

MACROECONOMIC ANALYSIS OF THE COHESION FUND IN CENTRAL AND EASTERN EUROPE AT REGIONAL LEVEL

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Abstract: *European funds and their impact at regional level have gained significant attention because there is a desire to distribute funds as efficiently as possible and in such a way that regions benefit in proportion to their needs. The Cohesion Fund is the main instrument for supporting economic, social, and territorial development. However, the issue has been debated many times and no consensus has been reached. Some believe that the Cohesion Fund supports regional development, while others disagree. This paper therefore analyzes the impact of the Cohesion Fund on NUTS2 regional development in 11 countries in Central and Eastern Europe and how it achieves or fails to achieve its overall objective. The results show that an increase in the Cohesion Fund contributes to an increase in the composite indicator, which shows the result of the overall objective. In our analysis, the Cohesion Fund has a positive and significant impact on regional development and succeeds in achieving its overall objective.*

Keywords: *Cohesion Fund; panel analysis; Central and Eastern Europe; regional development*

JEL classification: *O18; R11; R58*

1. Introduction

In the context of regional differences in living standards, the paper analyzes whether the Cohesion Fund contributes to regional and economic development and whether, through the amounts allocated, it fulfills its overall objective. These differences lead to general inequality, which brings a certain degree of unfairness or injustice that can have social and political consequences (Breinlich et. Al, 2014). The question has often been raised as to whether the Cohesion Fund is allocated to regions in a way that benefits them, or whether the policy for allocating funds should be changed. At the same time, the analyzed area of Central and Eastern Europe is a region that has experienced conflicts, wars, and economic difficulties, which makes our analysis particularly relevant. The Cohesion Fund, created more than three decades ago, has always aimed to support the poorer regions of EU member states. It has various specific objectives depending on the multiannual financial framework. Between 2000 and 2006, the Cohesion Fund's priority was to support less developed EU countries with a GDP of less than 90% of the EU average, focusing on the environment, transport, and sustainable infrastructure (European Union, 2006). The 2007-2013 period added to transport and the environment, the reduction of regional disparities and sustainable projects (European Union, 2008). Between 2014 and 2020, the focus was on the transition to a

green economy, infrastructure, sustainable development, and economic and social cohesion (European Commission, 2025). The current framework, 2021-2027, shows a focus on the green transition, more connected and sustainable infrastructure, economic development, and social and territorial cohesion (European Union, 2024). Overall, the general priorities remain the same throughout the multiannual financial frameworks.

Some say that Structural Funds and Cohesion Fund allocations have a positive impact on regional development only up to a maximum investment value, after which they lose their impact. Thus, fund allocation could be improved by reducing transfers that exceed the maximum level (Cerqua and Pellegrini, 2017). One factor conditioning the impact of the Cohesion Fund on GDP per capita can be reflected in the country's inflation and public debt. Therefore, if a country has low inflation and moderate public debt, it benefits significantly from the Cohesion Fund (Dicharry et al., 2019). It has also been found that the main beneficiaries of the Cohesion Fund in a country are the most urbanized regions, such as capital cities (Mirošník et al., 2014). However, EU funds play an important role in regional development, but their effect may be diminished in the event of macroeconomic uncertainty (Pinar and Karahasan, 2024). Contrary to the positive benefits listed, there have also been studies that have said that investments from EU structural funds have not contributed to reducing regional disparities, and separate analysis of the funds has led to ambiguous results (Butkus et al., 2019). Hence, in this paper, we will analyze how the Cohesion Fund achieves its overall objective at the NUTS2 level: strengthening the economic, social, and territorial cohesion of the European Union (European Commission and Council, 2021).

The article is structured into separate sections. The first section consists of an introduction, which outlines the relevance of the Cohesion Fund and its impact so far. The second section presents the relevant theoretical framework for the proposed topic. The third section is the methodology, which describes the methods, data, and software used. The fourth section discusses the results of the methods applied and outlines the impact of the Cohesion Fund, followed by the last section, which draws the general conclusions of the article.

2. Literature Review

For the period 2000-2006, Crescenzi et al. (2008) found that 50% of the Cohesion Fund has been spent on infrastructure projects. At the same time, the authors noted that regions with better infrastructure tend to grow faster, but the positive impact is short-lived. Becker et al. (2012) conducted a generalized propensity score estimation to measure whether European Union funds stimulated development at the NUTS3 level between 1994 and 2006. The authors found that, overall, EU funds stimulate regional growth. However, 18% of regions experienced a decline, suggesting a more efficient allocation of funds. De Toni et al. (2021) highlighted the lack of territorial involvement in the distribution of European funds at the regional level. The authors believe that the lack of spatial concentration leads to regional development problems, especially for peripheral regions.

Regarding EU27, Shebanin et al. (2022) analyzed the value of Cohesion Fund financing during the period 2014-2020 and found a direct link to countries' GDP and gross value added. An increase in the Cohesion Fund leads to an increase in GDP and gross value added, but also to a decrease in the unit cost of labor. Scotti et al. (2022) used spatial panel analysis to examine the impact of structural and Cohesion Funds at the European

NUTS2 level for the period 2007-2014. The results of the study indicate economic growth and long-term benefits. The sectors that benefit most from these funds are infrastructure, research and development, energy, and human resources. In contrast, the environmental sector showed a slightly negative impact.

Based on an analysis of 56 regions in Central and Eastern Europe between 2007 and 2018, Tiganasu and Lupu (2023) concluded that regions have strengthened their socio-economic cohesion with the help of European funds such as the CF, ERDF, and ESF. Crucitti et al. (2023) present an unusual result. They show that the spillover effects of countries benefiting from the Cohesion Fund have a positive and long-term impact on 45% of countries that do not benefit from this fund. Giannini and Martini (2024) found that European Union funds, especially the Cohesion Fund, play a big role in the regional convergence of GDP per capita at the NUTS2 level between 2000 and 2021. Along with this, physical and human capital also help with convergence.

In addition to regional development, Kutun and Yigit (2007) found that cohesion and structural funds helped new members catch up with the living standards of member states and integrate economically. At the same time, Crucitti et al. (2023) have shown that the impact of Cohesion Policy is considerable in the less developed regions of the European Union. The Cohesion Fund has supported the reduction of socio-economic disparities, and its focus is on regions with low GDP per capita. In contrast, Petrakos et al. (2025) report that the Cohesion Fund appears to favor regions with better infrastructure quality and investment levels.

Calegari et al. (2021), in their study on the impact of cohesion policy on GDP per capita and on the overall well-being of society, find positive effects on well-being and education levels through the cohesion fund. Agnello and Pizzuto (2025) found that the absorption of European funds is declining from one multiannual financial framework to another. Most often, the money is invested in the last years of a multiannual financial framework, putting pressure on project completion and leading to inefficient allocation. At the same time, the authors' work shows that less developed regions have low absorption from the Cohesion Fund due to governance and institutional capacity.

Thus, the literature highlights the support provided by the Cohesion Fund for regional development, economic integration, and living standards, but also its limitations.

3. Methodology

Various econometric methods were used for this research, such as: (1) fixed effects panel regression analysis; (2) random effects panel regression analysis; (3) robust regression model; (4) Arellano-Bond model; (7) maximum likelihood regression; (8) Poisson model; (9) regression with instrumental variables. To test the robustness of the results, models such as XTPCSE (Panel-Corrected Standard Errors) and XTSSC were used.

The dependent variable was created as a composite indicator using principal component analysis (PCA) from: GDP, motorway length (km), and railway length (km). The independent variables include: the level of education of the population, population size, unemployment rate, and the amount allocated from the Cohesion Fund (see table 1). The variables were selected according to the general objectives of the Cohesion Fund from official sources such as Eurostat and European data (data.europa.eu).

Table 1 Description of dependent and independent variables

Dependent variable	
GDP_PPS per inhabitant	Gross domestic product (GDP) at current market prices by NUTS 2 region, expressed in Purchasing Power Standard (PPS, EU27 = 100), per inhabitant, at NUTS2 level
Motorways - km	Total length of motorways (kilometers) at NUTS2 level
Railways - km	Total railway lines in Kilometers, on NUTS2 level
Independent variables	
EU_Payment_annual	Annual payments from the EU Cohesion Fund to each NUTS2 region.
Population by education levels 3-8	Total population aged 25–64 with upper secondary, post-secondary non-tertiary, or tertiary education (levels 3–8), at NUTS2 level.
Population	Total population in the NUTS2 region.
Unemployment	Unemployment rate for population aged 15–74 years, at NUTS2 level.

The data was collected at NUTS2 level for 11 countries in Central and Eastern Europe (the Czech Republic, Poland, Croatia, Slovenia, Slovakia, Hungary, Romania, Bulgaria and the three Baltic States: Estonia, Latvia and Lithuania) for the period 2000-2022. The software used was Stata.

4. Results

The Cohesion Fund's overall objective is to reduce regional, economic, and social disparities among the regions of the Member States. In this way, it supports the overall harmonious development of the European Union. Using the methods employed, we can highlight the impact of the Cohesion Fund on economic growth and the factors that contribute most significantly to its impact.

Table 2 PCA analysis for the composite indicator

Variable	Obs.	Mean	Std. Dev.	Min	Max
Composite indicator	1,230	-9.53e-10	1.152652	-2.483758	5.360844

Table 2 shows the construction of the composite indicator consisting of: GDP, motorway length (km), and railway length (km). The number of complete observations of the three variables for the dependent variable is 1230. GDP had 1254 observations, motorway length (km) had 1254 observations, and railway length (km) had 1230 observations. The mean of the composite indicator is 0, with no overall positive or negative trend in the values. The standard deviation is close to 1, the values of the composite indicator being moderately spread around the mean. The minimum values are -2.48 and the maximum values are 5.36, showing the variation in the observations. The variables taken into account for constructing the composite indicator reflect the overall objective of the Cohesion Fund, namely investment in transport networks and financing projects in less developed countries in order to reduce economic and social disparities.

Table 3: Results of econometric analyses using Stata

	(1) ln_Y	(2) ln_Y	(3) ln_Y	(4) ln_Y	(5) ln_Y	(6) ln_Y	(7) ln_Y	(8) ln_Y	(9) ln_Y
	Xtreg (fe)	Xtreg (re)	Rreg	Xtabond	Xtpcse	Xtscc	Xtreg (mle)	poisson	iyreg
main									
ln_CF	0.00363*** (0.00104)	0.00371*** (0.00104)	0.00530*** (0.00135)	-0.000610 (0.000542)	0.00434** (0.00145)	0.00434 (0.00253)	0.00371*** (0.000680)	0.00414** (0.00147)	0.00434** (0.00145)
ln_Education	1.754*** (0.172)	1.741*** (0.170)	1.121*** (0.0587)	0.166* (0.0659)	1.189*** (0.0502)	1.189*** (0.0587)	1.742*** (0.0697)	0.910*** (0.0477)	1.189*** (0.0633)
ln_Population	-0.243 (0.204)	-0.211* (0.0998)	-0.188*** (0.0112)	-0.159*** (0.0408)	-0.178*** (0.00959)	-0.178*** (0.0169)	-0.212*** (0.0410)	-0.134*** (0.00900)	-0.178*** (0.0121)
ln_Unemployment	-0.0873*** (0.0115)	-0.0886*** (0.0116)	-0.127*** (0.00937)	-0.0130*** (0.00328)	-0.134*** (0.0108)	-0.134*** (0.0151)	-0.0885*** (0.00577)	-0.0919** (0.00705)	-0.134*** (0.0101)
L.ln_Y				0.891*** (0.0236)					
_cons	-2.827 (3.120)	-3.218* (1.501)	-0.787* (0.311)	1.742* (0.709)	-1.181*** (0.160)	-1.181** (0.390)	-3.208*** (0.746)	-1.714*** (0.225)	-1.181*** (0.336)
sigma_u _cons							0.198*** (0.0190)		
sigma_e _cons							0.0785*** (0.00163)		
N	1212	1212	1212	1101	1212	1212	1212	1212	1212
R ²	0.731	0.731	0.506		0.479	0.479			0.479

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The results in Table 3 show that the Cohesion Fund (ln_CF) has a positive and statistically significant impact on the dependent variable (ln_Y) in most models (with the exception of the Arellano-Bond model). Similarly, the level of education (ln_Education) positively and significantly influences ln_Y in all models, while population (ln_Population) and unemployment rate (ln_Unemployment) have a significant negative impact.

The estimated coefficients, ranging between 0.0036 and 0.0053, show that a 1% increase in Cohesion Fund allocations leads, on average, to an increase of approximately 0.004% in the composite indicator ln Y. This effect is robust across most estimation methods (fixed effects, random effects, MLE, robust models), confirming the positive contribution of European funds to economic convergence.

The first two models, fixed effects analysis and variable effects analysis, show that 80% of the variation can be explained by differences between regions. The most significant coefficients being the Cohesion Fund and the level of education of the population. Following the Hausman test, it can be observed that fixed effects panel analysis is favored over random effects panel analysis. Models 3 show similar coefficients to the fixed effects panel analysis, and the model mitigates the influence of outliers. Models 5 and 6 support the correction of autocorrelation and heteroscedasticity. The results of these two models confirm the general trends: the cohesion fund is positive and significant, the level of education has a strong positive impact, and the population size and unemployment rate have a negative influence. Model 4 shows us that past performance mostly explains current values. Also, in this model, the Cohesion Fund isn't statistically significant. The latest models confirm the effects of the other models.

In our analysis, we use NUTS2 level data for 11 countries in Central and Eastern Europe, the territorial level also used for the implementation of Cohesion Policy by the

European Commission. The use of NUTS2 data captures in detail the differences in regional development and the variation in the Cohesion Fund. The results of the analysis show a positive and significant effect of the Cohesion Fund on the composite indicator (GDP, kilometers of motorway, and kilometers of railway). The role of the Cohesion Fund in the convergence process is also confirmed. Although the magnitude of the results is modest, the dynamic model suggests that the actual effects manifest themselves gradually over time. Based on the results obtained, we can say that the Cohesion Fund plays an important role in regional development and achieves its overall objective.

5. Conclusion

Throughout the multiannual financial frameworks, the Cohesion Fund had well established objectives, adjusted to the needs of the regions and tailored to the lessons learned from previous financial frameworks. The literature shows that European Union funds contribute to stimulating regional development, including through a direct connection to GDP and gross value added in beneficiary countries (Becker et al., 2012; Shebanin et al., 2022; Giannini and Martini, 2024). The benefits of economic growth through the Cohesion Fund are long-term (Scotti et al., 2022). However, the lack of territorial involvement in the distribution of European funds at the regional level leads to development problems, especially for peripheral regions (De Toni et al., 2021). The Cohesion Fund has strengthened socio-economic cohesion by helping Member States to achieve the standard of living of Member States and general well-being (Kutan and Yigit, 2007; Calegari et al., 2021; Tiganasu and Lupu, 2023).

The Cohesion Fund's overall objective is to strengthen the economic, social, and territorial cohesion of the European Union. The variables used were closely linked to this objective. The data used at the NUTS2 regional level allowed for a more detailed picture of the variation in the effectiveness of the Cohesion Fund.

The models showed that an increase in Cohesion Fund allocations leads to an increase in the composite indicator, which represents the outcome of the overall objective. In this paper, we found an unexpected result in the fact that the level of education has a strong impact on regional performance. Our expectations were focused on variables such as GDP, regional governance, infrastructure, etc. At the same time, regions with a large population tend to have a significant negative effect, most likely due to a lack of infrastructure. Infrastructure risks to be insufficient due to population growth. The unemployment rate is also negative, contributing to reduced economic performance and even infrastructure.

The results show the contribution of this fund to the development of NUTS2 regions in the 11 countries of Central and Eastern Europe and their economic convergence. Although the scale of the results can be described as modest, the real effects are gradually becoming apparent over time. Thus, we can conclude that in the analyzed territory, the Cohesion Fund has a positive and significant impact on the regions and at the same time manages to achieve its proposed objective.

The study is limited by the fact that the effects of the funds may be delayed over time and cannot be fully captured by the models used.

Appendix

Table 4 NUTS 2 regions of CEE

Czech Republic CZ01 Praha CZ02 Střední Čechy CZ03 Jihozápad CZ04 Severozápad CZ05 Severovýchod CZ06 Jihovýchod CZ07 Střední Morava CZ08 Moravskoslezsko Poland PL11 Łódzkie PL12 Mazowieckie PL21 Małopolskie PL22 Śląskie PL31 Lubelskie PL32 Podkarpackie PL33 Świętokrzyskie PL34 Podlaskie PL41 Wielkopolskie PL42 Zachodniopomorskie PL43 Lubuskie PL51 Dolnośląskie PL52 Opolskie PL61 Kujawsko-Pomorskie PL62 Warmińsko-Mazurskie PL63 Pomorskie Hungary HU10 Közép-Magyarország HU21 Közép-Dunántúl HU22 Nyugat-Dunántúl HU23 Dél-Dunántúl HU31 Észak-Magyarország HU32 Észak-Alföld HU33 Dél-Alföld	Croatia HR03 Jadranska Hrvatska HR04 Kontinentalna Hrvatska Slovakia SK01 Bratislavský kraj SK02 Západné Slovensko SK03 Stredné Slovensko SK04 Východné Slovensko Slovenia SI01 Vzhodna Slovenija SI03 Zahodna Slovenija Bulgaria BG31 Severozapaden BG32 Severen tsentralen BG33 Severoiztochen BG34 Yugoiztochen BG41 Yugozapaden BG42 Yuzhen tsentralen Estonia EE00 Eesti Latvia LV00 Latvija Lithuania LT00 Lietuva Romania RO11 Nord-Vest RO12 Centru RO21 Nord-Est RO22 Sud-Est RO31 Sud - Muntenia RO32 București - Ilfov RO41 Sud-Vest Oltenia RO42 Vest
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