4 REVISITING OKUN'S LAW AT THE REGIONAL LEVEL: EVIDENCE FROM CENTRAL AND EASTERN EUROPE

Narcis COPCA[1], Tanase STAMULE[2], Maria Cristina GEAMBASU[3] Zouhair ENNAOUMI[4], Marina Diana AGAFITEI[5], Eduard Mihai MANTA[6] Dalia ŠTREIMIKIENĖ[7]

Abstract

This paper presents a re-examination of the relationship between unemployment and economic performance in Central and Eastern Europe with focus on the informal economy and institutional quality. A two-way fixed effects model with Driscoll-Kraay standard errors is applied to NUTS-2 regional panel data covering six countries (Bulgaria, Croatia, Czechia, Hungary, Poland and Romania) over 2002-2021. The results demonstrate strong regional support for Okun's Law showing an inverse and significant relationship between unemployment and real GDP per capita. A one percentage point increase in unemployment reduces regional output by approximately 0.7-0.9%. The size of the informal economy is also negatively connected to economic performance, suggesting that informality plays an important role in constraining productivity in the formal sector. Extensions with governance indicators indicate that improvements in the rule of law and government effectiveness have a positive relationship with regional economic performance while political stability has a weaker relationship intra-country. These findings reinforce the importance of labour market conditions, formalisation and institutional quality in the growth of the regional economy in Central and Eastern Europe.

Keywords: *Okun's law, CEE regions, Uncertainty, Informal economy, Two-way fixed effects, Institutional quality, Driscoll–Kraay standard errors*

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1 Faculty of Medicine, Carol Davila University of Medicine and Pharmacy, St. Maria Clinical Hospital, Bucharest University of Economic Studies, Bucharest, Romania, narcis.copca@man.ase.ro

2 Department of Business Administration, Bucharest University of Economic Studies, Bucharest, Romania, tanase.stamule@fabiz.ase.ro

3 Economic Cybernetics and Statistics Doctoral School, Bucharest University of Economic Studies, Bucharest, Romania, geambasumaria14@stud.ase.ro

4 Department of Economics and Statistics, University of Salerno, Salerno, Italy, zennaoumi@unisa.it

5 Economic Cybernetics and Statistics Doctoral School, Bucharest University of Economic Studies, Bucharest, Romania, diana.agafitei@csie.ase.ro

6 Department of Cybernetics and Statistics, Bucharest University of Economic Studies, Bucharest, Romania, eduard.manta@csie.ase.ro

[7] Faculty of Economics, Széchenyi István University, Gyor, Hungary, dalia.streimikiene@lei.lt

1. Introduction

The work of Arthur Okun in 1962 showed that there was a negative correlation between unemployment and GDP growth, which has been subsequently confirmed across many economies and over many time periods. There were significant differences in Okun's coefficients between countries, implying that, while the link may exist overall, its size and details can vary considerably based on geographical and temporal conditions (Freeman 2001). The diversity underlines the significance of regional-specific research for grasping the full implications of Okun's Law.

The economic literature has been preoccupied with explaining the intricate relationship between changes in GDP and unemployment rates among economies undergoing transition. However, in transitional economies – those changing from centrally planned to market-oriented systems – this link presents new challenges and opportunities for research. Some common notable features experienced by these economies consist of labor market liberalisations, privatisation programs targeted towards state-owned companies, and establishment of new institutional arrangements. Such alterations could lead to differing interpretations of already known economic theories such as Okun's Law.

Starting with early 2000s, Central and Eastern European nations such as Bulgaria, the Czech Republic, Croatia, Hungary, Poland, and Romania have experienced significant economic transformations. Due to these developments, it has become critical to understand this complex relationship between GDP and unemployment in these places.

This study aims to investigate this relationship by including the influence of external shocks and the informal economy. Okun's Law, which assumes an inverse link between GDP growth and unemployment rates, serves as the theoretical basis. However, the influence of financial crises, pandemics, and internal economic dynamics requires a more detailed examination. Using panel data from 2002 to 2021, this study tries to validate the fundamental concepts of Okun's Law while also investigating the profound implications of major economic disruptions and the universal impact of the informal economy.

2. Literature review

The strength of the unemployment – GDP relationship varies drastically between advanced countries and emerging countries. Cross-country studies have shown that the correlation between unemployment and GDP tends to be weaker when it comes to the emerging countries; this could be related to the distinct labour market dynamics and economic frameworks (Ball et al., 2019). For instance, recent research focusing on Southeast Europe indicates that Okun's effect can be negligible in less developed regions; Arifi et al. (2023) found no significant impact of GDP growth on unemployment across six Western Balkan countries. Similarly, a panel study on selected developing economies (including CEE members like Hungary and Poland) reported no long-run cointegration between output and unemployment rates (Sari, 2021), calling into question the universality of Okun's Law in emerging contexts.

Although extensively studied in developed nations, its applicability in transitional economies is still debated. Izyumov and Vahaly (2002) have analysed this relationship in 25 transition countries. They have discovered that Okun's Law applies in "reform leader" countries, such as EU accession countries, but only partially in "reform laggards," and frequently just during specified times. Building on these findings, Andreescu (2024) analysed five OECD-member CEE countries in the post-2009 crisis period and observed that while an Okun's Law-type relationship persisted, the magnitude of unemployment's responsiveness to output varied considerably between countries, reflecting structural changes in the aftermath of the global financial crisis.

The relationship between GDP and unemployment is not a constant; thus the relationship can be altered by major external factors like financial crises and pandemics. Knotek (2007) discovered that this association varies significantly during the business cycle, notably during moments of economic instability. For example, throughout the 2008 financial and economic crisis, several countries went through disruptions of the regular connections between gross domestic product (GDP) and unemployment rates. Also, Çevik found out that in nine transitional economies cyclical unemployment is more elastic to cyclical output during downturns than in upswings, thus displaying asymmetric response to economic cycles (Çevik, Dibooğlu, and Barişik, 2013). Also, the COVID-19 epidemic brought significant challenges, affecting both GDP and employment levels worldwide. Pasipanodya (2020) emphasised how, in Zimbabwe, the informal economy reduced the impact of economic contractions on unemployment during downturns, implying that informal sectors play a buffer function during crises.

Another topic that has received a lot of attention in the recent years is the informal economy and its impact on Okun's. Pikoulakis applied a model to the informal economy and discovered that, while corporation and personal income taxes have no impact on this sector, the cost of capital does. This conclusion indicates that traditional fiscal strategies may be less effective in economies with large informal sectors (Pikoulakis, 2010).

In Nigeria, Raifu found that the informal economy had a considerable impact on the link between unemployment and GDP. This study discovered that sectoral output responses differed, with the services sector showing a larger link than the other sectors. This difference in the responses is highlighting the importance of considering sector-specific dynamics when studying larger economic statistics (Raifu, 2022). In China, Feng presented a larger version of Okun's Law that incorporates agricultural labour transfer to better reflect labour market dynamics in transitional economies (Feng, 2018). Adelowokan and Okutimiren had discovered that, in Nigeria, the informal economy has a significant impact on the correlation of economic growth and unemployment, and that there are short-term and long-term links between unemployment and economic growth (Adelowokan and Okutimiren, 2019).

In the context of emerging Europe, high levels of informality remain a pressing concern. Kelmanson et al. (2019) highlight that weak governance and institutional deficiencies in several CEE countries have contributed to expanded shadow economies, which can undercut the formal unemployment-GDP linkage. Moreover, despite gradual post-transition improvements, the informal sector in the Western Balkans still accounts for a significant share of economic activity, nearly 30% of GDP as of 2021 (Asllani et al., 2025). This persistent informality can dampen the observed Okun’s Law relationship by absorbing labour outside the formal economy. Notably, better governance has been associated with stronger economic performance; for example, Raczkowska et al. (2023) find that improvements in governance quality correlate with higher GDP per capita in EU countries, suggesting that institutional strength may reinforce the conditions for a robust Okun’s Law effect.

Studies on various transitory zones shed light on the application of Okun's Law. According to Boďa and Považanová's (2019) study of Visegrád Group nations, Okun's Law's validity changes greatly, and its coefficients do not remain constant over time. Studies also suggest that Okun's coefficients vary significantly between US states, impacted by characteristics such as labour market flexibility, educational attainment, and industrial mix (Guisinger et al., 2015).

Similarly, regional statistics from Spain, the Czech Republic, and Slovakia show that Okun's Law may not apply uniformly, as local economic situations and investment levels influence the relationship (Villaverde and Maza, 2009; Durech et al., 2014). At the pan-European level, recent evidence suggests that Okun’s Law remains structurally stable over time but with a smaller coefficient in Eurozone countries. Crucially, cross-country differences in structural factors, particularly the stringency of product market regulation, help explain why some economies (especially in the Euro Area periphery) exhibit a weaker unemployment–output relationship (Campos et al., 2024).

In search of solutions that effectively address issues related to unemployment and stimulate economic growth, it is imperative to analyse and understand the correlation between variations in gross domestic product (GDP) and changes in the unemployment rate. Appreciating this relationship contributes to the development of economic policies and measures aimed at minimising the negative impact of economic fluctuations on the labour market and promoting robust economic stability at the societal level.

The main questions that this research is trying to answer are:

- What is the nature of the relationship between GDP variations and changes in the unemployment rate in Central and Eastern European countries?

Understanding the relationship between GDP and unemployment is critical for policy makers. This study will investigate whether changes in GDP are strongly correlated with changes in unemployment rates, as well as how this relationship evolves over time in Central and Eastern European countries.

- How do different economic events and governance factors influence the GDP-unemployment relationship?

This question seeks to investigate the impact of various control variables, such as the informal economy, geopolitical, financial events, and governance factors (e.g., political stability, government effectiveness, regulatory quality, rule of law, and corruption control), on the GDP-unemployment relationship. By including these variables into the analysis, the study aims to provide a thorough picture of how external shocks and institutional quality influence economic stability and labour market outcomes.

According to the literature, the hypothesis regarding the expected sign for the unemployment rate coefficient is < 0. Since employed individuals contribute to the generation of goods and services, while unemployed individuals do not participate in the production of economic goods, it can be assumed that an increase in the unemployment rate is accompanied by a reduction in the real GDP volume.

3. Model specification

3.1 Model Description and Hypothesis

According to the previous section, this research is guided by the hypothesis of an unemployment rate coefficient with a negative expected sign (< 0). To this end, employed individuals generate commodities and services, whilst unemployed individuals do not. It follows that an increase in the unemployment rate implies a fall in the actual amount of GDP. This hypothesis, grounded in Okun's law, has been extensively examined across the economic literature; however, there is limited research addressing how the inclusion of the informal economy may influence the validity and strength of this relationship.

This study collected data from Central and Eastern European EU members which include Bulgaria, the Czech Republic, Croatia, Hungary, Poland, and Romania. The analysis period covers 2002 to 2021 thereby allowing for examination of long-term trends as well as better understanding of Okun's law across these selected regions. The unit of analysis is the NUTS-2 region (n=51), observed annually from 2002–2021 (T=20), resulting in 1,020 observations. The main sources were Eurostat and World Bank, and all analysis was conducted through R Studio using the R programming language. While more recent data are available for GDP and unemployment, the empirical analysis is restricted to 2021, as no harmonised post-2021 estimates of the informal economy exist at the regional level, particularly due to the limited availability of consistent monetary data required by the currency demand approach. The empirical analysis involves a comprehensive approach, considering the degree of informality and uncertainty factors, with the general specification of the model being as follows:

$$\mathrm{GDP}_{\mathrm{cap\ i,t}} = \beta_0 + \beta_1 * \text{ Unemployment rate}_{\mathrm{i,t}} + \beta_2 * \mathrm{X}_{\mathrm{i,t}} + \varepsilon_{\mathrm{i,t}} \qquad (1)$$

In Eq. (1), *i* represents the number of regions, *t* represents the time period, while X is matrix of control variables.

The variables used through this research were split as it follows:

- Dependent variable: GDP (Gross Domestic Product) volume.
- Independent variable: Unemployment rate
- Control variables:
  - Informal economy[*] (expressed as a percentage of GDP using the currency demand method).
  - Governance factors (political stability, government effectiveness, regulatory quality, rule of law, control of corruption).

The informal economy was estimated using the currency demand method, which assumes that most undeclared transactions are conducted in cash. Excess cash in the economy was used as a measure of informality. For this, cash demand was estimated in an economy without informality, based on factors such as the tax rate, GDP per capita, interest rate, regulatory power, and number of ATMs. The differences between real and estimated cash demand provided the relative level of the underground economy. While this approach relies on a counterfactual benchmark, it constitutes a structural estimation strategy rather than a Difference-in-Differences design, as no explicit treatment, control group, or exogenous policy shock is defined.

Governance indicators are not available at the NUTS-2 level for the entire sample period. In principle, national governance indicators could be regionalised using the methodology proposed by González-Fernández and González-Velasco (2015), which allocates national institutional scores across regions based on each region's share of the national population. However, a purely population-based allocation may fail to capture heterogeneity in economic relevance and administrative capacity across regions. Therefore, in this study, national governance indicators were regionalised using weights based on regional GDP per capita. This approach aims to better reflect differences in economic activity and institutional exposure across regions. Importantly, governance indicators are introduced as control variables to capture broad institutional environments rather than to identify causal regional-level effects. Moreover, to mitigate potential biases arising from measurement error or limited within-country variation, governance variables are included one at a time, and the core results regarding unemployment and informality remain robust across specifications.

[*] *Numerous terms are used interchangeably in the literature to refer to economic activities that are not captured by official statistics, including shadow economy, underground economy, hidden economy, unregistered economy, informal economy among others. In this article, we will use the term informal economy (IE) consistently to refer to such phenomena. According to the System of National Accounts (SNA, 2025) par. 39.2 "The informal economy refers to the productive activities carried out by persons or economic units that are not covered by formal arrangements established by regulations and laws, such as registration, regulation, payment of taxes, and coverage of workers by social security and other labour laws and regulations."*

Two-way panel regression models with fixed effects for regions (region fixed effects) and years (year fixed effects) are used to perform the empirical analysis. The region fixed effects control for region-specific (i.e., time invariant) characteristics (e.g., region's developmental history, geography, structural economy), and the year fixed effects control for common changes in macroeconomic conditions (i.e., shocks) faced by all regions that occur simultaneously in time.

Given the panel data's regional structure, it is likely that the errors are heteroskedastic, serially correlated, and cross-sectionally dependent. Therefore, standard errors estimated for all models utilize the Driscoll-Kraay correction for panels with large time dimensions and correlated errors.

If the residuals of the econometric model exhibit heteroskedasticity, serial correlation over time, or across regions, then the fixed effects estimator may provide biased inference in panel datasets with regional observations. For example, economic shocks like financial crises and pandemics cause contemporaneously correlated errors across regions; on the other hand, regional economic dynamics generate persistent autocorrelation. In this paper, we use Driscoll-Kraay standard errors to provide covariance matrix estimates that are consistent for both heteroskedasticity and autocorrelation, and robust to very general forms of cross-sectional dependence.

Formally, the Driscoll–Kraay estimator computes a non-parametric covariance matrix of the estimated coefficients based on cross-sectional averages of the moment conditions, allowing the error terms to be correlated across panels and over time. Let $\hat{\beta}$ denote the fixed effects estimator. The Driscoll–Kraay covariance matrix is given by:

$$\widehat{Var}(\hat{\beta}) = (X'X)^{-1}\hat{\Omega}_{DK}(X'X)^{-1} \qquad (2)$$

, where $\hat{\Omega}_{DK}$ is constructed using Newey–West type autocorrelation corrections applied to cross-sectionally averaged residuals. This approach remains valid as the number of cross-sectional units grows large and is particularly suitable for panels with moderate to large time dimensions. This estimator was originally proposed by Driscoll and Kraay (1998) and has since become standard in empirical macroeconomic and regional panel data analyses.

To assess robustness to the baseline model results, additional specifications are also estimated employing region fixed effects and COVID-19 dummy variable for 2020 and 2021. The baseline two-way panel regression model including both region and year fixed effects has year fixed effects absorbing all common time-varying shocks (including the coronavirus pandemic). The coronavirus pandemic variable is collinear with the year fixed effects; therefore, the coronavirus pandemic dummy variable is omitted from the model by its construction. This finding confirms that the time fixed effects fully absorb the impact of coronavirus pandemic shocks.

3.2 The Analysis

To fully comprehend the dataset, an exploratory data analysis must be performed prior to the primary study. This entails analysing data distributions, formulating appropriate hypotheses, and choosing appropriate statistical models using graphical and statistical techniques. To better understand the data and spot outliers, Table 1 offers descriptive statistics such as minimum, maximum, mean, and quartiles (Q1, Q2, Q3). In Bulgaria, for example, GDP per capita was as low as 28.45 thousand EUR in 2002 in the Yuzhen Tsentralen region, and as high as 405.72 thousand EUR in the Prague region, the Czech Republic, in 2019.

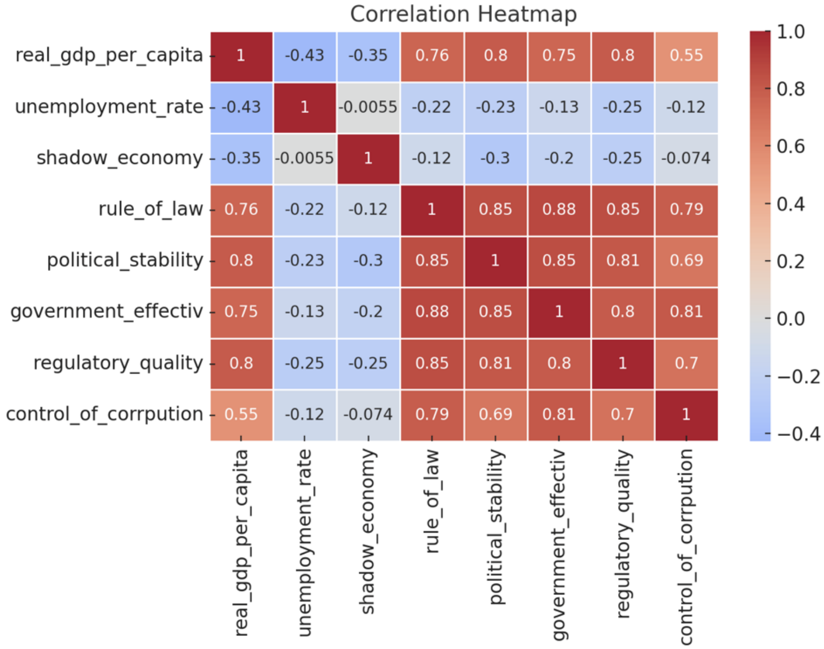
Table 1. Variable descriptive analysis

Variables	Measurement unit	Min	Q1	Q2	Mean	Q3	Max	Standard deviation
Dependent variable								
Gross Domestic Product per capita	Thousand EUR	28.45	66.29	89.27	100.33	116.79	405.72	54.28
Independent variable								
Unemployment rate	Percent	1.30	5.00	7.80	8.36	10.40	27.30	4.62
Informal economy	Percent of GDP	1.23	17.84	25.38	24.76	29.35	57.29	10.24
Rule of law	Score -2.5 to 2.5	-0.44	0.15	0.42	0.45	0.69	2.53	0.45
Political stability and absence of violence/ terrorism	Score -2.5 to 2.5	0.002	0.33	0.54	0.60	0.78	2.58	0.42
Government effectiveness	Score -2.5 to 2.5	-0.59	0.13	0.43	0.42	0.67	2.40	0.45
Regulatory quality	Score	-0.09	0.48	0.70	0.76	0.91	2.99	0.44
Control of corruption	Score -2.5 to 2.5	-0.74	-0.08	0.26	0.22	0.45	1.64	0.36

Important relationships between important economic and governance variables are shown by the correlation matrix that is presented in figure 1. These relationships are essential to perform a solid panel analysis. Positive relationships have been seen between real GDP per capita and governance indices, including political stability (0.799), government effectiveness (0.753), regulatory quality (0.799), rule of law (0.759), and corruption control (0.549). On the other hand, it shows slightly negative connections with both the informal economy (-0.348) and the unemployment rate (-0.426). Most governance indicators show weak negative correlations with the unemployment rate, and there is almost no association between the unemployment rate and the informal economy (-0.005). On the other hand, there is a weak negative correlation (-0.303) between the informal economy and political stability, government effectiveness, regulatory quality, rule of law, and corruption control.

The governance indicators have strong inter-correlations ranging from 0.688 to 0.879. These indicators include the rule of law, political stability, government effectiveness, regulatory quality, and control of corruption. These robust correlations point to possible problems with multicollinearity if these variables are added to a regression model at the same time. The strong association between political stability (0.853) and rule of law (0.879) or government effectiveness (0.853) could distort the model's findings. Taking multicollinearity into account is essential for accurate panel analysis. Hence, these different bilateral correlations will not be included in the same regression.

Figure 1. Correlation among key variables



4. Results and discussion

Regional GDP per capita has fluctuated a lot over time and from region to region in Central and Eastern Europe. The data show a general contraction of economic performance at the end of the 2000s, followed by a recovery and then a second contraction toward the end of the data sample. The level of regional GDP per capita also has a great deal of heterogeneity, which reflects the difference in both the structure of economies and their levels of development.

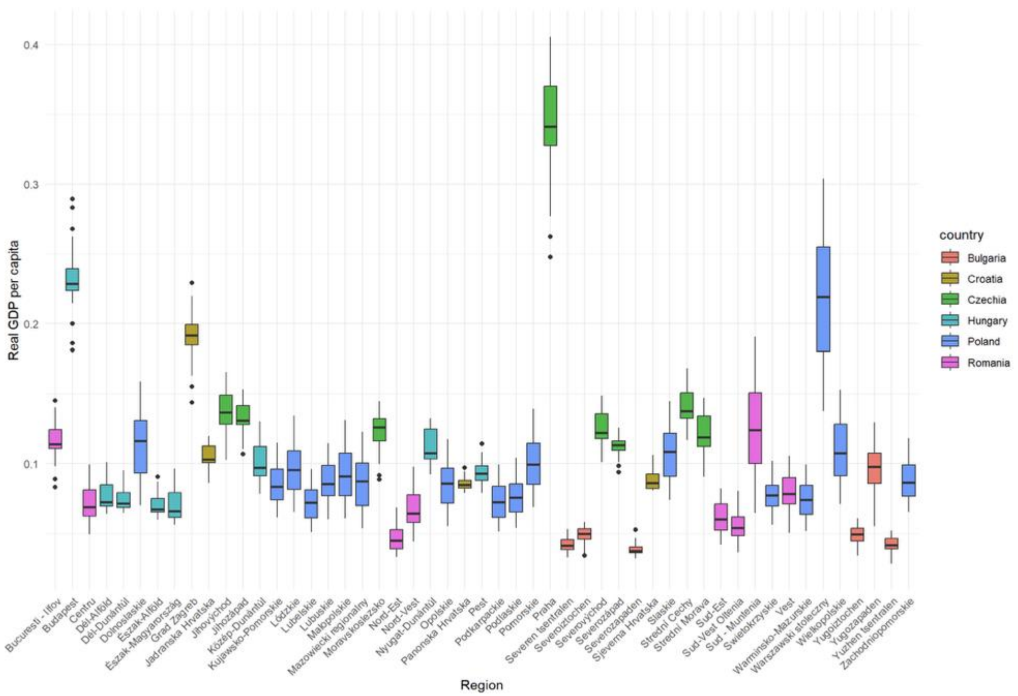
The level of informality is no different. The informal economy is represented by a spectrum of sizes, from small shares of GDP in developed urban regions to higher shares of informality in under-developed regions. Some regions have informal economies that are less than 1 percent of GDP, while others have considerably greater than 50 percent shares of their economy in the informal sector. The considerable structural differences between the different regions across the overall distribution of informality demonstrate the existence of significant differences among the regional economies in Central and Eastern Europe.

Figure 2 depicts how real GDP per capita varies by region in six countries: Bulgaria, Croatia, Czechia, Hungary, Poland, and Romania. Each box plot depicts the distribution of real GDP per capita within a certain region, emphasising the variability and central tendency of economic production. This analysis demonstrates large economic performance disparities within and between these countries.

Czechia has the highest regional GDP per capita, notably in one region, which much outperforms others, suggesting strong economic activity. Poland likewise shows significant variety, with some regions having high GDP per capita, indicating tremendous economic activity, but also pronounced regional inequality. Hungary has a moderate GDP per capita, but also exhibits significant geographical diversity. In contrast, Croatia, Romania, and Bulgaria have lower and more uniform GDP per capita, reflecting more homogeneous but generally inferior economic performance.

The presence of outliers in nations such as Czechia and Poland highlights regions with higher economic production than their national averages. This variance in regional economic development emphasises the need for specific economic policies to overcome uneven growth within these countries. Understanding regional variances is critical for policymakers seeking to promote equitable economic development and minimise inequities.

Figure 2. Distribution of Real GDP per capita across CEE regions



Source: Authors’ own creation.

Table 2 provides estimates of a baseline two-way fixed effect with respect to Driscoll-Kraay standard errors. The results reveal an inverse and highly statistically significant relationship between unemployment and economic performance; for example, an increase of one percentage point in the unemployment rate will lead to an approximate loss of 0.78% in real GDP per capita, providing further regional-level support for Okun’s Law in Central & Eastern Europe.

The size of the informal economy also demonstrates a significant negative relationship with respect to real GDP per capita; for instance, an increase of one percentage point in informality corresponds with a loss of approximately 0.19% in economic output, showing that informal economies detract from formal sector productivity and growth regardless of unobservable region-specific characteristics and common macroeconomic shocks.

Table 2. Baseline Regression: Two-Way Fixed Effects Estimates with Driscoll–Kraay Standard Errors.

Variables	TWOWAY-FE
Unemployment rate	–0.0078*** (***) (0.0009)
Informal economy	-0.0019(**) (0.0006)
R-squared	0.1070
Prob F-statistic	0.0000

*Note: The dependent variable is the logarithm of real GDP per capita. The table reports two-way fixed effects (region and year) estimates. Driscoll–Kraay standard errors, robust to heteroskedasticity, serial correlation, and cross-sectional dependence, are reported in parentheses. The unit of analysis is the NUTS-2 region. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.*

The results presented in Table 3 extend the baseline model by including institutional quality governance indicators. In all specifications, the unemployment rate continues to have a negative relationship and is highly statistically significant, confirming the regional level robustness of the Okun-type relationship. A one percentage point increase in the unemployment rate is estimated to be associated with a reduction in real GDP per capita of between 0.7% and 0.9%, representing a very robust and consistent result across all specifications.

Table 3. Extended Models with Governance and Institutional Quality: Two-Way Fixed Effects Estimates with Driscoll–Kraay Standard Errors

Variables	Model 1	Model 2	Model 3
Unemployment rate	-0.0091(***) (0.0010)	-0.0069(***) (0.0007)	-0.007426(***) (0.0008)
Informal economy	- 0.0012(*) (0.0005)	-0.0010(*) (0.0006)	-0.0015(*) (0.0006)
Rule of law	0.1290 (***) (0.0317)		
Political stability		0.0834 (*) (0.0427)	
Government effectiveness			0.1224 (*) (0.0591)
R-squared	0.1870	0.1410	0.1460
Prob F-statistic	0.0000 (***)	0.0000 (***)	0.0000 (***)

*Note: The table reports two-way fixed effects (region and year) estimates of the impact of unemployment, informality, and institutional quality on regional economic performance. The dependent variable is the logarithm of real GDP per capita. Each column includes one governance indicator at a time to avoid multicollinearity, given the high correlation among institutional variables. Driscoll–Kraay standard errors, robust to heteroskedasticity, serial correlation, and cross-sectional dependence, are reported in parentheses. The unit of analysis is the NUTS-2 region. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.*

The informal economy continues to show negative relationships with overall economic performance. However, the statistical significance declines in the specification that includes political stability. This finding suggests that while the negative influence of informality on regional output is robust, it may partially be mediated by institutional and political characteristics.

Of the governance indicators, the rule of law and government effectiveness are both very positively related to regional economic performance. Improvements in these dimensions of institutional quality are associated with higher levels of real GDP per capita, supporting the idea that strong legal institutions and effective public sector performance are critical to promoting regional economic growth. Conversely, political stability is found to have a relatively weak and less robust relationship, achieving significance only at the 10% level when using Driscoll-Kraay standard errors.

The relatively weaker effect of political stability on regional economic performance may result in part from the lack of between-country variation at the regional level and from the sharing of common political shocks at the time level due to the inclusion of time fixed effects. This does not imply that political stability is irrelevant to the process of economic development, rather its impact is primarily cross-nationally rather than intra-nationally within the European Union.

To evaluate how the COVID-19 pandemic affected regions economically, a robustness check has been performed, where an explicit pandemic dummy variable has been generated for use as an independent variable in conjunction with region fixed effects. The coefficient for the COVID-19 dummy was found to be negative and statistically significant, which provides evidence of a large negative effect on the regional economy from the pandemic.

In the two-way fixed effects model, the COVID-19 pandemic has been accounted for in year fixed effects which account for events that affect all regions uniformly. By including a COVID-19 dummy in the two-way fixed effects model, the COVID-19 dummy is completely collinear with year fixed effects and was therefore omitted from the model. This confirms that the impacts of the pandemic will be completely accounted for by year fixed effects.

Table 4. Robustness analysis: COVID-19 Shock

Variables	**Model 4**
Unemployment rate	-0.0275(***) (0.0041)
Informal economy	0.0078(***) (0.0019)
COVID-19 dummy	-0.1486(**) (0.0458)
R-squared	0.6490
Prob F-statistic	0.0000(***)

*Note: The table reports region fixed effects estimates with Driscoll–Kraay standard errors robust to heteroskedasticity, serial correlation, and cross-sectional dependence. The COVID-19 dummy equals one for the years 2020–2021 and zero otherwise. This specification is reported as a robustness check. In the baseline two-way fixed effects models, year fixed effects absorb all common time-specific shocks, including the COVID-19 pandemic; consequently, an explicit COVID dummy is perfectly collinear with year effects and is omitted by construction.*** p < 0.01, ** p < 0.05, * p < 0.10.*

The research findings support clear evidence of a negative relationship between unemployment and the economic performance of regions of Central and Eastern Europe, consistent with the principles outlined by Okun's law. The negative association found between unemployment rates and GDP continues to be supported by alternative data and alternative econometric specifications. This connection supports prior empirical research conducted by Andreescu (2024) who documents a persistent but heterogeneous Okun-type relationship across CEE countries in the post-crisis period. However, in contrast to the weak relationships in Western Balkan countries

(Arifi et al.,2023) or in broader developing economy pairwise linearity (Sari,2021), our evidence confirms a statistically significant unemployment–GDP link across the studied CEE regions, supporting the relevance of Okun’s mechanism in more integrated EU transition economies.

The total size of the informal economy in Central and Eastern Europe is negatively correlated with the GDP per capita, indicating that the existence informal economy creates a disincentive to formally participate in the market, after controlling for unobserved regional differences, as well as accounting for the impacts of common macroeconomic shocks. The results of this paper support those of Kelmanson et al. (2019) and Asllani et al. (2025) who have shown that there remains a large amount of distortive informal market activity occurring in phases of growth in emerging European countries. The positive relationship observed in our dynamic GDP estimation, between the previous-sized informal economy and GDP growth, may indicate that informal economic activity serves as a buffer for firms and individuals during periods of economic decline, and this is consistent with evidence presented in Pasipanodya (2020) who provides evidence of instructive lessons learned during crisis periods.

Other extensions involving the incorporation of governance indicators reveal that indicators of the rule of law and government effectiveness, both have a significant impact on regional economic performance, whereas the impact of political stability is less robust when measured by intra-country regional differences. These results are consistent with other recent empirical evidence reported by Raczkowska et al. (2023) who provide strong evidence of a positive correlation between good governance and improvement in economic performance in nations of the EU, and further support the theory that institutionalized governments can help to translate the economic growth that takes place in regions into improved labour market conditions.

The analysis relative to the robustness of all of the above statistics confirm that the main results of this report are not biased by unusual events such as the Covid-19 pandemic or by cross-sectional dependence across regions of the CEE. Together these findings represent strong empirical evidence to support subsequent discussions of economic growth mechanisms and associated economic policy implications.

5. Discussions

This regional-level study presents strong evidence about the relationship between unemployment, informality, and economic performance in Central and Eastern Europe, and reassesses Okun's Law within a context of significant structural change and institutional differences. Using two-way fixed effects with Driscoll-Kraay standard errors, we find a consistent and stable inverse relationship between regional unemployment levels and real GDP per capita across NUTS-2 regions, despite controlling for unobserved regional characteristics, common macroeconomic shocks, and cross-section dependence.

The relative size and statistical significance of the unemployment coefficient are similar to those reported in prior cross-country and regional studies (i.e. Okun, 1962; Ball et al, 2019; Bođa et al, 2019), thus this study builds upon previous research by showing that Okun-type dynamics are substantively influenced at the sub-national level in Central and Eastern Europe. Also, the findings demonstrate that regional labour market slack generates substantial economic loss at the regional level, thereby emphasizing the need for a labour-centered growth strategy in economies experiencing significant regional inequalities.

A negative contemporaneous association exists between the size of the informal economy and regional economic performance in addition to unemployment, indicating that informality may constrain productivity in the formal economy through reduced tax revenues, weaker enforcement of labour standards, and misallocation of resources (Schneider and Enste, 2002; Williams and Schneider, 2016). Within the literature, while some have cited the potential buffering role of informal activity during the periods of economic decline, the results from this study indicate that informality is much more closely related to lower levels of formal economic output at the regional level (La Porta and Shleifer, 2014), thereby highlighting the importance of differentiating between short-term coping mechanisms and longer-term developmental outcomes related to the informal economy.

The incorporation of governance indicators allows for a more clearly articulated rationale regarding the findings. Specifically, regional economic performance, in part indicated by the rule of law and government effectiveness, is positively and significantly correlated with improvements in institutional quality, which supports the institutional theories of growth where effective legal frameworks and capable public administrations facilitate investment, productivity, and functioning of labour markets (Acemoglu etal., 2005; Rodríguez-Pose, 2013). Conversely, political stability has a lower and less stable correlation with regional GDP per capita, which may suggest that there is not sufficient geographic variance (i.e., between regions within countries) in political stability and/or that common political shocks are effectively absorbed by time-fixed effects. This does not imply that political stability has no relevance economically, rather that the primary economic significance of political stability is through inter-country influence over regions as opposed to intra-country influence over regions.

The comprehensive analysis of the impact of the COVID-19 pandemic on the results further enhances the conclusions reached. The fixed year effects captured in the baseline specification capture any shock event which is common to all regions: i.e. COVID-19. However, the alternative estimates with the explicit inclusion of a COVID-19 dummy do show, indeed, a statistically significant negative relationship between the impact of the pandemic and the economic performance of the regions (König and Winkler, 2021). Moreover, the inclusion of pandemic related control variables in the regressions does not alter the estimates of the unemployment and informality variables which suggests that the core relationships revealed in this analysis are related to structural issues and not specific to the crisis.

Overall, the findings demonstrate the linkages between labour market conditions, informal employment, and the quality of institutions in determining regional economic performance in Central and Eastern Europe. The persistence of Okun-type relationships at the regional level suggests that macroeconomic growth alone is not enough to help close the regional labour market gap; rather, they will require targeted employment policies. The negative relationship between informality and the economic performance of a region indicates the need for policies that promote formalisation of employment while strengthening the capacity of institutions.

From a policy perspective, these findings imply that efforts to reduce informality and unemployment should be pursued concurrently with improvements to governance and regulatory effectiveness. Labour market activation policies, increased enforcement of formal employment contracts, and reforms to enhance the performance of public institutions may provide additional support for regional economic development. Given the large variations in the quality of institutions across Central and Eastern European regions, policy strategies must be tailored to local conditions rather than relying on identical national policies.

6. Limitations and future research directions

There are multiple limitations within this analysis that present possibilities for future investigations. To start, the investigation only relies on aggregated NUTS-2 regional datasets which could mask intra-regional heterogeneity concerning both labour market adjustments and informal labour. Additional investigations can use micro level, or firm-level, datasets to get more detailed dynamics concerning these issues. The second limitation is that estimation methodology for the informal economy uses a monetary demand methodology, which is widely utilised, yet relies upon data availability and assumptions regarding the utilisation of cash. Specifically, there is no consistent, post-2021 monetary data can be utilised to extend shadow-informal economy estimations after 2021. As new data becomes available, alternative methodologies for estimating these would be worthwhile to follow up on. The third limitation is that the only governance indicators available are national level only, and thus a weight-based methodology has been used to regionalise them for use; while this is consistent with previous studies, this is still an area that would benefit from collecting and analysing sub-national governance datasets. Finally, additional investigation can explore long-term or shaped dynamic relationships (using both cointegration and cumulative correlated effects approaches) given an adequate amount of observed data points (time-period matching).

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