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Contribution of EU Cohesion Policy to Regional Growth: Evidence from V4 Countries*

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Abstract

The EU Cohesion Policy is one of the European Union's key policy instruments for reducing economic and social disparities among its regions. The paper evaluates the policy contribution to regional economic growth in V4 (Visegrad Four) countries. The study establishes a significant variation in ESIF (European Structural and Investment Funds) distribution at the NUTS2 (Nomenclature of Territorial Units for Statistics) level within the V4 regions over 2000–2018. It suggests that ESIF absorption was not evenly distributed across regions within the V4 countries. This finding indicates that regional disparities in ESIF distribution may have contributed to economic imbalances within the countries. Secondly, a causal link between regional growth and ESIF absorption is identified. Along with other covariates, the use of the ESIF shows a statistically significant, although very modest, effect on the economic growth of V4 countries. Finally, the assumption of cross-country growth dispersion is investigated. The research results suggest statistically significant regional growth differences between Czechia and Slovakia on the one hand and Poland and Hungary on the other. It implies that the impact of ESIF absorption on economic growth may have varied among these V4 countries, potentially due to differences in policy implementation, economic structures or other factors.

Keywords: EU Cohesion Policy, economic growth, ESIF, V4 countries

JEL Codes: E61 R11, R58

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1. Introduction

The EU Cohesion Policy is one of the three pillars of the European political and economic area alongside the single market and monetary union. It is the only policy of the European Union that explicitly deals with economic and social inequalities. This policy involves transferring funds among member states through the European Union's budget for economic growth and sustainable development through investments in human and physical capital (Schwarcz et al., 2019).

The main reason for adopting the Cohesion Policy was the constant increase in socio-economic disparity among EEC (European Economic Community) member states (Molle, 2007). Each subsequent extension of the EEC widened the gap between stronger and weaker regions, and since adopting the single market, this tendency became even more highlighted. Therefore, to reverse this trend, the Single European Act committed the EEC to a policy promoting cohesion and convergence (Mellors and Copperthwaite, 2005). This legal regulation applied to the regional policy until the EEC was formally incorporated into the EEC Treaty for the first time as a recognized means of achieving economic and social cohesion (Leonardi, 2005).

Many authors have addressed conceptual issues of the Cohesion Policy and its achieved results. Likewise, they have emphasized that due to excessive complexity, it is challenging to evaluate the Cohesion Policy from the point view of set political objectives (Bachtler and Wren, 2007), funding from familiar EU sources (Bouvet and Dall'erba, 2010) and also in terms of available data (Pastor et al., 2010). However, most authors have found ground on the importance of the policy. Bachtler and Wren (2007) and Fratesi and Wishlade (2017) noted the growing importance of the Cohesion Policy in the EU during its development. It follows from this context that the Cohesion Policy has become the most critical EU policy in terms of funding.

Over the programming periods, the European Commission, an executive arm of the EU, has allocated substantial funds for Cohesion Policy support. In the programming period 2007–2013, the figure set was 347 billion EUR; in the period 2014–2020, there was an increase of 13.2%; and in the current programming period 2021–2027 along the conventional multiannual financial framework, an unprecedented financial instrument – Next Generation EU (NGEU) with a budget allocation of 807 billion EUR was adopted. The NGEU instrument was created as a support tool to help the EU member states overcome the consequences of the COVID-19 pandemic. The main component of the instrument is the Recovery and Resilience Facility, with a substantial allocation of 723 billion EUR, consisting of grants and loans. The V4 countries have also benefited from the Cohesion Policy substantially. For instance, in 2014–2020,

the ESIF funding for Czechia was 22.7 billion EUR, for Hungary 22.5 billion EUR, for Poland 78.8 billion EUR and for Slovakia 14.3 billion EUR. In the current programming period, there were minor changes in the ESIF allocations; however, another financial instrument became available – the Recovery and Resilience Facility.

This research paper assesses the effectiveness of the EU Cohesion Policy, particularly the distribution of the ESIF and its impact on regional economic growth within the V4 countries. The findings highlight disparities in ESIF distribution at both the intra-regional and inter-regional levels and suggest that the policy has had a statistically significant but relatively modest effect on economic growth. Additionally, the study points to variations in economic growth outcomes among the V4 countries, potentially influenced by the policy's implementation and other factors. These findings can be valuable for policymakers and researchers interested in regional development and the effectiveness of the EU Cohesion Policy.

The novelty of the research results from a more detailed analysis of ESIF absorption and distribution at a regional level and the empirical connection of EU funding with economic growth. Also, the study's exclusivity follows from the research subject – the V4 countries, often considered as a relatively homogenous group of countries sharing a common history, culture and geography. For this purpose, a relatively new data platform was used to access historical payments from all EU financial instruments at the NUTS2 regional level. Hence, the main research questions may be highlighted:

1. Have EU funds substantially contributed to the regional growth in V4 countries?
2. Are there significant national growth differences among the V4 countries?

In summary, the research seeks to provide a comprehensive assessment of ESIF utilization, its impact on regional development and its role in the economic growth of the V4 countries. This approach and the specific focus on the V4 group make the study relevant and distinctive in EU funding and regional development research.

The primary sample for the empirical investigation includes regions of V4 countries at the NUTS 2 level, thus $n = 35$ units. The research period includes the time series from 2002 to 2018 due to the availability of all the control variables, especially the ESIF subsidies. The paper is organized as follows. First, the theoretical part of the paper covers the period after the V4 countries' accession to the EU in 2004. Then, the paper elaborates on present theory and empirics on the results of the Cohesion Policy implementation in the EU, including its impact on regional disparities. Section 3 outlines the methodological framework and research methods. Section 4 presents the research results, especially the model fit and subsequent statistics. and a discussion of the results. Finally, conclusions of the study are provided in Section 5.

2. Literature Review

2.1 V4 countries' position within EU

The cohesion level and joint performance of V4 countries towards the EU have been evaluated in several studies (Kuzelewska et al., 2015; Kořan, 2017; Cabada and Wais, 2018). However, the overall benefit of cooperation within the V4 countries is relatively modest. The most significant successes have been the Central Europe Free Trade Agreement and the Visegrad Fund for promoting science, culture and education. However, in other areas such as infrastructure or army modernization, the V4 countries have failed to yield significant results (Kuzelewska et al., 2015). Kořan (2017) noted a "shift in the posture" of V4 countries in the geopolitical field of the EU since 2009. There is an effort of V4 countries to become more proactive players in international policy. He defines three goals that V4 countries have integrated into its political scope: (1) support to EU enlargement (especially Eastern and Southeastern European countries); (2) narrower cooperation within the scope of Eastern European countries; and (3) a shared vision of regional and cohesion policy.

Nič (2016) evaluated the institutional background of the V4 countries. This group does not have any formal structures or institutional framework. Operation of the V4 group is based on standard processes: rotation of annual presidency and regular meetings at the presidential or ministerial level. However, a dense network of relations among various stakeholders in civic society has emerged over time.

2.2 Results of Cohesion Policy implementation in EU

In the long term, most authors consider the contribution of the Cohesion Policy to the mitigation of regional disparities as unconvincing or even contradictory (Farole et al., 2011; Pieńkowski and Berkowitz, 2015; Ederveen et al., 2003; Bachtler et al., 2013). These expert statements only underline the necessity of adoption of management concepts, appropriate administration, and implementation of the Cohesion Policy in everyday practice. In this area, many shortcomings can be eliminated or reduced using appropriate managerial approaches and tools. Very often, only basic supervisory procedures are applied, such as only planning or control. The execution process is barely supervised. However, most authors admit that the Cohesion Policy may be conditionally efficient in its results. The quality of the institutional environment or decentralization of decision-making have been indicated as essential conditions.

When evaluating the EU Cohesion Policy's crucial objective – reducing regional disparities – we might get an inconsistent picture instead (Pellegrini et al., 2013; Petrakos et al., 2005; Landesmann and Römisch, 2006; Capello and Cerisola, 2020). Many studies have documented a gradual increase in regional disparities since the 1980s, measured as GDP per capita or employment level (Martin, 2005; Puga, 2002; Eckey and Türck, 2007; Rodriguez-Pose and Gill, 2004; Geppert and Stephan, 2008). A multi-way convergence or divergence phenomenon in the EU is visible. A convergence has been shown in developed Northwestern and Central-Eastern European countries. On the contrary, a divergence has been detected among the Mediterranean countries. Eckey and Türck (2007) discussed the emergence of different convergence clubs on the EU map. Capello and Cerisola (2020) asserted that uneven distribution of production factors in the regions instead stimulate disparities in the EU as effects of spatial concentration or productivity; thus, the factual situation "does not consider trade-off between efficiency and cohesion but press cohesion through efficiency". Landesmann and Römisch (2006) added that differences in incomes copy a "core-periphery" spatial pattern in countries such as the UK, Spain, Portugal and partially Germany, as well as in Central and Eastern Europe.

The EU funds are another side of the same coin as the EU Cohesion Policy. Therefore, the efficient use of EU funds is naturally the centrepiece of interest of EU states. However, the overall picture is somewhat mixed. Statistical analyses have not shown that external financing could lead to a permanent and substantial acceleration of development in these countries and achieve convergence compared to countries that do not use similar Cohesion Policy instruments (Dall'erba and Gallo, 2008). When analysing the Cohesion Policy applied in the EU15 in 1989–2012, Bachtler et al. (2013) criticized conceptual deficiencies in the formulation of programme goals proposed within the policy, which were neither specific nor measurable. However, they added that there has been an improvement over time due to adopting "best practices". In an analysis of the effectiveness of funds spent by the ESIF in 1994–1999 and 2000–2006, Crescenzi (2009) mentioned a discrepancy between the concentration of funds (especially for Objective 1) and the concentration of lagging regions. This means that the support funding for lagging regions is lower than it should be regarding the set criteria. Boldrin and Canova (2001) concluded that EU regional policy mainly motivated redistributive purposes by achieving the political balance on which the European Union is built. In conclusion, they added that the Cohesion Policy does little to promote economic growth.

In more detailed studies, however, some authors have noted positive effects of the EU Cohesion Policy on regional growth and development (Bachtler et al., 2013; Fiaschi et al., 2017; Crescenzi and Guia, 2018; Ferrara et al., 2017). Bachtler et al. (2013) added that the availa-

ble data show that the programme investment interventions achieved great successes and disappointments. However, the system of indicators for monitoring and managerial evaluation of programmes has significantly improved while dealing with considerable difficulties (definition, system data aggregation, priorities fragmentation, etc.). Fiaschi et al. (2017) talked about a significant effect of the Cohesion Policy in terms of increased competitiveness (measured as GDP per employee) and a decrease in the rate of regional disparities in regions falling under Objective 1 (Convergence). By considering numerous areas of programme intervention, Crescenzi and Guia (2018) documented a positive relationship between expenditures from the ESIF and growth of added value (GVA in %) in the case of "Environment" or "Infrastructure", while areas such as "Entrepreneurship", "Innovation" and "Labour Market" came out as statistically insignificant. Conversely, Ferrara et al. (2017) evaluated the impact of support from the ESIF on R&D as positive. They also pointed to significant shortcomings in the case of ESIF implementation in terms of programme interventions.

The falling "profitability" of ESIF funds was noted by Butkus et al. (2020), who pointed out the presence of support from the ESIF as diminishing marginal returns in the sense that a higher rate of transfers can generate a higher growth rate. However, a decreasing return on investment or transfer can be observed in practice. Gagliardi and Percoco (2016) investigated the effects of the Cohesion Policy on rural areas in the most backward regions of the EU. Positive effects of the Cohesion Policy in the context of the examined socioeconomic indicators have manifested themselves mainly in rural areas forming the catchment area of core cities but not in peripheral areas with a distinctly rural character. Vedrine and Gallo (2021) analysed the effects of the ESIF on regional disparities acting "within" regions and "among" regions. The results fall on the "trade-off" between disparities "within" and "among" regions. The ESIF has positively mitigated the impact of economic growth disparities within regions but has not led to a reduction of disparities among regions.

Despite the evident contradictions in individual authors' empirical research, the EU recognizes the fundamental shortcomings of the Cohesion Policy in delivering its results. In the period before the fundamental reform of the EU's Cohesion Policy, in his report to the DG Regio, Barca (2009) justified the need for a clear and explicit distinction between intervention policies aimed at raising incomes and growth (the "efficiency" goal) and interventions aimed at reducing disparities (the "social inclusion" goal). At the same time, it calls for a new model of application policy, the so-called place-based policy, an approach based on the territorial context, where policies and support tools must be locally defined and locally based on specifics and the possibility to use local resources.

3. Data and Methodology

3.1 Model and auxiliary diagnostics

Formal econometric analysis of economic growth includes two major topics. The first theme revolves around the question of convergence, and the second theme concerns the identification of growth determinants, i.e., which factors seem to explain observed differences in growth (Aghion and Durlauf, 2005).

At the beginning, it is necessary to differentiate between ESIF funding and ESIF absorption. ESIF absorption means ESIF funds spent by the final beneficiary (i.e., a NUTS2 region), which differs from ESIF funding. ESIF funding expresses the amount of funds allocated by the central authority, but the real absorption rate almost always differs (and is usually lower) from the allocation rate. Hence, the data inference was made based on ESIF funds spent (i.e., absorbed) by the region.

The paper's objective is twofold. Firstly, the ESIF absorption rate at the NUTS2 level of the V4 countries since their accession is examined. One-way analysis of variance (ANOVA) is adopted for this task. It is assumed that there are significant differences in the ESIF absorption rate efficiency within and among the V4 countries, respectively. For this purpose, secondary data from the COHESIONDATA platform were used. Note that financial records only related to the Cohesion Policy objectives were used. This platform provides historical payments by the member states and NUTS2 regions. Due to data availability, ESIF payments in the period 2000–2018, including pre-accession and post-accession periods, were used. Secondly, the possible link between regional growth and ESIF absorption, along with the other covariates, is investigated. Again, regional growth differences are expected; thus, the model choice is adjusted for this purpose.

To fulfil the second objective of the paper, cross-sectional data for NUTS2 regions ($N = 35$) and the period 2002–2018 (T = 16) were combined in the economic growth model, resulting in a micro panel model. Unfortunately, the most recent observations ($t_i = 2019, ...$) are missing, because of limited availability of ESIF absorption datasets.

A typical assumption for micro panels is that individuals are mutually independent while observations for a given individual are correlated across periods. This means that the observations follow a clustered dependence structure. Because of this, the literature sources suggest using cluster-robust covariance matrix estimators where possible (Hansen, 2019). There is also reason to believe that panels are autocorrelated. The use of spatial statistics methods examines this suggestion.

Several models are deployed in the study, while assuming different correlation structures of errors e_i. A natural starting point is often a pooled OLS regression, assuming that an individual effect e_i (cross-sectional or time-specific effect) does not exist ($e_i = 0$). In such a case, ordinary least squares (OLS) provide efficient and consistent parameter estimates. It is formally given as:

$$y_{it} = x'_{it}\beta + e_{it} \tag{1}$$

where β is a $k \times 1$ coefficient vector and e_{it} is an error term, uncorrelated with x_{it}. The dependence on y_{it} may enter through the variance. However, the error term e_{it} is likely correlated over time for a given individual, so cluster-robust standard errors that cluster on the individual and with correlated errors are used, yielding a more efficient estimator, known as the pooled feasible general least squares (PFGLS) model.

$$\hat{V}_{pool} = \left(X'X\right)^{-1}\left(\sum_{i=1}^{N} X_i \hat{e}_i \hat{e}_i' X_i\right) \tag{2}$$

Another approach to panel data regression is the random-effect model. The random-effect model assumes that the errors u_i and ε_{it} are conditionally mean and zero, uncorrelated and homoscedastic. This is also known as a one-way error component model. In vector notation, it can be written as:

$$e_i = 1_i u_i + \varepsilon_i \tag{3}$$

where 1_i is a $T_i \times 1$ vector of 1's. The one-way error component regression model is:

$$y_{it} = x'_{it}\beta + u_i + \varepsilon_{it} \tag{4}$$

Given the error structure, the natural estimator for β is a generalized least squares (GLS) or feasible general least squares (FGLS) estimator, replacing the unknown σ_u^2 and σ_ε^2 with estimates. For the study, a cluster-robust covariance matrix estimator is used:

$$\hat{V}_{gls} = \left(\sum_{i=1}^{N} X_i' \Omega_i^{-1} X_i\right)^{-1}\left(\sum_{i=1}^{N} X_i' \Omega_i^{-1} X_i \hat{e}_i \hat{e}_i' \Omega_i^{-1} X_i\right)^{-1}\left(\sum_{i=1}^{N} X_i' \Omega_i^{-1} X_i\right)^{-1} \tag{5}$$

Specifically, the evaluation of the growth differences among the V4 regions at the country level is the centrepiece of the study. For this purpose, a one-way least squares dummy variable (LSDV) model with cluster-robust standard errors is deployed. The choice of such a model is intentional. There is sufficient ground to adopt this kind of model. The main reason for using a fixed-effect approach LSDV model with time-invariant country intercepts considered dummy variables) is appropriate when the differences among the clusters (clusters of regions –

V4 countries) are of primary interest. Hence, one of the paper's objectives is to make cross-country economic growth comparisons based on the growth of countries' regions represented as clusters and modelled by the dummy variables. More detailed explanations about the pros and cons of the fixed-effect and random-effect approach can be found in Rabe-Hesketh and Skrondal (2021). The individual-specific effect (V4 country) u_i is interpreted as a time-invariant unobserved missing variable. Correlation between u_i and x_{it} will cause both pooled and random-effect estimators to be biased. Hence, a fixed group effect model examines individual intercept differences, assuming the same slopes and constant variance across individuals (regional group of V4 countries). Since individual-specific effects are time-invariant and considered a part of the intercept, u_i is allowed to be correlated with the regressors. The LSDV model uses dummy variables, which are widely used because it is relatively easy to estimate and interpret substantively. The LSDV estimator is equal to the estimator obtained from the OLS estimation of y_{it} on x_{it} and N individual-specific indicator variables $d_{j,it}$, $j = 1, ..., N$, where $d_{j,it} = 1$ for the ith observation if $j = 1$ and $d_{j,it} = 0$ otherwise. Hence, the model is:

$$y_{it} = \left(\sum_{j=1}^{N} \alpha_i d_{j,it} \right) + x'_{it}\beta + \varepsilon_{it} \tag{6}$$

The classical covariance matrix estimator for the fixed-effect estimator is valid when the error terms ε_{it} are homoscedastic and serially uncorrelated, but is invalid otherwise. A covariance matrix estimator which allows ε_{it} to be heteroscedastic and serially correlated across t is the cluster-robust covariance matrix estimator, clustered by the individual:

$$\hat{V}_{fe}^{cluster} = \left(\dot{X}'\dot{X} \right)^{-1} \left(\sum_{i=1}^{N} \dot{X}'_i \hat{\varepsilon}_i \hat{\varepsilon}'_i \dot{X}_i \right) \left(\dot{X}'_i \dot{X}_i \right)^{-1} \tag{7}$$

where $\hat{\varepsilon}_{i'}$ is the fixed-effect residuals. (6) was first proposed by Arellano (1987). Furthermore, (7) can be multiplied by a degree-of-freedom adjustment. The adjustment is recommended by the theory of Hansen (2007) as:

$$\hat{V}_{fe}^{cluster} = \left(\frac{n-1}{n-N-k} \right) \left(\frac{N}{N-1} \right) \left(\dot{X}'\dot{X} \right)^{-1} \left(\sum_{i=1}^{N} \dot{X}'_i \hat{\varepsilon}_i \hat{\varepsilon}'_i \dot{X}_i \right) \left(\dot{X}'_i \dot{X}_i \right)^{-1} \tag{8}$$

These estimators are convenient because they are simple to apply and allow for unbalanced panels.

The list of the variables is provided in Table A1. For the model assembly, secondary data from the EUROSTAT are used. All variables are expressed as differences in logarithms, excluding the dummy variables.

Finally, there is sufficient ground to assume that the panels are also autocorrelated. Hence, the panels represent regions of V4 countries; such a possibility is examined through the measure for spatial autocorrelation. Two popular indices for measuring spatial autocorrelation applicable to a point distribution are Geary's ratio and Moran's I index (Wong and Lee, 2005). For research purposes, Moran's I index was calculated.

$$I = \frac{n \sum\sum w_{ij} \left(x_i - \overline{x}\right)\left(x_j - \overline{x}\right)}{\sum\sum w_{ij} \sum \left(x_i - \overline{x}\right)^2} \tag{9}$$

where s_{ij} represents the similarity of point i's and point j's attributes, w_{ij} represents the similarity of point i's and point j's locations, with $w_{ii} = 0$ for all points, and x_i represents the value of the attribute of interest for the point i, and n representing the total number of points. Significance testing of spatial autocorrelation is measured at the 5% significance level, or $\alpha = 0.05$, is included (notation omitted).

In summary, to lay the ground for the model, one-way ANOVA and probability distribution of ESIF absorption rates on a regional level were analysed. Secondly, the least squares dummy variable (LSDV) model with cluster-robust standard errors was adopted as the main research method for handling the panel data. The research method provides an advantage for measuring the intercepts representing the regional growth effects nationally.

4. Results and Discussion

The first part of the results is devoted to ESIF absorption in the pre-accession and post-accession periods of the V4 countries at the NUTS2 regional level. It includes all financial instruments within the ESIF framework in the period 2000–2018, accessed from the COHESIONDATA database. The ESIF is calculated as the sum per region and expressed per capita.

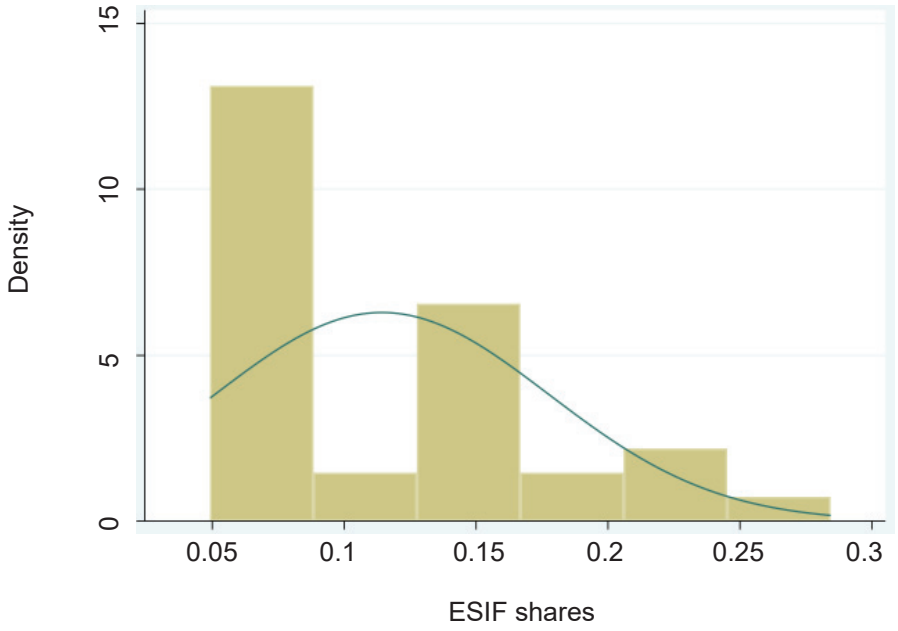
Total ESIF absorption is the response variable, and V4 country is the factor variable. The table shows means, standard deviations and frequency of ESIF absorption by V4 country. There are slight differences among the V4 countries in ESIF absorption, with Hungary representing the outlier. Also, it might be seen that there is a much larger variance within the countries than among the countries. Indeed, eta-squared (η^2), the ratio of the among-groups sum of squares to the total sum of squares, was 0.35. This result means that just 35% of the variance in ESIF absorption is explained by differences among the V4 countries.

Table 1: Results of one-way ANOVA analysis

	Summary of total				
Country	**Mean**	**Std. dev.**	**Freq.**		
CZ	3408.525	693.5708	8		
HU	4159.3	930.32635	7		
PL	3031.8875	403.72094	16		
SK	3263.7	298.25808	4		
Total	3369.9514	717.82379	35		
Analysis of variance					
Source	**SS**	**df**	**MS**	**F**	**Prob > F**
Among groups	6247155.09	3	2082385.03	5.73	0.0031
Within groups	11272058.5	31	363614.79		
Total	17519213.6	34	515270.988		
Bartlett's equal-variance test: chi2(3) = 8.4608 Prob>chi2 = 0.037					

Source: author's calculations

Figure 1: Probability distribution of ESIF absorption at regional level



Source: author's calculations

Figure 1 shows the probability distribution of ESIF absorption at a regional level. The distribution is positively skewed, showing the tail of the distribution extending more to the right. It may be assumed that most regions cluster on the left side of the distribution, meaning that more regions in V4 countries exhibit less absorption, while a few regions exhibit more absorption tailed on the right. Hence, the regional absorption across the V4 countries is not proportional, which can fuel the regional gap. Annex 2 provides more details on ESIF absorption at the country level.

Table 2: Panel data regression results

	LSDV	POOLED OLS	REM
	gdp_growth	gdp_growth	gdp_growth
eu_payment	0.0154*** (4.97)	0.0150*** (4.73)	0.0153*** (4.88)
reg_share	42.01** (3.54)	42.51** (3.23)	42.79*** (3.39)
labour	0.350** (3.07)	0.338** (2.93)	0.344** (2.99)
pop_dens	−1.793*** (−4.66)	−1.212** (−3.11)	−1.543*** (−3.88)
unemp	−0.157*** (−13.10)	−0.155*** (−13.85)	−0.156*** (−13.59)
rd_pers	−0.000788 (−0.04)	0.000895 (0.04)	0.000276 (0.01)
	CNR		
2. HU	−0.0123* (−2.67)		
3. PL	−0.0113** (−2.93)		
4. SK	0.0222** (3.20)		
_cons	0.0380*** (9.73)	0.0330*** (11.49)	0.0329*** (11.09)
N	557	557	557
R-sq	0.328		
adj. R-sq	0.317		

Notes: t statistics in parentheses, * p<0.05, ** p<0.01, *** p<0.001

Source: author's calculations

In the second part, the results of the three models with different conditions related to error modelling are presented. Individual-specific effects of V4 countries are presented as dummy variables. Prior to the modelling, the IPS panel unit root test and test of cointegration were performed. The IPS test confirmed that the panels are stationary at $p < 0.001$. Similarly, the Kao test for cointegration (both in Appendix) of the variables confirmed that all the panels are cointegrated at $p < 0.001$. These results suggest causal links among the variables evaluated in the panels.

Table 3 shows the results of the panel regression models. The models consist of six predictors and four dummy variables in the case of the LSDV (one omitted for perfect multicollinearity). The regression explains 32.77% of the variance in economic growth; such model performance may be evaluated as mediocre. In the set of quantitative variables, all the predictors except *rd_pers* (people in R&D) are highly statistically significant.

The results of other models (pooled OLS, REM) are briefly mentioned. All the covariates, except *rd_pers*, are statistically significant. However, additional testing, especially the LM test for random effects (see Appendix) and *F*-test for fixed effects (see Appendix) favour the LSDV model over the others.

Finally, the spatial autocorrelation of the panels was tested. The test statistics were average regional growth over the period 2002–2018; for this purpose, Moran's I coefficient (1.8) was calculated.

Table 3: Moran's summary

Moran's index	0.146
Expected index	−0.0294
Var(I)	0.009533
z-score	1.7994
p-value	0.07194

Source: author's calculations

According to the results, Moran's spatial autocorrelation index was 0.146, which suggests moderate positive spatial autocorrelation. The calculated coefficient was statistically significant just at $p < 0.1$. It suggests that regions of the V4 countries are not strongly autocorrelated.

In the investigation, we addressed a current and intensively discussed topic – the contribution of the Cohesion Policy to the economic growth of the V4 countries. The topic was placed into the international framework of research into this issue.

In the first part, ESIF absorption at the regional level was examined. The results pointed to relatively small differences among the V4 countries (the explained variance was only 35%); however, there are substantial differences among the regions at the country level. Subsequently, the probability distribution histogram shows positive skewness, which suggests a disproportional distribution of funds at the regional level. According to the box plot (see Appendix), the biggest disparities in ESIF distribution were recorded in Hungary, Slovakia and Poland. On the contrary, a relatively proportionate distribution was recorded in Czechia (with one outlier). However, Poland also shows the lowest ESIF drawing on average per capita.

There is already some evidence about disproportionate ESIF distribution in V4 countries. Medve-Bálint (2016) mentioned economic and political bias influencing the distribution of ESIF funds. In Poland and Hungary, the richer localities have absorbed higher shares of EU grants per capita. According to evidence, while EU funding is positively associated with the local popularity of the governing party in Poland, the Hungarian analysis suggests that both local and regional political factors affect the ESIF flows. Political bias in EU funds redistribution at a country level has also been noted by Kemmerling and Bodenstein (2006) and Dotti (2012), who have observed fairly widespread redistributive practices in the EU governed by partisan politics.

Several studies have been devoted to assessing the impact of ESIF funding in the V4 countries (Brown et al., 2017; Ministry of Economic Development of Poland, 2017) as well as convergence. Brown et al. (2017) stated that the majority share of investment subsidies from the ESIF was directed to infrastructure and the environment, followed by other productive investments. The Visegrad Group highlights accelerated social and economic development progress of the V4 countries resulting from structural and cohesion fund investments. Specifically, the impact appears in real convergence (approx. 25–30% of the real convergence of the V4 GDP with the EU average) and closing the income gap to the EU average (Ministry of Economic Development of Poland, 2017). Bartkiewicz et al. (2011) assessed the role of EU funds in creating economic growth in the V4 countries. In 2010, the best year in terms of implementing the Cohesion Policy, the positive effects are estimated at 3–4% of GDP and about 2% of the number of employees, depending on the country. In other words, the lack of redistribution of funds from EU15 to V4 countries would have resulted in lower wealth and fewer jobs.

Secondly, the contribution of the ESIF to regional growth was investigated. Assuming the regional growth differences among the V4 countries, the LSDV model was applied. The results

show a statistically significant, albeit very small, positive contribution of ESIF funds to the regional growth of V4 countries. Controlling for other covariates, regional growth differences among the V4 countries were examined using dummy variables. The highest average growth over 2002–2018 was recorded in Slovak and Czech regions, followed by Poland and Hungary. The subsequent spatial analysis confirmed a moderate regional spatial autocorrelation among the V4 regions.

Regional differences in the EU countries are a well-recognized topic. In the Eighth Cohesion Report (EC, 2021) the European Commission highlighted progress of less developed eastern EU regions, leading to a substantial reduction of the GDP per capita gap. However, the report expressed concerns regarding the sustainability of the "catching up". Finally, it added that employment had been growing, but regional disparities in the EU remained larger than before 2008 (EC, 2021).

Foreign investments are considered one of the main factors contributing to the high economic growth in the V4 countries during the transition and post-accession period (Nežinský and Fifeková, 2014; Dorozynski and Kuna-Marszalek, 2016; Raisová and Ďurčová, 2014). Mainly, FDI (foreign direct investments) have influenced the capital stock (through gross fixed capital formation) but also favourably affected the technological preparedness and productivity growth of the V4 countries (Nežinský and Fifeková, 2014).

Similarly, the structural changes in the labour market and possible trade-offs between intensive and extensive labour use have played a major role in shaping the economic prospects of V4 countries (Hudcovský et al., 2017; Paľová and Vejačka, 2018). Catching up on the process of the technological gap in developed Western countries has played a significant role in employment development during the early stages of transformation. From an overall point of view, the increase in labour productivity positively influences the growth of added value. However, from an employment point of view, such strong growth in labour productivity hampers adequate employment growth (Hudcovský et al., 2017).

Technological progress is often causally attributed to the achieved fast labour productivity in the V4 countries. Technological progress, from 1998 to 2016, influenced labour markets in V4 countries differently. During the transition period (1990–2004), V4 countries recorded only modest economic growth (1.7% p.a. on average); however, capital stock formation as a share of GDP was at quite an impressive level of 25.5% p.a. on average. The average annual growth in total factor productivity was 2.1% p.a. on average. In the post-accession period (2005–2013), the economic growth was 2.7% p.a. on average, and the differences in capital stock formation were scant; the average annual growth in total factor productivity slowed to just 0.9% p.a. (Baláž et al., 2017).

5. Conclusion

The EU Cohesion Policy is considered one of the main pillars of the European Community, focusing on promoting economic convergence and reducing interregional disparities in the EU Member States. The paper generally highlighted the development aspects of V4 countries following their accession to the EU and becoming recipients of the EU Cohesion Policy. Hence, the paper's objective was twofold: (1) to provide a more detailed picture of ESIF distribution at the NUTS2 regional level, and (2) to examine the contribution of the Cohesion Policy to the regional economic growth of V4 countries since their accession.

The results provide relatively fragile evidence for the above-mentioned research topics. Regional ESIF distribution over 2000–2018 points to a rather fractured absorption rates "within" the regions with different V4 country-level effects. The subsequent regression analysis using different methods of panel data analysis confirmed a statistically significant effect of the ESIF funds on the regional growth of the V4 countries. However, the effect was very small: on average, just 0.015% growth per 1% increase in drawn funds per capita. Such a small figure has to be interpreted with caution; unequal distribution of funds over the years and regions, lagging in drawing funds or efficiency of fund use could affect the results. Moreover, a detailed regional breakdown (at the NUTS3 level) could provide more accurate results.

Finally, the economic growth of the V4 countries was evaluated by using the country dummy variable, grouping regions of each V4 country on behalf of the dummy variable. Specifically, for evaluation purposes, the LSDV model was used. The model showed statistically significant growth differences at the country level at the significance level $p < 0.05$. According to the model, Slovak and Czech regions, on average, showed higher growth rates over the study period. However, the findings are not conclusive. The regional growth differences among countries are relatively small and the growth patterns are very similar. Also, the EU benefits should not be restrained to ESIF funding only. There are other benefits following the V4 countries' membership in the EU. In most cases, trade integration, lower costs of debt and indirect benefits of EU transfers are often highlighted.

There were also some limitations of the study. The results point to vast regional differences in the ESIF absorption rates at the national level. However, the model represents it by a single variable (eu_payment), assuming the same slope for each country, resulting in a bigger standard error of the estimated variable coefficient. Each country may have unique factors influencing its ESIF absorption rate that are not captured by the single variable used. Within the scope of the topic, future research should focus on more accurately measuring the ESIF's contribution to growth and development using qualitative and quantitative methods. Cross-country compar-

isons may also provide more evidence of the efficiency of the use and management of ESIF distribution at the regional level.

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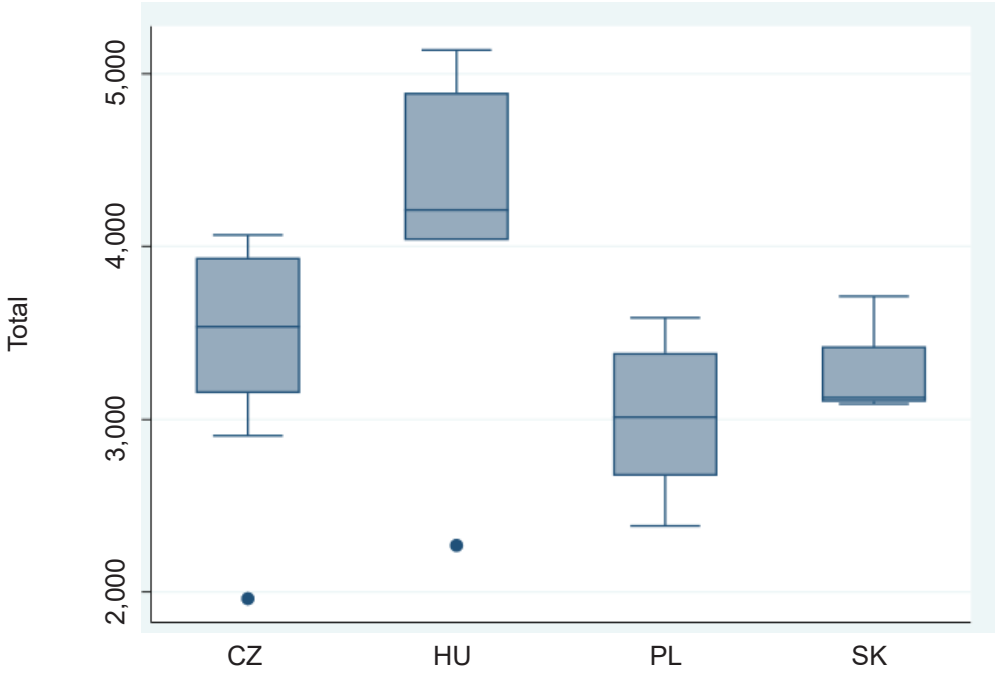
Appendix

Table A1: List of variables

gdp_growth	GDP growth per capita (constant prices)
eu_payment	ESIF regional transfer in absolute value
reg_share	Regional share in country's GDP per capita (constant prices)
labour	Labour stock in thousands
pop_dens	Regional population density (population per square kilometre)
unemp	Regional unemployment rate (%)
rd_pers	Number of people employed in R&D
cz	Czechia – dummy variable
sk	Slovakia – dummy variable
pl	Poland – dummy variable
hu	Hungary – dummy variable

Figure A1: Regional ESIF absorption rates at country level



Source: author's calculations

Table A2: Panel unit root test

Im–Pesaran–Shin unit root test					
H0: All panels contain unit roots	Number of panels = 35				
Ha: Some panels are stationary	Number of periods = 16				
AR parameter: Panel-specific	Asymptotics: T,N -> Infinity				
Panel means: Included	sequentially				
Time trend: Not included					
ADF regressions: No lags included					
	Fixed-N exact critical values				
	Statistic	**p-value**	**1%**	**5%**	**10%**
t-bar	–3.8619		–1.820	–1.730	–1.690
t-tilde-bar	–2.6770				
Z-t-tilde-bar	–10.3308	0.0000			

Source: author's calculations

Table A3: Test of cointegration

Kao test for cointegration		
H0: No cointegration		Number of panels = 35
Ha: All panels are cointegrated		Avg. number of periods = 13.429
Cointegrating vector: Same		
Panel means:	Included	Kernel: Bartlett
Time trend:	Not included	Lags: 0.80 (Newey–West)
AR parameter:	**Same**	**Augmented lags: 1**
	Statistic	**p-value**
Modified Dickey–Fuller t	–21.6471	0.0000
Dickey–Fuller t	–23.3924	0.0000
Augmented Dickey–Fuller t	–13.9691	0.0000
Unadjusted modified Dickey–Fuller t	–25.6534	0.0000
Unadjusted Dickey–Fuller t	–23.7890	0.0000

Source: author's calculations

Table A4: Test for random effects

Breusch and Pagan Lagrange multiplier test for random effects		
gdp_growth[id,t] = Xb + u[id] + e[id,t]		
Estimated results:		
	Var	**SD = sqrt(Var)**
gdp_gro~h	0.0056775	0.0753489
e	0.000895	0.0299159
u	0	0
Test: Var(u) = 0		
chibar2(01) = 0.00		
Prob > chibar2 = 1.0000		

Source: author's calculations

Table A5: F–test for fixed effects

(1) 2.cnr = 0
(2) 3.cnr = 0
(3) 4.cnr = 0
chi2(3) = 47.59
Prob > chi2 = 0.0000

Source: author's calculations