.3 (–30%; +30%). We executed 5,000 alternative scenarios for each participating country (Hungary, Slovakia, Slovenia, Czech Republic, Poland, Romania, Bulgaria, Croatia) and for each analyzed date (2004, 2013, 2019), so 125 thousand random indicator values were simulated. The results were consistent, and the standard deviation was stable and stayed within the –1 and 1 thresholds (although it was very close to the 1 bin border).

Figure 2

Visualization of simulation results when changing economic conditions

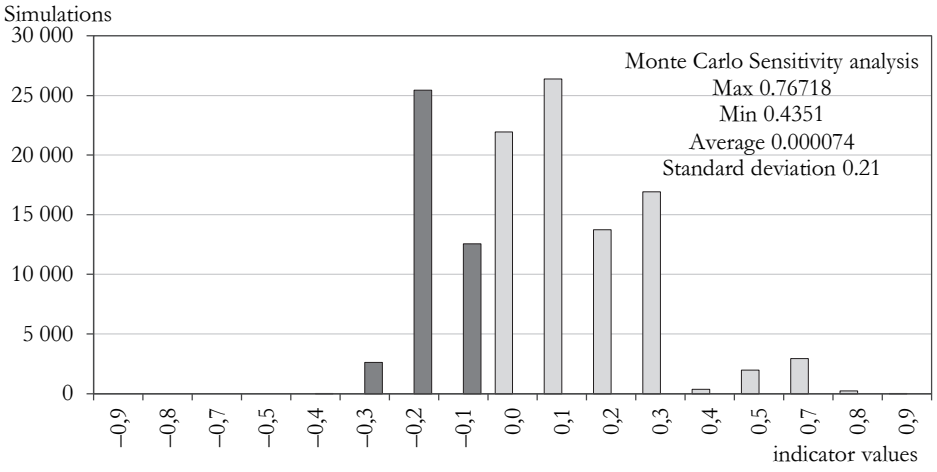


Source: Constructed by the authors based on the results of composite indicator analysis.

The distribution is slightly different from the normal 68-95-99 rule; it is 79-96-99% but still falls in the normal measures (not triangle or equal distribution). Figure 2 shows the results of the simulations. The mean indicator value was 0.1, and more than 30,000 calculations resulted in this result. To further increase the robustness of our model, we also performed simulations related to the weights of the indicators. We executed two more sensitivity analyses with two different approaches. First, we calculated the contribution of the indicators based on their variances to the total eigenvalues, basically calculating individual weights for each indicator. These individual values were then simulated with the same Monte Carlo approach with +/–30% ratios. In the case of the second analysis, the same method was used, but we used weightings based on the grouping of our indicators (Table 5). The difference between the results is statistically significant (see results in Figures 3 and 4). In the case of the individual indicator weighting simulations, a huge number of the indicator values could not stay within the normal threshold (standard deviation 0.2, the limits were +/–0.2). When using the group weightings, the higher number of simulation results stayed within the normal –1 and 1 range (standard deviation 1.75, the limits were +/–1.8). It shows that with individual weights for each variable, our complex indicator becomes uncertain. It also confirms the findings of previous research – when creating a composite indicator based on principal component analysis (PCA) factor analysis, it is always worth using subgroups for the variables, as it provides further robustness to the model (OECD 2008, Freudenberg 2003).

Figure 3

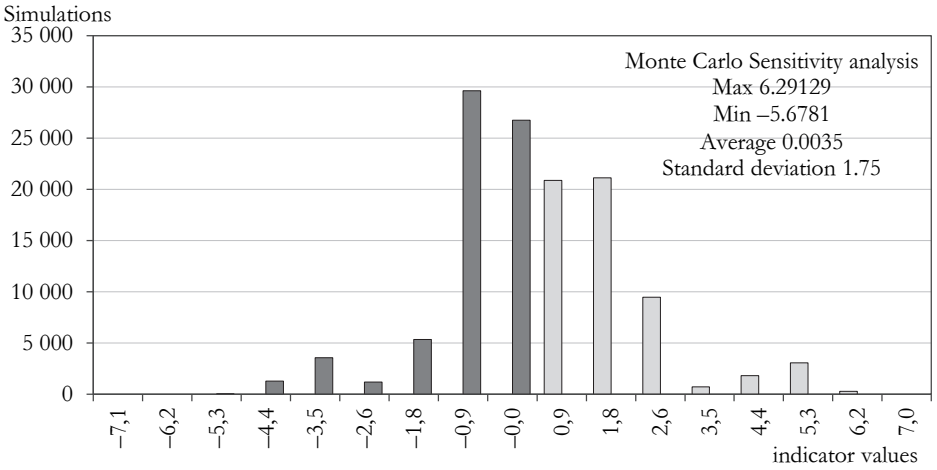
Visualization of simulation results based on subgroup weights



Source: Constructed by the authors based on the results of composite indicator analysis.

Figure 4

Visualization of simulation results based on individual weights



Source: Constructed by the authors based on the results of composite indicator analysis.

The simulations showed that our measures can be considered robust, as the standard deviation for the indicator value remained a constant 3.5, which means that the model is not too sensitive to the changing factors. Even in cases of extreme measures when indicators' values were multiplied by 0.1 and 1.9 (–90%; +90%), the standard indicator value deviation stayed between 3.68 and 3.73, and the distribution was also mostly normal 80-97-99.

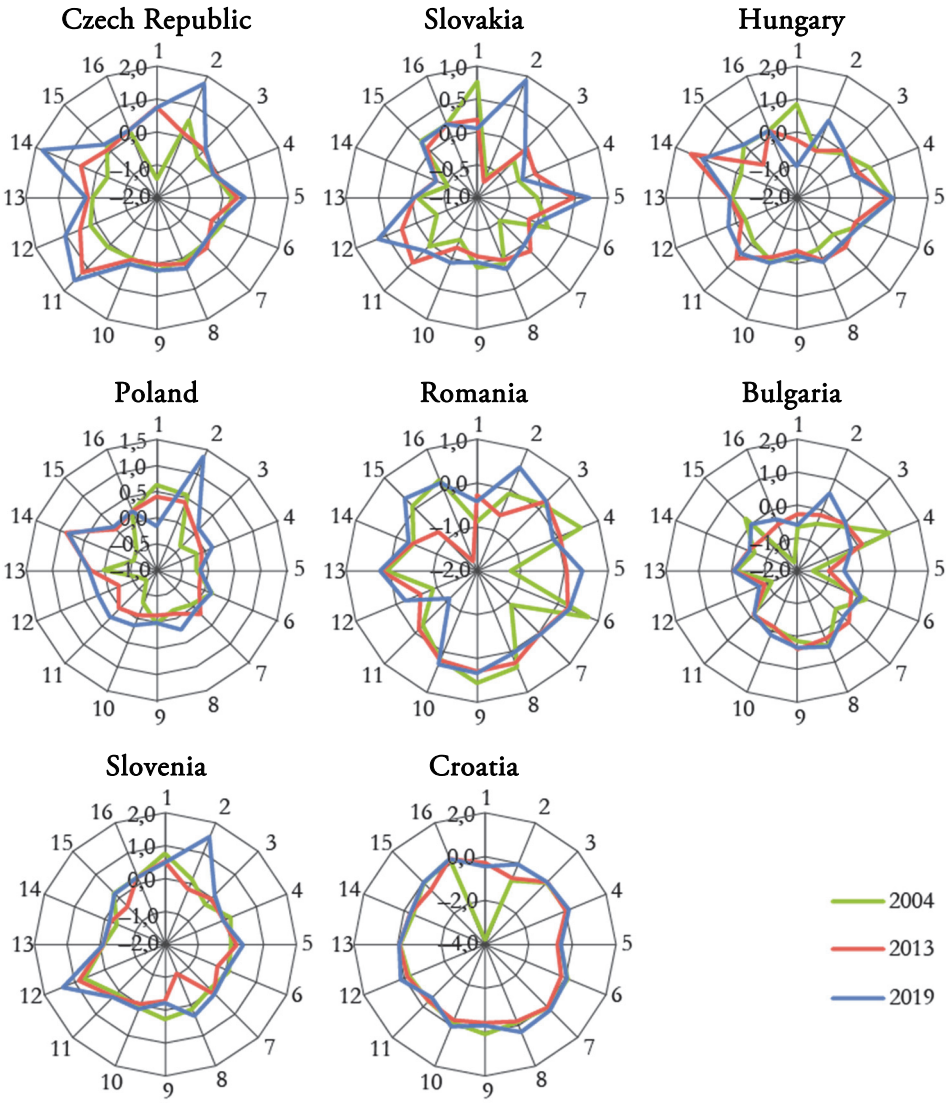
Back to the details

Given that it may be utilized as a summary indicator, a composite indicator is an appropriate tool to see CEE countries' economic development after EU accession. On the other hand, the composite indicator values can also be broken down so that the contribution of indicators and subcomponents can be determined. As a result, countries may be described using just one factor, and their weaknesses can be brought to the front. In this instance, we have used spider type charts to visualize the performance of the CEE countries (Figure 5).

The temporal dimension was established using data from 2004, 2013 and 2019. 2004 have been selected as it was the accession date for most of the postsocialist countries. 2013 has been the accession date for Croatia, and it was also the first successful year after the global financial crisis. 2019 was the last stable year without any economic shocks, such as the COVID-19 pandemic.

Figure 5

Visualization of country performances*



* The variables see in the Table 2.
Source: Constructed by the authors based on the results of composite indicator analysis.

These results show that new member states could improve their performance in almost all the criteria following their respective accession rounds. The exceptions are the values of the BTI index in Hungary, Poland and Bulgaria, where we can observe a decrease. We can also observe some deterioration in macroeconomic indicators,

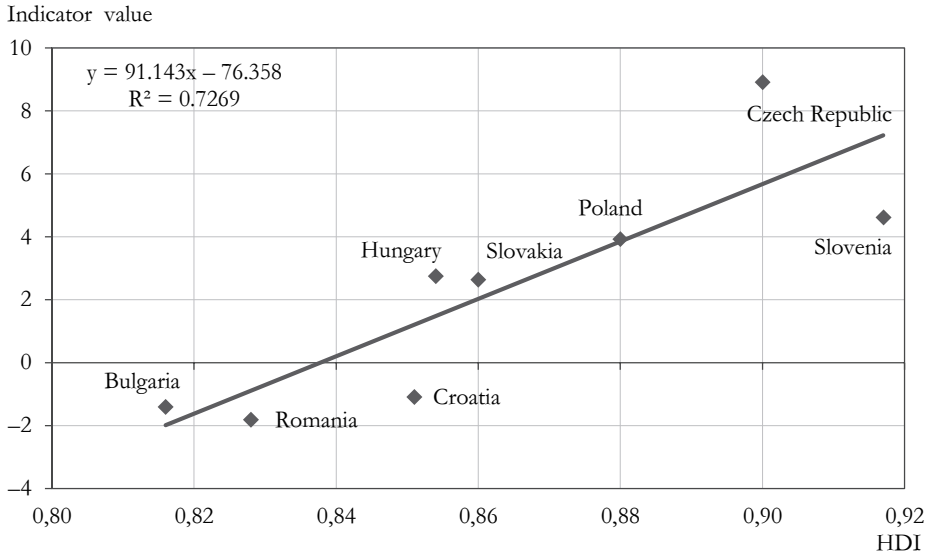
such as higher inflation rates, higher budget deficits and government debt, mainly in CEE countries that have not yet joined the eurozone. However, in Slovakia and Slovenia, the productivity/unit labor cost ratio decreased, probably as a result of adopting the EUR and experiencing higher wages.

Validation of results

It is important to compare the composite indicator results to other indicators. Since a country's human development index (HDI) primarily describes its socioeconomic development, it is important to examine the relationship between this indicator and our composite indicator. Figures 6 and 7 illustrate an analysis of the correlation between our composite indicator and HDI (Szép et al. 2022, Kashour 2023) using data from 2019 and 2013.

Figure 6

Visualization of country performances based on HDI compared to our indicator values, 2019

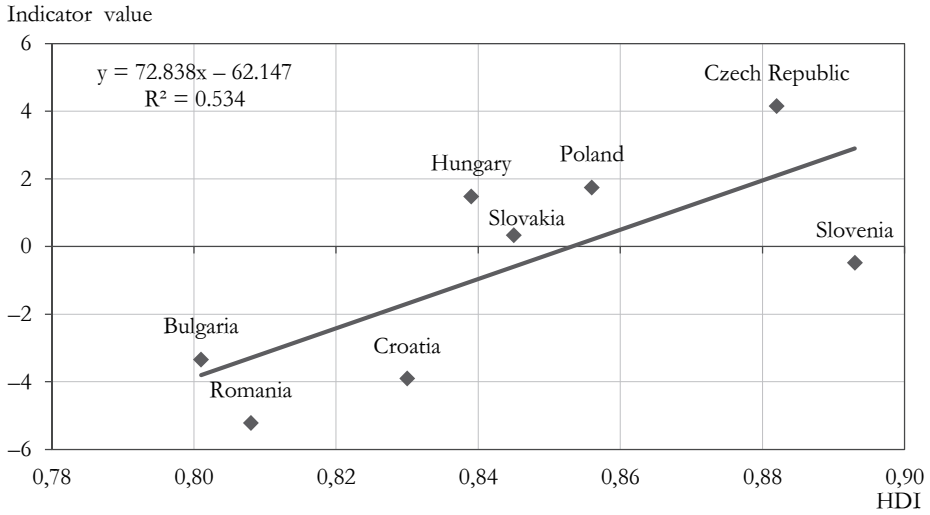


Source: Constructed by the authors based on the results of composite indicator analysis.

The correlation between the composite indicator and the HDI is strong, $R^2 = 0.73$. This shows a relation between the two indicators. Looking at the 2013 data, comovement was also observed in terms of the closeness of the relationship, showing a moderate result of $R^2 = 0.53$. The strong correlation between the composite indicator and HDI data, retaining validity across different time periods, supports that the weighting of the subindicators is balanced and well defined.

Figure 7

Visualization of country performances based on HDI compared to our indicator values, 2013



Source: Constructed by the authors based on the results of composite indicator analysis.

Presentation and dissemination

After visualizing the composite indicator values, we can see how the situation in CEE countries has changed in terms of economic integration maturity and integration profile. The time frame of our analysis was from 2004 through 2021, but here, we visualized the results from 2004, 2013 and 2019 for the reasons mentioned above.

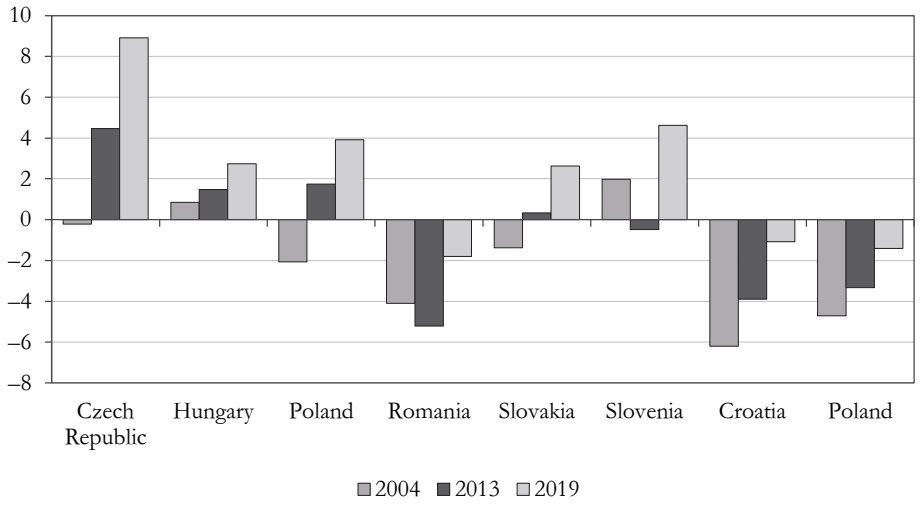
It is clear that the Czech Republic significantly increased its results, while the performance is moderately higher in countries such as Poland, Hungary, Slovakia, and Slovenia. It is also clear that Romania and Bulgaria showed the poorest performance among the analyzed countries, but Croatia's results are also relatively low (Figure 8). The composite indicator clearly reflects how EU accession assisted these countries to develop over time. It is important to note that Croatia has spent only 9 years inside the union compared with 15 years in the cases of Romania and Bulgaria. All other countries in the analysis joined 18 years ago.

Czech Republic was able to improve its performance in all areas except for productivity, which slightly decreased in the examined period. The highest improvements can be observed in the areas of trade balance, increase in competitiveness, and outward and inward foreign direct investments. The Czech improvement in trade balance is the highest in the region. In the case of Poland, where we can observe the second highest increase in the composite indicator, the increase in productivity is outstanding in the region, which leads to higher economic growth.

Significant improvements can be observed in IFDI and OFDI stocks likewise; both significantly increased in the examined period in the country. OFDI stocks show the highest increase in the region. Slovakia and Slovenia were able to improve their competitiveness significantly. The share of medium- and high-tech exports is the highest in Slovakia, Hungary, Czech Republic, and Slovenia. While the highest increase in medium- and high-tech exports can be observed in the case of Bulgaria, its share is still low compared to these countries. Croatia was able to slightly increase its performance in every aspect. The improvement in BTI (economic transition) is the most remarkable in the region (albeit from lower indicator values). In Romania and Bulgaria, IFDI stock and medium- and high-tech export shares increased significantly from 2004 to 2019, even though they started from low bases. At the same time, productivity and trade balance deteriorated significantly.

Figure 8

Values of the composite indicator of CEE



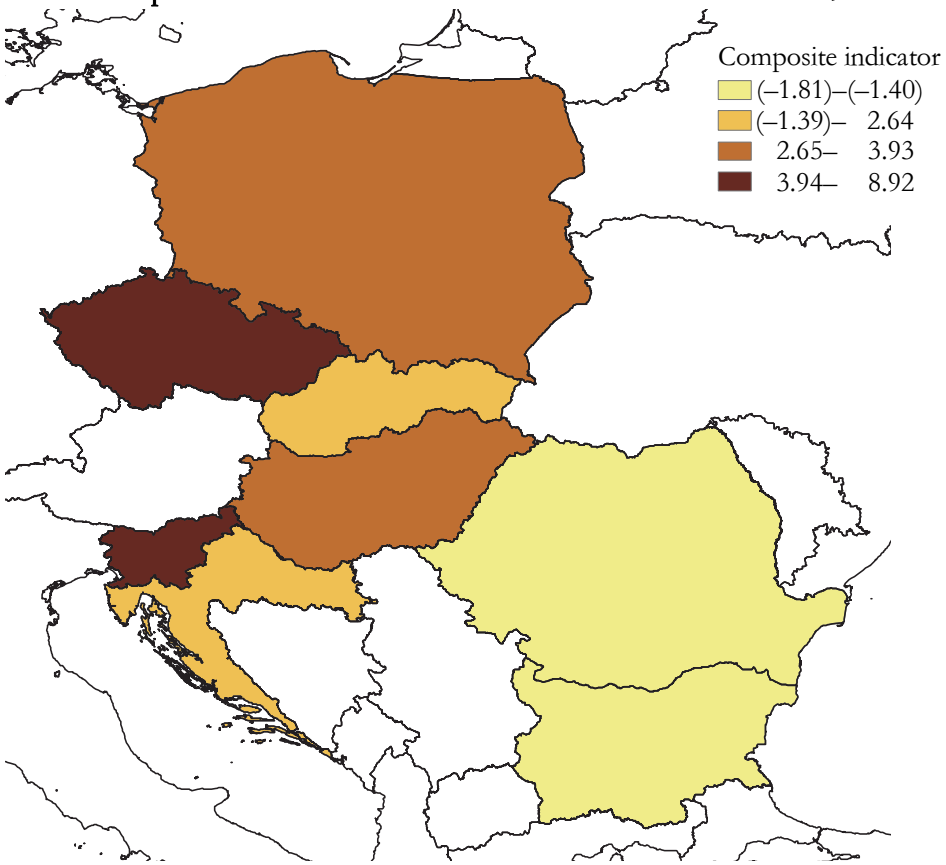
Source: Constructed by the authors based on the results of composite indicator analysis.

The results clearly support our hypotheses. First, CEE countries that developed their economic (trade and FDI) relations with other EU members were able to increase their composite indicator values and thus their integration profile performance. Unsurprisingly, countries that joined the EU earlier were more successful in this respect (Figure 9). Second, it also comes out clearly that countries located in closer geographical proximity to core countries such as Germany, Austria or Italy were the most successful in this process. The Czech Republic achieved the highest result; its high competitiveness improved further, and its close economic ties with Germany and Austria played a significant role in development. In the case of

Slovakia, improvements show a pattern similar to the cases of Hungary, Poland and Slovenia, but we found lower composite indicator values mainly due to Slovakia's lower performance in IFDI and OFDI activities and less improvement in trade balance compared to Czech Republic.

Figure 9

Map of CEE countries with their indicator values from 2019



Source: Constructed by the authors based on the results of composite indicator analysis.

As such, it appears that Slovakia is the second most successful economy among the CEE countries in terms of benefitting the most from EU accession. Poland, Slovenia and Hungary achieved similar results, and their improvement is also significant and obvious (Figures 8 and 9). The results of Romania, Bulgaria, and Croatia are more worrying. They do not share any borders with the core countries, and they are also struggling with lower competitiveness, labor market challenges, and relatively weak institutions characterized by high corruption or weak rule of law. These aspects are obviously region-specific phenomena, and these three countries were performing worse than the other five.

Conclusions

Our results are in line with previous findings in the corresponding literature (Allard 2009, Grela et al. 2017, Palánkai 2010 and Tankovsky–Endrődi-Kovács 2021). The novelty of this study is that it examined the results of accession by introducing a new approach and composite indicator. The methodology allowed us to examine how economic integration maturity and profile changed over time and to judge how successfully these member states have been able to exploit the benefits of the integration.

The eight CEE countries in the analysis have benefitted from European integration and have been able to reach higher economic performance since their accessions. Countries that could form a favorable business environment for foreign direct investments (Czech Republic, Poland and Slovenia) showed higher performance. In accordance with Pina–Sicari (2021), we can propose that relatively higher economic benefits from EU accession are mainly derived from embeddedness in Western European (German) supply chains. In parallel, these countries could also increase their outward FDI, which was outstanding in their performance compared to the other countries in the region. On the other hand, they are still facing serious challenges, such as lower labor productivity and GDP growth or unstable current account balances. The performance values for Romania, Bulgaria, and Croatia fall below the regional average. In their cases, challenges of preserving convergence are more relevant. Inefficient bureaucracy and low-quality institutions are decreasing their competitiveness and FDI attracting capabilities.

The variables representing economic policy suggest that countries benefitted more from membership if, in addition to creating a favorable business environment for Western multinational corporations, they could effectively improve their productivity and support their domestic companies in internationalization, thus increasing outward foreign direct investments. Our results suggest that countries with strong institutions and relatively high BTI indices are more successful in this. However, to learn more about this relationship, further research is necessary.

The study successfully quantified that these countries have developed from an economic perspective, but the applied methodology has some drawbacks. One of the limitations of our paper is that we mainly focused on the accession criteria supported by the European Commission and Tibor Palánkai. As such, geopolitical analysis was not the subject of this paper, but it is worth mentioning that the region's importance is increasing in parallel with the war in Ukraine. As a key player on the Eastern borders of the EU, Russia also has significant interest in the CEE regions. Creating and maintaining the energy union became a key aspect for Brussels. The countries in our analysis tend to be the most dependent on Russian energy, and increasing prices will significantly decrease their competitiveness. Their high embeddedness in supply chains can also lead to further loss of competitiveness for the EU on global markets.

The main limitation of this paper and its methodology is a lack of qualitative analysis, as it only contains quantifiable aspects and indicators while ignoring aspects that cannot be quantified (e.g., the negative effects of FDI, improvements in quality of life or judicial independence) (Freudenberg 2003). Nevertheless, it is an appropriate approach to examine these countries' economic output after their accession to the EU.

For further research directions, this methodology can be extended to Western Balkans or other countries that are willing to join the European Union. It is worth comparing these countries' performance to that of EU candidate countries to obtain a comprehensive understanding of policies that can serve as role models for countries aspiring to join the EU. It could represent a kind of benchmark or target performance, which can further highlight and contribute to a better understanding of the ongoing processes (Dočekalová–Kocmanová 2016). Similar calculations can be executed for other regional cooperations to measure their effectiveness and effects on member states. Another research direction is to reveal the role of cities and clusters in our results (Páthy 2017). Finally, more and noneconomic indices can be involved in future research to obtain a more complex picture of these countries' integration maturity and profile, as Karl et al. (2013) did in their research.

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