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Abstract

Purpose — This study examines whether Okun's Law varies across business-cycle phases and whether labor-market rigidity shapes the unemployment-output relationship across countries.

Design/methodology/approach — The analysis covers 52 countries over 1980-2020 and distinguishes between expansionary and recessionary periods. It applies country-level autoregressive distributed lag models and Pooled Mean Group panel ARDL estimators to estimate short-run and long-run Okun coefficients. Labor-market rigidity is incorporated through the OECD Employment Protection Legislation index, while Granger causality and impulse-response analyses are used to examine dynamic interactions.

Findings — The results indicate long-run cointegration between output and unemployment in most countries, with more stable evidence in developed economies. Okun's coefficients are larger in magnitude during recessions, indicating stronger unemployment responses to output contractions. Short-run effects are relatively stronger in less rigid labor markets, whereas higher employment protection is associated with more stable long-run unemployment dynamics. Adjustment speeds differ across country groups, with slower responses observed in developed economies. The directional interaction between output and unemployment also varies across business-cycle phases, with unemployment feedback becoming more pronounced during recessions.

Research limitations/implications — The findings should be interpreted as associational rather than causal, since employment protection is related to broader institutional characteristics, including informality, bargaining structures, and enforcement quality.

Originality — This study contributes by integrating business-cycle asymmetry and labor-market rigidity within a unified cross-country framework for examining Okun's Law. By incorporating the OECD Employment Protection Legislation index into country-level and panel ARDL models, it provides new evidence on how institutional settings are associated with the unemployment-output relationship across different phases of the business cycle.

Keywords: Okun's Law, Unemployment, Output gap, Labor-market rigidity, Employment protection legislation, Business cycles, Recession.

JEL Code: E24, E32, C33, J08.

1. Introduction

Okun's Law, a foundational concept in macroeconomics, posits an inverse empirical relationship between unemployment and output growth. Since Arthur Okun's (1962) seminal work first documented this pattern for the United States, numerous studies have confirmed its relevance across countries and time (Ball et al., 2017; Lee et al., 2020). In the U.S. context, a one-percent increase in output above potential typically reduces unemployment by about 0.3–0.5 percentage points, underscoring its policy significance (Mankiw, 2019).

Despite its prominence, the stability and universality of Okun's Law remain contested. A growing body of evidence documents substantial variation in the strength of the unemployment–output relationship across countries, over time, and across business-cycle phases. While many studies verify its consistency in advanced economies (Ball et al., 2015; Ball et al., 2017; Bartolucci et al., 2018), others document cross-country and temporal variation (Gordon, 2010; Oh, 2018; Pizzo, 2019; Lee et al., 2020; Boda & Povazanova, 2021; Aginta et al., 2023). These discrepancies are often linked to structural and institutional differences that shape how economies respond to cyclical shocks (Meyer & Tasci, 2012; Chinn et al., 2014; Valadkhani & Smyth, 2015; Oh, 2018; Mutascu & Sokic, 2021; Donayre, 2022). In particular, labor-market regulations and employment protection may influence the responsiveness of unemployment to output fluctuations.

Yet, systematic cross-country evidence on how institutional rigidities interact with business-cycle dynamics remains limited. In particular, the role of labor-market institutions remains insufficiently explored in a systematic cross-country setting. Employment protection legislation (EPL), as a standardized measure of labor-market rigidity, offers a natural candidate for explaining cross-country differences in the responsiveness of unemployment to output fluctuations. Yet, existing studies often rely on indirect proxies or analyze institutional effects separately from business-cycle dynamics.

This study addresses this gap by jointly examining the cyclical and institutional determinants of Okun's Law. Using a cross-country framework covering 52 economies over an extended period, it evaluates how the strength and symmetry of the unemployment–output relationship vary across expansionary and recessionary phases, and how these dynamics are conditioned by labor-market rigidity. By integrating EPL into both country-level and panel models, the analysis provides a unified perspective that links macroeconomic fluctuations with institutional structures.

The remainder of the paper is structured as follows. Section 2 reviews the related literature and identifies the research gap; Section 3 outlines the research objectives and hypotheses; Section 4 describes the data and methodology; Section 5 presents the empirical results; and Section 6 concludes the study.

2. Literature Review

Empirical research on the unemployment–output relationship has developed along several distinct strands, focusing on its stability, asymmetry, and cross-country variation.

One strand examines the time variation of the relationship (Chinn et al., 2014; Valadkhani & Smyth, 2015; Pizzo, 2019; Boda & Povazanova, 2021; Mussida & Zanin, 2023; Porras-Arena & Martin-Roman, 2023a; Sharma & Rai, 2025). These inconsistencies are generally attributed to structural heterogeneity, differences in labor-market flexibility, and variations in countries' responsiveness to business cycle fluctuations (Butkus et al., 2023). Gordon (2010) attributes the emergence of "jobless recoveries" to changes in productivity, labor intensity, and working hours, which weaken the traditional linkage. Meyer and Tasci (2012) further show that fluctuations in labor-force participation contribute to instability, particularly during recessions. Although the magnitude of the Okun coefficient varies over time, its negative sign remains a robust empirical regularity. Economou and Psarianos (2016) show that stronger labor protections can attenuate unemployment responsiveness, while Boda and Povazanova (2021) highlight the role of demographic differences.

A second strand emphasizes cyclical asymmetry. Empirical evidence consistently shows that unemployment responds more strongly to output contractions than to expansions (Oh, 2018; Mutascu & Sokic, 2021). Bartolucci et al. (2011) and Grant (2018) provide early evidence of asymmetric adjustment, while Boda and Povazanova (2021) confirm that downturns generate disproportionately larger employment effects. Mussida and Zanin (2023) show that this asymmetry intensified during the Great Recession but weakened during the COVID-19 period, reflecting the role of policy interventions such as job-retention schemes. Donayre (2022) further shows that Okun's Law intensifies in deep contractions but weakens during mild recessions and expansions, reinforcing the cyclical asymmetric hypothesis.

A third strand focuses on cross-country heterogeneity in Okun coefficients, often linking it to institutional and structural differences. Ball et al. (2017) report coefficients ranging from –0.45 in the United States to –0.85 in Spain, and as low as –0.15 in Japan. In East Asia, Kim et al. (2014) find that output dynamics dominate in Korea, whereas labor-market factors are more important in Japan, Hong Kong, and Singapore. These variations are frequently attributed to differences in labor-market institutions, employment protection, and adjustment mechanisms in labor demand and participation. Recent cross-country evidence indicates that the strength of the relationship varies systematically with income levels and economic regimes, with weaker or insignificant responses in lower-income economies often associated with informality and structural rigidities (Sovbetov, 2025).

Despite these advances, an important dimension remains insufficiently integrated into empirical models. In many emerging and developing economies, a substantial share of employment occurs in the informal sector, which operates largely outside formal labor regulations. As a result, standard indicators such as unemployment rates and employment protection legislation may only partially capture labor-market dynamics. This helps explain why Okun-type relationships are often weaker or statistically insignificant in such contexts, as employment adjustments may occur outside formal measurement frameworks. Moreover, structural transformations associated with digitalization and Industry 4.0 have altered labor-market conditions by weakening collective bargaining power and increasing flexibility in employment arrangements. These developments indicate that the unemployment–output relationship reflects both institutional and structural factors. This limitation has motivated recent efforts to construct multidimensional labor-market indicators that integrate employment, protection, and wage dynamics to better capture overall labor-market performance (Álvarez-Fernández et al., 2025).

The role of formal labor-market institutions has received comparatively less systematic attention in cross-country empirical frameworks. Existing studies often rely on indirect proxies such as union density or composite flexibility indices (Economou & Psarianos, 2016; Nebot et al., 2019; Butkus et al., 2023), and their findings remain fragmented. More direct and internationally comparable measures, such as the OECD Employment Protection Legislation index, have been less frequently incorporated into empirical models.

Existing evidence nonetheless provides partial insights into the role of institutions. Economou and Psarianos (2016) show that countries with lower labor-market policy spending exhibit stronger and more persistent unemployment responses to output shocks, whereas higher spending dampens short-run effects, indicating that greater flexibility amplifies cyclical sensitivity. Complementing this view, Nebot et al. (2019) identify institutional rigidity, labor hoarding, and risk aversion as key mechanisms underlying asymmetric responses, although these channels have rarely been jointly incorporated into dynamic empirical frameworks.

Methodological approaches also contribute to differences in empirical findings. Boda and Povazanova (2023) and Porras-Arena and Martin-Roman (2023b) show that differences in specification, data transformation, and lag selection can significantly affect results. Chinn et al. (2014) caution that first-differencing, though commonly employed, may eliminate long-run information, while Meyer and Tasci (2012) note that omitting cointegration can bias short-run estimates. These methodological caveats underscore the advantages of using models such as the autoregressive distributed lag (ARDL) framework, which captures both short- and long-run relationships and accommodates country-specific heterogeneity (Obst, 2022).

Overall, the literature reveals three persistent gaps. First, cyclical asymmetry and institutional rigidity are typically analyzed separately rather than within a unified framework. Second, the institutional dimension, particularly the role of employment protection, remains underexplored in cross-country settings. Third, methodological inconsistencies limit comparability across studies. Addressing these gaps, the present study integrates employment protection legislation into both country-level and panel models to jointly examine the cyclical and institutional determinants of the unemployment–output relationship.

3. Research Objectives & Hypotheses

This study reassesses the validity and dynamics of Okun's Law across 52 economies over the period 1980–2020, with a particular focus on the moderating role of labor-market rigidities. The empirical analysis employs an autoregressive distributed lag (ARDL) framework, which enables the simultaneous estimation of short-run dynamics and long-run equilibrium relationships across countries and business-cycle phases.

Research objectives are threefold:

(i) to estimate both short- and long-run Okun coefficients across countries using ARDL specifications;

(ii) to examine whether the relationship between unemployment and output is asymmetric across expansions and recessions; and

(iii) to test how the strictness of employment protection legislation (EPL) conditions this relationship over time and across economies.

Based on the reviewed literature and the research objectives, the following testable hypotheses are formulated:

- **H1:** Output and unemployment are cointegrated in both the short and long run, consistent with Okun's Law.
- **H2:** The magnitude of Okun's coefficient varies across business-cycle phases, being stronger during recessions.
- **H3:** Stricter employment protection (higher EPL) dampens the unemployment response to output shocks, particularly in the long run.

4. Data & Methodology

4.1. Data and Sample Construction

Unemployment and real GDP data are obtained from the *World Bank World Development Indicators* database[1]. Labor-market rigidity is measured using the *OECD Employment Protection*

[1] https://databank.worldbank.org/source/world-development-indicators

Legislation (EPL) index[2], which provides standardized indicators of labor protection for both OECD and selected partner (non-member) economies. The study uses unbalanced panel data where the macroeconomic variables extend back to 1980, whereas the EPL data begins from 1985 onwards. The final sample includes 52 countries, reflecting the maximum cross-country coverage permitted by consistent data availability for all three variables.

For each country, the EPL indicator averages three dimensions: (i) protection of regular workers against individual dismissals; (ii) regulation of temporary employment forms, including fixed-term contracts and temporary agency work; and (iii) additional requirements for collective dismissals. Each component is scored on a scale from 0 to 6, where higher scores signify stricter protection for regular workers and more stringent limitations on temporary employment arrangements. Policies aimed at enhancing labor market flexibility, such as facilitating the dismissal of regular employees or easing the hiring of temporary workers, result in lower EPL scores, whereas policies that strengthen employment protections increase the respective indices. While widely used, the EPL index captures primarily formal regulatory aspects of labor-market rigidity and does not fully reflect other institutional dimensions such as bargaining structures, informal employment, or differences in enforcement across countries.

Table 1. Data Sources

Variables	**Coverage**	**Source**
Unemployment Rate	1980-2020	World Bank Database
Real GDP	1980-2020	World Bank Database
EPL Index	1985-2020	OECD Database

4.2. Empirical Strategy

The empirical literature on Okun's Law predominantly employs either first differencing or deviation gap methodologies, which subtract actual GDP from its potential. While these methods are effective in capturing short-term relationships, they neglect potential long-term

[2] https://www.oecd.org/en/data/datasets/oecd-indicators-of-employment-protection.html

effects by removing low-frequency information (Chinn et al., 2014). Such omissions may lead to inaccurate conclusions if long-term relationships significantly influence short-term variations in employment or output. To address this limitation, we adopt the ARDL framework, which is particularly suited for exploring potential cointegration between variables. This methodology is applicable to variables that are integrated of order zero *I(0)* or one *I(1)*, but not of higher orders. The results of the Augmented Dickey-Fuller (ADF)[3] unit root tests for *U*, *Y*, ΔU_t, and ΔY_t, confirm that all series are either *I(0)* or *I(1)*, validating the use of both the ARDL and error correction models. The empirical framework identifies statistical associations rather than causal effects, since employment protection legislation forms part of a broader institutional environment that includes labor-market policies, bargaining systems, enforcement quality, and informality.

Following Pesaran et al. (2001), we specify the ARDL model for Okun's Law as follows:

$$\Delta U_t = c + \tau + \sum_{i=1}^{k} \alpha_i \Delta U_{t-i} + \sum_{j=0}^{l} \left(\beta_j \Delta Y_{t-j} + \theta_j \Delta Y_{t-j} DUMMY_{t-j}\right) + \sum_{n=0}^{m} \rho_n \Delta EPL_{t-n} + \phi_1 U_{t-1} + \phi_2 Y_{t-1} + \phi_3 Y_{t-1} DUMMY_{t-1} + \phi_4 EPL_{t-1} + \varepsilon_t \qquad (1)$$

where *U* and *Y* are unemployment rate and natural logarithm of real output, respectively. The ε_t denotes a White noise stationary error term, while DUMMY takes the value of 1 during recession periods and 0 otherwise. The parameter β_j represents the short-run Okun's coefficient during expansion periods, whereas $\beta_j + \theta_j$ captures the short-run Okun's coefficient during recession periods. These coefficients are expected to be negative, consistent with the theoretical underpinnings of the law.

Setting short-run dynamics to zero ($\Delta U_t = \Delta Y_t = 0$), long-run Okun's coefficient during expansion and recession periods is derived as $-\phi_2/\phi_1$, and $-(\phi_2 + \phi_3)/\phi_1$, respectively. The standard errors of short- and long-run Okun's coefficient are computed manually using the Delta method (Dorfman, 1938) as:

[3] Stationarity of the data used in this study is examined under ADF unit root test with equation of $\Delta Y_t = \theta_0 + \theta_1 T + \rho Y_{t-1} + \varepsilon_t$. The results of ADF unit root test are reported in the appendix page.

$$SE\left(-\frac{\phi_2}{\phi_1}\right) = \sqrt{\left(\frac{-\phi_2}{\phi_1{}^2}\right)^2 Var(\phi_1) + \left(\frac{-1}{\phi_1}\right)^2 Var(\phi_2)} \quad (2)$$

$$SE\left(-\frac{\phi_2 + \phi_3}{\phi_1}\right) = \sqrt{\left(\frac{\phi_2 + \phi_3}{\phi_1{}^2}\right)^2 Var(\phi_1) + \left(\frac{-1}{\phi_1}\right)^2 [Var(\phi_2) + Var(\phi_3)]} \quad (3)$$

Using bound test (Wald Test), we examine the long-run interactions between *U* and *Y* under the null hypothesis $H_0{:}\phi_1 = \phi_2 = 0$. The resulting F-statistics is compared against critical bounds values provided by Pesaran et al. (2001, pp.300-301), considering model specifications. A long-run interaction between the series is confirmed only if the F-statistics exceed the critical bounds, thereby justifying the application of further RECM analysis.

The corresponding restricted error correction model (RECM) is expressed as:

$$\Delta U_t = c + \sum_{i=1}^{k} \alpha_i \Delta U_{t-i} + \sum_{j=0}^{l} \left(\beta_j \Delta Y_{t-j} + \theta_j \Delta Y_{t-j} DUMMY_{t-j}\right) + \sum_{n=0}^{m} \rho_n \Delta EPL_{t-n} + \lambda ECT_{t-1} + \varepsilon_t \quad (4)$$

where ECT_{t-1} represents the residual derived from the long-run Okun's model: $U_{t-1} = \delta_0 + \delta_1 Y_{t-1} + \delta_2 Y_{t-1} DUMMY_{t-1} + \delta_3 EPL_{t-1} + \varepsilon_t$. Thus, Okun’s coefficients during expansion and recession become $\delta_1 = -\phi_2/\phi_1$ and $\delta_2 = -(\phi_2 + \phi_3)/\phi_1$, respectively.

The *Δ* indicates first differences and *k*, *l*, and *m* are optimal lags of the dependent and independent variables are determined using the Schwarz Information Criterion (SIC) with maximum four lags. The coefficient of ECT_{t-1} (error correction term), *λ*, is anticipated to negatively signed in bounds of $-1 \leq \lambda \leq 0$, indicating convergence towards equilibrium. It shows the speed of self-adjustment of RECM model back to equilibrium (by correcting its previous period disequilibrium) following a shock that disturbs this equilibrium, and this last period's deviation from a long-run equilibrium influences the model’s short-run dynamics. A positive, on the other hand, would imply divergence from equilibrium, raising concerns about autocorrelation, whereas would indicate model instability, potentially due to structural breaks.

In case of *λ<-1*, then the model is not stable over time horizon, indicating potential structural breaks should be corrected.

To address heteroskedasticity and serial correlation, we employ HAC-robust least squares estimators without including any whitening options. Further, we assess stability of ARDL and RECM models using the CUSUM of squares test, which examines changes in cumulative sum of recursive residuals over time.

To ensure robustness, we panelize the ARDL results by incorporating labor market rigidities using the Pooled Mean Group (PMG) technique. We investigate short-run dynamics through impulse-response functions derived from the Granger-causality test. This approach simulates the impact of a one standard deviation *"shock"* over time, allowing us to capture dynamic interactions and causal pathways between unemployment and output. Granger-causality analysis is employed to identify the direction and nature of causality using the following bivariate linear autoregressive models:

$$\Delta U_{c,t} DUMMY_t = \sum_{i=1}^{p} \alpha_{1c,i} \Delta U_{c,t-i} DUMMY_t + \sum_{j=1}^{p} \beta_{1c,j} \Delta Y_{c,t-j} DUMMY_t + \varepsilon_{1c,t} \tag{5}$$

$$\Delta U_{c,t}(1 - DUMMY_t) = \sum_{i=1}^{p} \alpha_{2c,i} \Delta U_{c,t-i}(1 - DUMMY_t) + \sum_{j=1}^{p} \beta_{2c,j} \Delta Y_{c,t-j}(1 - DUMMY_t) + \varepsilon_{2c,t} \tag{6}$$

Here, t represents time, c denotes cross-sections, p is the maximum lag determined by SIC, α and β are coefficients capturing lagged terms. The equations 5 and 6 capture causality impact on pure expansion and recession periods respectively. Wald (F) tests are conducted under the null hypotheses $H_{01}{:}\beta_1 = 0$ (or $H_{02}{:}\alpha_2 = 0$), given assumptions of covariance stationarity and linearity on $\Delta U_{c,t}$ and $\Delta Y_{c,t}$. The magnitude of the causality interaction is estimated by the logarithm of the corresponding F-statistic. In panel case, to accommodate heterogeneity across cross-sections, we adopt the Dumitrescu-Hurlin (2012) methodology. This approach employs standard Granger Causality regressions for each cross-section individually, performing Wald (F-test) test of p linear hypotheses $\beta_{11} = \dots = \beta_{1p} = 0$ (or $\alpha_{21} = \dots = \alpha_{2p} = 0$) to retrieve W_i, and take its average for N cross-sections deriving $\overline{W}$ which is termed as *"Wbar statistic"*.

$$\overline{W} = \frac{1}{N}\sum_{i=1}^{N} W_i \tag{7}$$

where *Wi* is standard adjusted Wald statistics for cross-section *c*. The standardization of this statistic, appropriately weighted in unbalanced panels, follows a standard normal distribution that is termed as *"Zbar statistic"*.

$$\overline{Z} = \sqrt{\frac{N}{2p}} * (\overline{W} - p) \tag{8}$$

This $\overline{Z}$ statistic is favored for panel datasets with large numbers of cross-sections (*N*) and time periods (*T*).

5. Results and Discussion

Following Chinn et al. (2014), we further examine Okun's Law under the ARDL framework to capture both short- and long-term effects of real output gap fluctuations on the unemployment gap. Table 2 reports the results for 52 countries, grouped by the S&P Global Index[4] into developed, emerging, and frontier markets (see Appendix). The bound test is applied to assess cointegration: $H_0{:}\phi_1 = \phi_2 = 0$ during expansions, and $H_0{:}\phi_1 = \phi_2 = \phi_3 = 0$ during recessions. F-statistics are compared with critical values at Pesaran et al. (2001, pp.300-301).

We find evidence of a long-run relationship between output and unemployment in the majority of countries, particularly among developed economies, thereby confirming H1. Countries such as Australia, Austria, and the United States exhibit strong and statistically significant relationships (p < 0.01), whereas several emerging and frontier markets, including Argentina, Brazil, India, Indonesia, South Africa, and Turkey, yield insignificant long-run results, suggesting

[4] www.spglobal.com/spdji/en/landing/topic/market-classification

that additional structural and institutional factors may be influencing the relationship. This is particularly relevant for economies with large informal sectors, where labor-market adjustments often occur outside formal employment channels and are therefore not fully captured by official unemployment statistics. In such contexts, the estimated Okun relationship may understate the true responsiveness of employment to output fluctuations. Furthermore, ongoing technological change and the weakening of collective bargaining structures may alter the transmission of output shocks to labor markets, contributing to the observed cross-country heterogeneity.

Table 2 reveals substantial variation in Okun's coefficients across countries. Long-run multipliers during expansions are computed as $-\phi_2/\phi_1$ (denoted as long-run Y^N), while recessionary multipliers are given by $-(\phi_2+\phi_3)/\phi_1$ (denoted as long-run Y^R). On average, the long-run Okun coefficient is −0.31 in developed markets and −0.29 in emerging/frontier markets, consistent with Gordon (2010), Economou and Psarianos (2016), and Lee et al. (2020). During recessions, these values rise in magnitude to −0.32 and −0.30, respectively. This asymmetry indicates unemployment responds more sharply to output declines, consistent with mechanisms such as hysteresis documented in prior literature. These findings provide support for H2.

Short-run Okun coefficients also vary across country groups. During expansions, the average coefficient is −0.08 in developed markets, −0.10 in emerging markets, and −0.14 in frontier markets, suggesting faster transmission of output shocks to unemployment in less rigid labor markets. Error correction terms (ECTs) confirm this pattern of adjustment. Developed markets exhibit slower correction speeds (5.56%) compared to emerging (8.22%) and frontier markets (19.25%), consistent with higher wage and contract rigidities in advanced economies. Notably, some countries such as Belgium and Chile converge rapidly, while others like Iceland adjust more gradually.

The variation in adjustment speed may reflect differences in macroeconomic conditions and labor market structures. In developed economies, rigid wage-setting mechanisms and employment protections may slow the recalibration of labor markets following output shocks.

Conversely, emerging and frontier markets typically have more flexible contracts and less institutional inertia, enabling quicker employment responses. These results suggest that labor market dynamics, particularly wage flexibility and contract fluidity, play a pivotal role in determining how swiftly economies return to equilibrium after a shock.

Labor market institutions further shape these dynamics. We incorporate EPL into the ARDL framework to evaluate its effect. Across countries, stricter EPL is associated with smaller unemployment responses to output shocks, particularly over the long term. This aligns with Economou and Psarianos (2016), who found that higher labor market regulation dampens cyclical unemployment volatility and thus supports H3.

Long-run EPL coefficients are significantly negative in most countries, indicating that countries with stricter dismissal regulations experience more stable unemployment dynamics over time. For example, in Belgium, Germany, and Italy, the coefficient exceeds −0.03, consistent with stronger dampening effects. By contrast, countries with flexible labor markets like India or Indonesia display weaker, often insignificant coefficients. Short-run EPL effects are generally insignificant, though a few countries (e.g., Hungary, Portugal) show marginal significance, suggesting transitional employment frictions.

Overall, EPL appears to be associated with more stable unemployment dynamics over time. These relationships are best interpreted as institutional associations rather than isolated causal effects, since EPL operates within broader labor-market and regulatory environments. Countries with stronger EPL frameworks are associated with more stable unemployment trajectories in response to output shocks, albeit with slower adjustment speeds. This institutional dimension complements the cyclical patterns captured by Okun's Law and highlights the relevance of incorporating labor-market institutions into macroeconomic analyses of unemployment.

These findings are also consistent with broader structural transformations in labor markets. In particular, in economies with high levels of informal employment, labor-market adjustments may occur outside formal institutional frameworks, limiting the extent to which EPL and official unemployment measures capture the full dynamics of employment responses. In addition, the gradual erosion of collective bargaining power and the increasing role of technological change may influence how output shocks translate into labor-market outcomes. These factors are especially relevant in emerging and frontier economies and help explain the observed cross-country heterogeneity in Okun's coefficients.

Taken together, the results confirm the presence of Okun's Law across diverse economic settings, while indicating that its magnitude and stability vary systematically with both business-cycle phases and institutional environments. The evidence suggests that cyclical asymmetry and labor-market rigidity are closely associated with observed unemployment dynamics, rather than operating as independent factors, highlighting the relevance of integrating structural and institutional dimensions into empirical analyses of the unemployment–output relationship.

Table 2. Results for ARDL Model

COUNTRY	SHORT-RUN				LONG-RUN		
	ECT	Y^N	Y^R	EPL	Y^N	Y^R	EPL
PANEL A: Developed Markets							
Australia	-0.019*	-0.186***	-0.200***	-0.0004	-0.510**	-0.527**	-0.0267**
	(0.013)	(0.025)	(0.0289)	(0.0009)	(0.204)	(0.210)	(0.0040)
Austria	-0.051***	-0.030	-0.0267	-0.0005	-0.134***	-0.147***	-0.0254**
	(0.016)	(0.021)	(0.0215)	(0.0009)	(0.046)	(0.049)	(0.005)
Belgium	-0.085***	-0.171***	-0.180***	-0.0002	-0.506***	-0.519***	-0.0335**
	(0.025)	(0.034)	(0.019)	(0.0004)	(0.161)	(0.165)	(0.0071)
Canada	-0.043***	-0.124***	-0.131***	-0.0004	-0.421**	-0.440**	-0.0274**
	(0.016)	(0.032)	(0.024)	(0.0009)	(0.203)	(0.210)	(0.0067)
Denmark	-0.015*	-0.111***	-0.117***	-0.0005	-0.349**	-0.375**	-0.0320**
	(0.010)	(0.015)	(0.012)	(0.0009)	(0.169)	(0.182)	(0.0055)
Finland	-	-0.101***	-0.104***	-0.0004	-0.187	-0.240	-0.0250
		(0.017)	(0.017)	(0.0008)	(0.191)	(0.228)	(0.0046)
France	-0.009**	-0.119***	-0.123***	-0.0002	-0.200***	-0.244***	-0.0263**
	(0.004)	(0.033)	(0.038)	(0.0004)	(0.065)	(0.076)	(0.0051)
Germany	-0.019*	-0.071***	-0.077***	-0.0002	-0.172*	-0.201*	-0.0341**
	(0.011)	(0.0186)	(0.017)	(0.0003)	(0.098)	(0.114)	(0.0057)
Ireland	-0.031***	-0.056**	-0.090***	-0.0003	-0.288**	-0.329***	-0.0290**
	(0.008)	(0.022)	(0.019)	(0.0007)	(0.119)	(0.127)	(0.0053)
Israel	-0.108***	-0.078*	-0.079*	-0.0004	-0.284***	-0.285***	-0.0341**
	(0.032)	(0.046)	(0.044)	(0.0008)	(0.109)	(0.109)	(0.0059)
Italy	-0.032***	-0.012*	-0.009**	-0.0002	-0.232**	-0.236**	-0.0310**
	(0.011)	(0.006)	(0.004)	(0.0003)	(0.102)	(0.107)	(0.0064)
Japan	-0.023**	-0.019**	-0.020**	-0.0001	-0.089*	-0.093*	-0.0308**
	(0.011)	(0.009)	(0.008)	(0.0002)	(0.052)	(0.053)	(0.0070)
Luxembourg	-0.042***	-0.015**	-0.018*	-0.0004	-0.047*	-0.054*	-0.0328**
	(0.014)	(0.007)	(0.009)	(0.0008)	(0.027)	(0.029)	(0.0068)
Netherlands	-0.106***	-0.053***	-0.046***	-0.0003	-0.173***	-0.185***	-0.0310**
	(0.015)	(0.010)	(0.013)	(0.0005)	(0.029)	(0.032)	(0.0065)
New Zealand	-0.214*	-0.084*	-0.087**	-0.0003	-0.288***	-0.302***	-0.0324**
	(0.042)	(0.047)	(0.040)	(0.0007)	(0.097)	(0.099)	(0.0064)
Norway	-	-0.073**	-0.082**	-0.0002	-0.129	-0.137	-0.0228

		(0.035)	(0.041)	(0.0004)	(0.097)	(0.100)	(0.0042)
Portugal	-0.084***	-0.120***	-0.125***	-0.0005	-0.356**	-0.365**	-0.0337**
	(0.028)	(0.032)	(0.030)	(0.0010)	(0.160)	(0.168)	(0.0081)
South Korea	-0.063***	-0.0232**	-0.038***	-0.0004	-0.145***	-0.153***	-0.0264**
	(0.019)	(0.007)	(0.011)	(0.0009)	(0.049)	(0.051)	(0.0053)
Spain	-0.041***	-0.225***	-0.277***	-0.0004	-0.868***	-0.899***	-0.0344**
	(0.012)	(0.072)	(0.060)	(0.0009)	(0.277)	(0.283)	(0.0067)
Sweden	-	-0.100***	-0.107***	-0.0002	-0.441	-0.480	-0.0228
		(0.024)	(0.022)	(0.0003)	(0.340)	(0.355)	(0.0037)
Switzerland	-0.055***	-0.068***	-0.075**	-0.0001	-0.307***	-0.338***	-0.0298**
	(0.022)	(0.022)	(0.029)	(0.0003)	(0.078)	(0.087)	(0.0057)
United Kingdom	-0.028***	-0.074***	-0.071***	-0.0002	-0.335***	-0.342***	-0.0317**
	(0.006)	(0.021)	(0.021)	(0.0003)	(0.092)	(0.092)	(0.0055)
United States	-0.043***	-0.092***	-0.092***	-0.0005	-0.441***	-0.450***	-0.0298**
	(0.009)	(0.010)	(0.013)	(0.0010)	(0.116)	(0.118)	(0.0060)
PANEL B: Emerging Markets							
Brazil	-	-0.184***	-0.185***	-0.0004	-0.631	-0.649*	-0.0280**
		(0.039)	(0.036)	(0.0008)	(0.398)	(0.403)	(0.0064)
Chile	-0.099***	-0.182***	-0.201***	-0.0004	-0.639**	-0.643**	-0.0267**
	(0.268)	(0.034)	(0.029)	(0.0009)	(0.269)	(0.269)	(0.0040)
China	-0.021***	-0.061**	-0.063***	-0.0007	-0.018***	-0.028***	-0.0284**
	(0.005)	(0.024)	(0.023)	(0.0011)	(0.006)	(0.009)	(0.0048)
Colombia	-0.306*	-0.078***	-0.106**	-0.0003	-0.163**	-0.321**	-0.0192**
	(0.072)	(0.030)	(0.051)	(0.0007)	(0.080)	(0.093)	(0.0035)
Costa Rica	-0.034***	-0.036***	-0.030**	-0.0005	-0.135**	-0.138*	-0.0247**
	(0.012)	(0.007)	(0.013)	(0.0012)	(0.068)	(0.070)	(0.0049)
Czechia	-	-0.115***	-0.124***	-0.0006	-0.166	-0.217	-0.0173
		(0.031)	(0.033)	(0.0014)	(0.179)	(0.221)	(0.0033)
Greece	-0.126***	-0.239***	-0.227***	-0.0005	-0.600***	-0.623***	-0.0205**
	(0.024)	(0.074)	(0.063)	(0.0011)	(0.146)	(0.149)	(0.0036)
India	-	-0.036*	-0.029*	-0.0004	-0.042	-0.052	-0.0110
		(0.021)	(0.015)	(0.0009)	(0.10)	(0.121)	(0.0027)
Indonesia	-	-0.028**	-0.057***	-0.0006	-0.016	-0.025	-0.0127
		(0.013)	(0.018)	(0.0014)	(0.021)	(0.030)	(0.0020)
Malaysia	-	-0.092**	-0.087**	-0.0004	-0.106	-0.112*	-0.0123
		(0.046)	(0.035)	(0.0009)	(0.068)	(0.069)	(0.0020)
Mexico	-0.066***	-0.098**	-0.099**	-0.0005	-0.235*	-0.244*	-0.0262**
	(0.023)	(0.047)	(0.045)	(0.0009)	(0.132)	(0.134)	(0.0057)
Peru	-0.145***	-0.041	-0.038	-0.0007	-0.176*	-0.180*	-0.0237**
	(0.044)	(0.033)	(0.026)	(0.0015)	(0.092)	(0.093)	(0.0048)
Poland	-0.029***	-0.011	-0.018	-0.0004	-0.450*	-0.471*	-0.0269**
	(0.008)	(0.014)	(0.013)	(0.0009)	(0.257)	(0.261)	(0.0062)
Russia	-0.157***	-0.089**	-0.087***	-0.0006	-0.187**	-0.190**	-0.0267**
	(0.035)	(0.041)	(0.029)	(0.0014)	(0.076)	(0.077)	(0.0047)
Saudi Arabia	-	-0.042	-0.043	-0.0004	-0.047	-0.049	-0.0180**
		(0.033)	(0.035)	(0.0009)	(0.054)	(0.055)	(0.0039)
South Africa	-	-0.039	-0.0334	-0.0007	-0.334	-0.343	-0.0297**
		(0.058)	(0.042)	(0.0013)	(0.262)	(0.264)	(0.0047)
Thailand	-0.099***	-0.116**	-0.112**	-0.0006	-0.163**	-0.166**	-0.0232**
	(0.026)	(0.058)	(0.044)	(0.0010)	(0.070)	(0.071)	(0.0051)
Turkey	-	-0.052***	-0.068***	-0.0002	-0.164	-0.246	-0.0347**
		(0.015)	(0.015)	(0.0004)	(0.144)	(0.162)	(0.0065)
Uruguay	-	-0.122**	-0.117***	-0.0006	-0.199	-0.207	-0.0154**
		(0.054)	(0.040)	(0.0010)	(0.169)	(0.171)	(0.0031)
PANEL C: Frontier Markets							
Argentina	-	-0.102***	-0.073***	-0.0004	-0.111	-0.119	-0.0111
		(0.025)	(0.013)	(0.0007)	(0.090)	(0.094)	(0.0024)
Croatia	-0.106***	-0.175***	-0.189***	-0.0004	-0.367**	-0.465***	-0.0191**

	(0.029)	(0.058)	(0.052)	(0.0010)	(0.154)	(0.178)	(0.0042)
Estonia	-0.076***	-0.039	-0.040	-0.0006	-0.398*	-0.405*	-0.0178**
	(0.031)	(0.041)	(0.039)	(0.0010)	(0.207)	(0.209)	(0.0028)
Hungary	-0.044***	-0.066**	-0.057**	-0.0006	-0.331**	-0.333**	-0.0264**
	(0.014)	(0.028)	(0.022)	(0.0011)	(0.152)	(0.153)	(0.0041)
Iceland	-0.157*	-0.051**	-0.058**	-0.0008	-0.234***	-0.243***	-0.0188**
	(0.045)	(0.024)	(0.023)	(0.0017)	(0.082)	(0.083)	(0.0034)
Latvia	-0.116***	-0.132**	-0.113*	-0.0003	-0.325**	-0.326**	-0.0120
	(0.031)	(0.065)	(0.062)	(0.0006)	(0.142)	(0.143)	(0.0022)
Lithuania	-0.069*	-0.189***	-0.219***	-0.0006	-0.218*	-0.241*	-0.0182**
	(0.041)	(0.063)	(0.061)	(0.0013)	(0.128)	(0.137)	(0.0044)
Paraguay	-	-0.047*	-0.036*	-0.0002	-0.026	-0.036	-0.0273**
		(0.029)	(0.019)	(0.0005)	(0.021)	(0.024)	(0.0058)
Slovakia	-0.055***	-0.195***	-0.197***	-0.0004	-0.526**	-0.537**	-0.0178**
	(0.022)	(0.045)	(0.043)	(0.0008)	(0.264)	(0.270)	(0.0031)
Slovenia	-0.334***	-0.112***	-0.111***	-0.0005	-0.193***	-0.194***	-0.0137
	(0.046)	(0.037)	(0.033)	(0.0009)	(0.049)	(0.050)	(0.0025)

Notes: Analysis period: 1985Q1-2020Q4. Critical F-statistic values for the ARDL bounds tests are taken from Pesaran et al. (2001, pp. 300–301) for four alternative model cases. *I0* and *I1* denote the lower and upper critical bounds, respectively. HAC-robust standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The error-correction term (ECT) is presented only when long-run cointegration is confirmed by the ARDL bounds test. Superscripts "N" and "R" refer to normal and recessionary periods, respectively. Country classifications follow the S&P Global Market Classification framework(www.spglobal.com/spdji/en/landing/topic/market-classification) as detailed in Appendix A1.

To reinforce these findings, we estimate a panel ARDL model using the Pooled Mean Group (PMG) approach. While the PMG panel estimates provide a useful summary of average long-run relationships across countries, they impose homogeneity restrictions that may mask underlying cross-country differences. For this reason, the country-specific ARDL results presented in Table 2 remain central to the analysis, as they reveal substantial heterogeneity in both the magnitude and significance of Okun's coefficients across economies.

Table 3 presents long- and short-run Okun coefficients in PMG framework. Column (1) shows a long-run coefficient of −0.2885 ($p < 0.01$), while column (2) disaggregates results by business cycle phase: −0.2921 in expansions and −0.3057 in recessions, both significant. These results support stronger unemployment responses during downturns, consistent with Bartolucci et al. (2011) and Grant (2018). The EPL variable confirms its structural relevance: higher EPL levels are associated with lower unemployment in the long run (coefficient = −0.0115), although short-run effects remain statistically insignificant. This finding indicates that higher labor market rigidities are associated with more stable and lower long-run unemployment levels.

Short-run Okun coefficients are also statistically significant: −0.1017 in column (1), −0.0949 (expansion), and −0.1063 (recession) in column (2). These results confirm slightly stronger unemployment responses during contractions. The error correction term (λ) indicates that 9.68% of disequilibrium is corrected each period at 1% significance level. In column (2), the speed of adjustment drops to 8.95%, suggesting a slightly slower adjustment process compared to the model in column (1). This supports the notion that the speed of adjustment to equilibrium is weaker during recessions than in periods of economic growth.

Table 3. Pooled Mean Group Panel ARDL Results

	(1)	**(2)**
	Long-Run	**Long-Run**
Y^N	-0.2885***	-0.2921***
	(0.0622)	*(0.0594)*
Y^R	-	-0.3057***
		(0.0613)
EPL	-0.0115**	-0.0147**
	(0.0058)	*(0.0072)*
	Short-Run	**Short-Run**
λ	-0.0968***	-0.0895***
	(0.0344)	*(0.0355)*
ΔU_{t-1}	0.3219***	0.3151***
	(0.0655)	*(0.0647)*
ΔY^N	-0.1017***	-0.0949***
	(0.0347)	*(0.0331)*
ΔY^R	-	-0.1063***
		(0.0385)
EPL	-0.0004	-0.0005
	(0.0013)	*(0.0017)*
Intercept	0.0327***	0.0309***
	(0.0111)	*(0.0106)*
Trend	0.00005***	0.00004***
	(0.0000)	*(0.0000)*
Log Likelihood	29927.16	30005.67
Models Evaluated	16	16
Selected Model	ARDL(2, 1)	ARDL(2, 1, 1)
Total Panel Obs.	7383	7383

Notes: Analysis period: 1985Q1-2020Q4. The values in the table represent estimates derived from ARDL models using the Pooled Mean Group (PMG) panel technique. Columns (1) and (2) present the long-run and short-run Okun's coefficients, both with and without distinguishing between expansion and recession periods. The model's lags are determined by the Schwarz Information Criterion (SIC), allowing for four dynamic regressor lags and four autoregressive lags, along with fixed regressors for intercept and linear trend. Among 16 models, the ARDL(2,1) and ARDL(2,1,1) models are chosen for columns (1) and (2), respectively, as they yield the lowest SIC values (see Figure 1). The λ coefficient represents the error correction term (ECT_{t-1}). The HAC-robust standard errors are presented in parentheses. **: p<0.1, **: p<0.05, ***: p<0.01*. The ECT is error-correction term. The superscripts "N" and "R" denote normal and recessionary periods respectively.

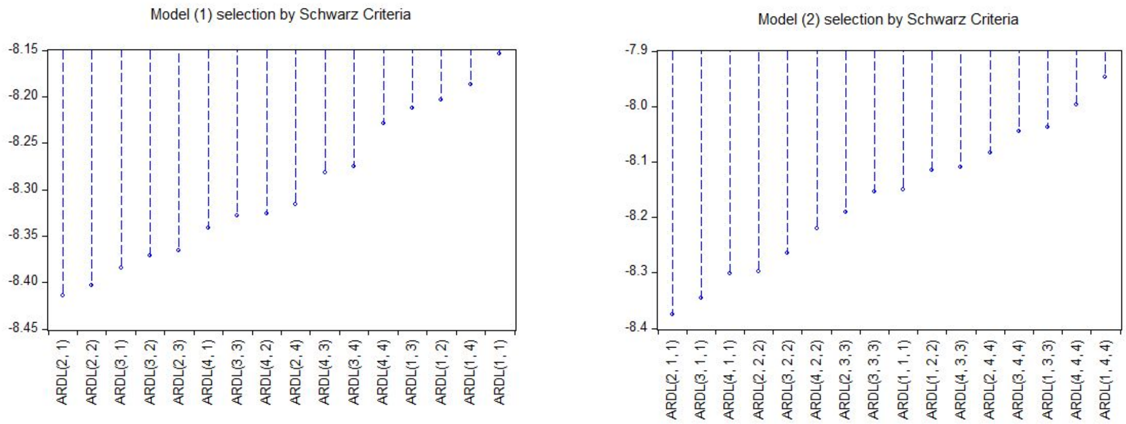

Figure 1. ARDL Model Selection by Schwarz Criteria

Impulse-response analysis (Figure 2) supports this dynamic adjustment. The analysis traces the effect of one-time Cholesky shocks of one standard deviation to the log of first differences in real output and unemployment over a 10-quarter horizon, with analytic standard errors and degrees of freedom appropriately adjusted. The solid blue lines depict the estimated responses, while the dotted red bands denote 95% confidence intervals.

The results reveal an immediate but short-lived negative response of real output to unemployment shock, dissipating by the seventh quarter. Conversely, a shock in output leads to a stronger and more persistent increase in unemployment, peaking around the fifth quarter and stabilizing by the ninth. This asymmetric pattern underscores the delayed and prolonged labor market response to output fluctuations, consistent with the notion of hysteresis and sticky labor adjustments (Obst, 2022).

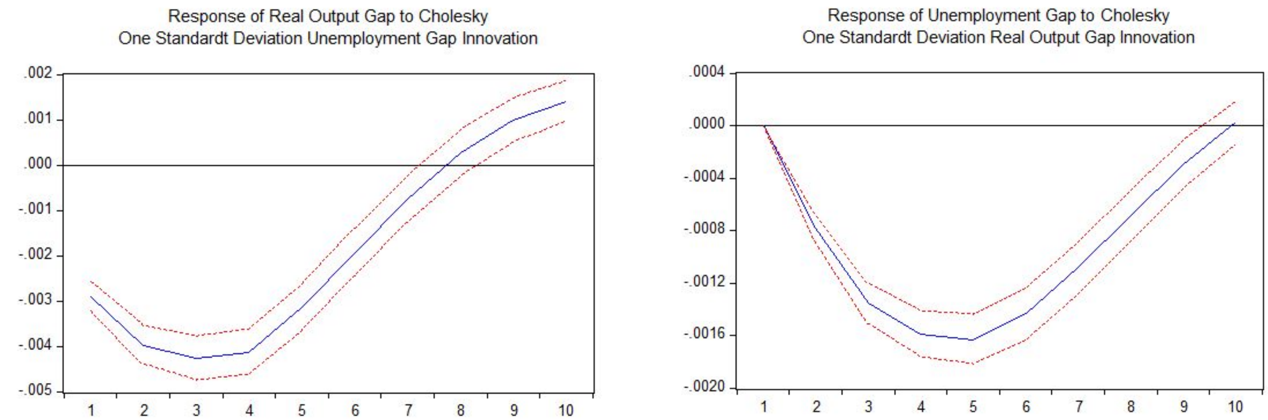

Figure 2. Okun's Law interaction under Panel Impulse-Response Test

Granger causality tests (Table 4) reveal bi-directional causality between the unemployment gap and output gap under both the standard Granger and Dumitrescu-Hurlin (DH) approaches. During expansions, output drives unemployment. However, during recessions, the reverse holds: unemployment shocks significantly influence output, highlighting unemployment as a key explanatory variable during downturns.

Table 4. Panel Pairwise Granger Causality Test of Okun's Law

Panel A: Standard Approach	***Obs.***	***F-Stats.***	***Magnitude***	***P-Value***
ΔY does not Granger cause ΔU	7766	96.2685	4.5671	0.0000
ΔU does not Granger cause ΔY	7766	35.0476	3.5567	0.0000
ΔY^N does not Granger cause ΔU^N	7766	10.9219	2.3907	0.0000
ΔU^N does not Granger cause ΔY^N	7766	2.4357	0.8902	0.0451
ΔY^R does not Granger cause ΔU^R	7766	13.3984	2.5951	0.0000
ΔU^R does not Granger cause ΔY^R	7766	22.7844	3.1261	0.0000
Panel B: Dumitrescu-Hurlin Approach	***W-Stats.***	***Zbar-Stats.***	***Magnitude***	***P-Value***
ΔY does not homogeneously cause ΔU	17.4864	33.5334	3.5125	0.0000
ΔU does not homogeneously cause ΔY	9.76571	14.2269	2.6551	0.0000
ΔY^N does not homogeneously cause ΔU^N	8.1496	10.1855	2.3209	0.0000
ΔU^N does not homogeneously cause ΔY^N	6.3873	5.7789	1.7542	0.0000
ΔY^R does not homogeneously cause ΔU^R	16.0115	29.8452	3.3960	0.0000
ΔU^R does not homogeneously cause ΔY^R	18.2959	35.5577	3.5712	0.0000

Notes: The analysis captures the periods of 1980Q1-2020Q4 allowing maximum of four lags. Panel A reports standard Granger causality approach results, whereas Panel B reports Dumitrescu-Hurlin approach causality. The subscript *"N"* and *"R"* denote expansion and recession periods respectively.

Taken together, the findings provide strong empirical support for Okun's Law across countries and business cycles, while highlighting the role of labor market rigidities in shaping the observed relationships. Institutional factors such as EPL are associated with long-term unemployment dynamics, especially in advanced economies. These findings underscore the importance of integrating structural and institutional dimensions into macroeconomic labor models.

6. Concluding Remarks

This study revisits the validity and dynamics of Okun's Law across 52 countries over 1980–2020, distinguishing between expansionary and recessionary phases while incorporating labor-market rigidity through the OECD's EPL index. The results confirm a robust inverse relationship between output and unemployment in most countries, with long-run cointegration evident in the majority of the sample. The findings further indicate that the strength of this relationship varies systematically across business-cycle phases, with more pronounced responses during recessions. In addition, labor-market rigidity, as proxied by EPL, is associated with more stable unemployment dynamics in the long run, although short-run effects remain limited.

The country-level results are broadly consistent with the panel evidence, indicating that the main findings remain robust across alternative empirical frameworks. Panel ARDL estimates confirm that both business-cycle conditions and labor-market rigidity are systematically associated with variations in the unemployment–output relationship across countries. Dynamic analyses provide additional insight into these patterns: the interaction between output and unemployment differs across business-cycle phases, with output changes typically preceding unemployment adjustments during expansions, while feedback from unemployment becomes more pronounced during recessions. These patterns underscore the importance of accounting for both macroeconomic conditions and institutional structures when evaluating labor-market adjustment.

Despite its broad coverage, this study has several limitations. First, data availability varies across countries, resulting in an unbalanced panel and limiting EPL observations prior to 1985. Second, although the EPL index is a widely used and standardized measure, it primarily captures formal employment protection and may not adequately reflect informal employment, collective bargaining power, or differences in enforcement across countries. Third, while the ARDL framework allows for the joint estimation of short- and long-run dynamics, alternative approaches could further assess the robustness of the findings. Future research could incorporate broader institutional measures, indicators of informality, or technological change to better capture evolving labor-market dynamics.

DECLARATIONS

Conflict of interest: The authors declare that they have no conflict of interest.

Data Availability: The data used in this study are publicly accessible from the following sources: unemployment and GDP growth rates are obtained from the *World Bank World Development Indicators* database (https://databank.worldbank.org/source/world-development-indicators), and the Employment Protection Legislation (EPL) index is available from the *OECD Indicators of Employment Protection* database (https://www.oecd.org/en/data/datasets/oecd-indicators-of-employment-protection.html).

REFERENCE

Aginta, H., Mendez, C., & Someya, M. (2023). Regional Okun's law and endogeneity: evidence from the Indonesian districts. Applied Economics Letters, 32(3), 329–336. https://doi.org/10.1080/13504851.2023.2267814

Álvarez-Fernández, G., Roch-Dupré, D., & Gómez-Bengoechea, G. (2025). Synthetic labor market index: Construction and application to the Spanish case. International Journal of Manpower, 46(8), 1563–1586. https://doi.org/10.1108/IJM-04-2024-0252

Ball, L., Daniel, L., & Loungani, P. (2017). Okun's Law: Fit at 50?. Journal of Money, Credit and Banking, 49(7), pp.1413-1441, https://doi.org/10.1111/jmcb.12420

Ball, L., Jalles, J.T. & Loungani, P. (2015). Do forecasters believe in Okun's law? An assessment of unemployment and output forecasts. International Journal of Forecasting, 31(1), pp. 176-184. https://doi.org/10.1016/j.ijforecast.2014.03.009

Bartolucci, F., Choudhry, M. T., Marelli, E., & Signorelli, M. (2018). GDP dynamics and unemployment changes in developed and developing countries. Applied Economics, 50(31), 3338–3356. https://doi.org/10.1080/00036846.2017.1420894

Boda, M. & Povazanova, M. (2021). Output-unemployment asymmetry in Okun coefficients for OECD countries. Economic Analysis and Policy, 69, 307-323. https://doi.org/10.1016/j.eap.2020.12.004

Boda, M. & Povazanova, M. (2023). How credible are Okun coefficients? The gap version of Okun's law for G7 economies. Economic Change and Restructuring, 56(3), 1467-1514. https://doi.org/10.1007/s10644-022-09438-9

Butkus, M., Dargenyte-Kacileviciene, L., Matuzeviciute, K. et al. (2023). The role of labor market regulations on the sensitivity of unemployment to economic growth. Eurasian Econ Rev 13, 373–427. https://doi.org/10.1007/s40822-023-00235-x

Chinn, M., Ferrara, L., & Mignon, V. (2014). Explaining US employment growth after the great recession: The role of output–employment non-linearities. Journal of Macroeconomics, 42, 118-129. https://doi.org/10.1016/j.jmacro.2014.07.003

Donayre, L. (2022). On the behavior of Okun's law across business cycles. Economic Modelling, 112. https://doi.org/10.1016/j.econmod.2022.105858

Dumitrescu, E.-I., & Hurlin, C. (2012). Testing for Granger non-causality in heterogeneous panels. Economic Modelling, 29(4), pp.1450–1460. https://doi.org/10.1016/j.econmod.2012.02.014

Economou, A., & Psarianos, I. N. (2016). Revisiting Okun’s law in European Union countries. Journal of Economic Studies, 43(2), 275–287. https://doi.org/10.1108/JES-05-2013-0063

Gordon, R.J. (2010). Okun's Law and Productivity Innovations. The American Economic Review, 100(2), 11-15. https://doi.org/10.1257/aer.100.2.11

Grant, A.L. (2018). The Great Recession and Okun's law. Economic Modelling, 69, pp. 291-300. https://doi.org/10.1016/j.econmod.2017.10.002

Kim, M.J., Park, S.Y., & Jei, S.Y. (2014). An empirical test for Okun’s law using a smooth time-varying parameter approach: evidence from East Asian countries. Applied Economics Letters, 22(10), 788–795. https://doi.org/10.1080/13504851.2014.978068

Lee, S., Schmidt-Klau, D., Weiss, J. & Chacaltana, J. (2020). Does economic growth deliver jobs? Revisiting Okun’s Law. ILO Working Papers No.17, International Labour Organization.

Mankiw, N.G. (2019). Macroeconomics (10th ed.), Worth Publishers, New York

Meyer, B., & Tasci, M. (2012). An Unstable Okun’s Law, Not the Best Rule of Thumb. Economic Commentary, Federal Reserve of Cleveland, No: 2012-08.

Mussida, C. & Zanin, L. (2023). Asymmetry and (in-)stability of Okun’s coefficients in nine European countries. The Journal of Economic Asymmetries, 28(C), https://doi.org/10.1016/j.jeca.2023.e00313

Mutascu, M. & Sokic, A. (2021). Okun's law in the US: New insights in time and frequency. Quarterly Review of Economics and Finance, 82, 207-222. https://doi.org/10.1016/j.qref.2021.09.008

Nebot, C., Beyaert, A., Garcia-Solanes, J. (2019). New insights into non-linearity of Okun’s law. Economic Modelling, 82(C), 202–210. https://doi.org/10.1016/j.econmod.2019.01.005

Obst, T. (2022). Dynamic version of Okun's law in the EU15 countries-The role of delays in the unemployment-output nexus. Scottish Journal of Political Economy, 69(2), 225-241. https://doi.org/10.1111/sjpe.12305

Oh. J.S. (2018). Changes in cyclical patterns of the USA labor market: from the perspective of nonlinear Okun's law. International Review of Applied Economics, 32(2), pp. 237-258. https://doi.org/10.1080/02692171.2017.1339023

Okun, A.M. (1962). Potential GNP, Its Measurement and Significance. Proceedings of the Business and Economics Statistics Section of American Statistical Association, pp.98-104.

Pesaran, M.H., Shin, Y., & Smith, R.J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. Journal of Applied Econometrics, 16(3), 289-326. https://doi.org/10.1002/jae.616

Pizzo, A. (2019). Literature review of empirical studies on Okun's law in Latin America and the Caribbean. ILO Working Papers No.252, International Labour Organization

Porras-Arena, M.S. & Martin-Roman, A.L. (2023a). The correlation between unemployment and economic growth in Latin America - Okun's law estimates by country. International Labour Review, 162(2), 171-198. https://doi.org/10.1111/ilr.12398

Porras-Arena, M.S. & Martin-Roman, A.L. (2023b). The heterogeneity of Okun's law: A metaregression analysis. Economic Modelling, 128. https://doi.org/10.1016/j.econmod.2023.106490

Sharma, A.K. & Rai, S.K. (2025). Efficacy of growth-led unemployment reduction hypothesis in India using Okun's law. International Journal of Manpower, 46(3), 391–409. https://doi.org/10.1108/IJM-02-2024-0091

Sovbetov, I. (2025). The dynamics of Okun's law: cross-country analysis across economic cycles (1980–2023). Empirica, 52, 687–720. https://doi.org/10.1007/s10663-025-09662-2

Valadkhani, A., & Smyth, R. (2015). Switching and asymmetric behaviour of the Okun coefficient in the US: Evidence for the 1948–2015 period. Economic Modelling, 50, 281-290. https://doi.org/10.1016/j.econmod.2015.07.001

APPENDIX

Table A1. Results of ADF Unit Root Test

<table>
<tr><th rowspan="2">COUNTRY</th><th rowspan="2">CODE</th><th rowspan="2">MARKET</th><th colspan="2">LEVEL</th><th colspan="2">1st DIFFERENCE</th><th colspan="2">1st DIFFERENCE</th></tr>
<tr><th>U</th><th>Y</th><th>ΔU</th><th>ΔY</th><th>U-U*</th><th>Y-Y*</th></tr>
<tr><td>Argentina</td><td>AG</td><td>Frontier</td><td>0.3364
(L:1|N:162)</td><td>0.9893
(L:0|N:162)</td><td>0.0000
(L:0|N:161)</td><td>0.0000
(L:0|N:161)</td><td>0.0009
(L:1|N:162)</td><td>0.0000
(L:3|N:159)</td></tr>
<tr><td>Australia</td><td>AU</td><td>Developed</td><td>0.1101
(L:2|N:160)</td><td>0.8890
(L:0|N:162)</td><td>0.0000
(L:0|N:159)</td><td>0.0000
(L:0|N:161)</td><td>0.0000
(L:2|N:160)</td><td>0.0043
(L:0|N:162)</td></tr>
<tr><td>Austria</td><td>OE</td><td>Developed</td><td>0.0493
(L:4|N:158)</td><td>0.4609
(L:1|N:161)</td><td>0.0000
(L:3|N:157)</td><td>0.0000
(L:0|N:160)</td><td>0.0035
(L:4|N:158)</td><td>0.0004
(L:1|N:161)</td></tr>
<tr><td>Belgium</td><td>BG</td><td>Developed</td><td>0.1585
(L:2|N:160)</td><td>0.8002
(L:1|N:161)</td><td>0.0000
(L:1|N:159)</td><td>0.0000
(L:0|N:160)</td><td>0.0055
(L:0|N:162)</td><td>0.0000
(L:2|N:160)</td></tr>
<tr><td>Brazil</td><td>BR</td><td>Emerging</td><td>0.3356
(L:1|N:161)</td><td>0.9435
(L:0|N:162)</td><td>0.0000
(L:0|N:160)</td><td>0.0000
(L:0|N:161)</td><td>0.0006
(L:1|N:161)</td><td>0.0003
(L:1|N:161)</td></tr>
<tr><td>Canada</td><td>CN</td><td>Developed</td><td>0.1495
(L:1|N:161)</td><td>0.8086
(L:1|N:161)</td><td>0.0000
(L:0|N:160)</td><td>0.0000
(L:0|N:160)</td><td>0.0001
(L:1|N:161)</td><td>0.0001
(L:1|N:161)</td></tr>
<tr><td>Chile</td><td>CL</td><td>Emerging</td><td>0.1689
(L:1|N:137)</td><td>0.8788
(L:0|N:162)</td><td>0.0000
(L:0|N:136)</td><td>0.0000
(L:0|N:161)</td><td>0.0003
(L:1|N:137)</td><td>0.0005
(L:0|N:162)</td></tr>
<tr><td>China</td><td>CH</td><td>Emerging</td><td>0.1441
(L:1|N:161)</td><td>0.8263
(L:2|N:160)</td><td>0.053
(L:0|N:160)</td><td>0.0000
(L:1|N:159)</td><td>0.0000
(L:1|N:161)</td><td>0.0012
(L:0|N:162)</td></tr>
<tr><td>Colombia</td><td>CO</td><td>Emerging</td><td>0.2745
(L:1|N:161)</td><td>0.9999
(L:0|N:162)</td><td>0.0000
(L:0|N:160)</td><td>0.0000
(L:0|N:161)</td><td>0.0000
(L:0|N:162)</td><td>0.0002
(L:0|N:162)</td></tr>
<tr><td>Costa Rica</td><td>CR</td><td>Emerging</td><td>0.8336
(L:1|N:117)</td><td>0.8717
(L:1|N:155)</td><td>0.0001
(L:0|N:117)</td><td>0.0885
(L:0|N:154)</td><td>0.0000
(L:0|N:118)</td><td>0.0000
(L:1|N:155)</td></tr>
<tr><td>Croatia</td><td>CR</td><td>Frontier</td><td>0.0092
(L:4|N:119)</td><td>0.8283
(L:4|N:159)</td><td>0.0026
(L:5|N:117)</td><td>0.0123
(L:3|N:158)</td><td>0.0000
(L:4|N:119)</td><td>0.0001
(L:4|N:159)</td></tr>
<tr><td>Czechia</td><td>CZ</td><td>Emerging</td><td>0.3010
(L:5|N:105)</td><td>0.7146
(L:1|N:109)</td><td>0.0005
(L:4|N:104)</td><td>0.0000
(L:0|N:108)</td><td>0.0093
(L:5|N:105)</td><td>0.0026
(L:2|N:109)</td></tr>
<tr><td>Denmark</td><td>DK</td><td>Developed</td><td>0.4226
(L:1|N:161)</td><td>0.5087
(L:0|N:162)</td><td>0.0002
(L:0|N:160)</td><td>0.0000
(L:0|N:161)</td><td>0.0005
(L:1|N:161)</td><td>0.0000
(L:0|N:162)</td></tr>
<tr><td>Estonia</td><td>EO</td><td>Frontier</td><td>0.0643
(L:2|N:124)</td><td>0.3139
(L:1|N:102)</td><td>0.0000
(L:0|N:123)</td><td>0.0462
(L:2|N:100)</td><td>0.0001
(L:3|N:123)</td><td>0.0005
(L:3|N:100)</td></tr>
<tr><td>Finland</td><td>FN</td><td>Developed</td><td>0.0513
(L:2|N:160)</td><td>0.5456
(L:3|N:159)</td><td>0.0107
(L:3|N:159)</td><td>0.0042
(L:2|N:158)</td><td>0.0000
(L:3|N:159)</td><td>0.0000
(L:3|N:159)</td></tr>
<tr><td>France</td><td>FR</td><td>Developed</td><td>0.0477
(L:1|N:161)</td><td>0.2763
(L:1|N:161)</td><td>0.0000
(L:0|N:160)</td><td>0.0000
(L:0|N:160)</td><td>0.0000
(L:3|N:159)</td><td>0.0000
(L:2|N:160)</td></tr>
<tr><td>Germany</td><td>BD</td><td>Developed</td><td>0.0796
(L:1|N:161)</td><td>0.7583
(L:0|N:162)</td><td>0.0000
(L:0|N:160)</td><td>0.0000
(L:0|N:161)</td><td>0.0003
(L:1|N:161)</td><td>0.0024
(L:0|N:162)</td></tr>
<tr><td>Greece</td><td>GR</td><td>Emerging</td><td>0.7338
(L:1|N:161)</td><td>0.7503
(L:0|N:162)</td><td>0.0001
(L:0|N:160)</td><td>0.0000
(L:2|N:159)</td><td>0.0043
(L:1|N:161)</td><td>0.0011
(L:1|N:161)</td></tr>
<tr><td>Hungary</td><td>HN</td><td>Frontier</td><td>0.5936
(L:1|N:117)</td><td>0.8706
(L:1|N:117)</td><td>0.0000
(L:0|N:116)</td><td>0.0000
(L:0|N:116)</td><td>0.0127
(L:1|N:117)</td><td>0.0036
(L:1|N:117)</td></tr>
<tr><td>Iceland</td><td>IC</td><td>Frontier</td><td>0.2531
(L:1|N:117)</td><td>0.3961
(L:1|N:93)</td><td>0.0000
(L:0|N:116)</td><td>0.0001
(L:0|N:92)</td><td>0.0102
(L:1|N:117)</td><td>0.0632
(L:1|N:93)</td></tr>
<tr><td>India</td><td>IN</td><td>Emerging</td><td>0.8675
(L:2|N:160)</td><td>0.9999
(L:0|N:162)</td><td>0.0000
(L:1|N:159)</td><td>0.0000
(L:0|N:161)</td><td>0.0167
(L:1|N:161)</td><td>0.0001
(L:0|N:162)</td></tr>
<tr><td>Indonesia</td><td>ID</td><td>Emerging</td><td>0.6576
(L:5|N:157)</td><td>0.6522
(L:0|N:162)</td><td>0.0000
(L:4|N:156)</td><td>0.0000
(L:0|N:161)</td><td>0.0000
(L:4|N:157)</td><td>0.0000
(L:2|N:160)</td></tr>
<tr><td>Ireland</td><td>IR</td><td>Developed</td><td>0.3161
(L:2|N:160)</td><td>0.8121
(L:2|N:160)</td><td>0.0028
(L:1|N:159)</td><td>0.0000
(L:1|N:159)</td><td>0.0005
(L:2|N:160)</td><td>0.0001
(L:3|N:159)</td></tr>
<tr><td>Israel</td><td>IS</td><td>Developed</td><td>0.3666
(L:1|N:111)</td><td>0.5174
(L:0|N:84)</td><td>0.0000
(L:0|N:110)</td><td>0.0000
(L:0|N:83)</td><td>0.0005
(L:1|N:111)</td><td>0.0053
(L:2|N:82)</td></tr>
<tr><td>Italy</td><td>IT</td><td>Developed</td><td>0.0779
(L:3|N:159)</td><td>0.1292
(L:1|N:161)</td><td>0.0071
(L:2|N:158)</td><td>0.0000
(L:0|N:160)</td><td>0.0000
(L:3|N:159)</td><td>0.0000
(L:3|N:159)</td></tr>
<tr><td>Japan</td><td>JP</td><td>Developed</td><td>0.5065
(L:1|N:161)</td><td>0.0004
(L:0|N:162)</td><td>0.0000
(L:0|N:160)</td><td>0.0000
(L:0|N:161)</td><td>0.0039
(L:1|N:161)</td><td>0.0003
(L:0|N:162)</td></tr>
<tr><td>Latvia</td><td>LV</td><td>Frontier</td><td>0.2353
(L:1|N:109)</td><td>0.3261
(L:2|N:100)</td><td>0.0000
(L:0|N:108)</td><td>0.0158
(L:1|N:99)</td><td>0.025
(L:1|N:109)</td><td>0.0018
(L:3|N:99)</td></tr>
<tr><td>Lithuania</td><td>LN</td><td>Frontier</td><td>0.0857
(L:3|N:103)</td><td>0.4136
(L:0|N:102)</td><td>0.0000
(L:0|N:102)</td><td>0.0000
(L:0|N:101)</td><td>0.0914
(L:0|N:106)</td><td>0.0016
(L:3|N:99)</td></tr>
<tr><td>Luxembourg</td><td>LX</td><td>Developed</td><td>0.8439
(L:1|N:149)</td><td>0.7230
(L:2|N:160)</td><td>0.0000
(L:0|N:148)</td><td>0.0000
(L:1|N:159)</td><td>0.0024
(L:1|N:149)</td><td>0.0000
(L:2|N:160)</td></tr>
<tr><td>Malaysia</td><td>MY</td><td>Emerging</td><td>0.4532</td><td>0.7470</td><td>0.0000</td><td>0.0000</td><td>0.0000</td><td>0.0000</td></tr>
</table>

			(L:0|N:142)	(L:1|N:161)	(L:0|N:141)	(L:0|N:160)	(L:0|N:142)	(L:1|N:161)
Mexico	MX	Emerging	0.1423 (L:1|N:161)	0.9271 (L:1|N:161)	0.0000 (L:0|N:160)	0.0000 (L:0|N:160)	0.0003 (L:1|N:161)	0.0000 (L:1|N:161)
Netherlands	NL	Developed	0.0825 (L:9|N:153)	0.6572 (L:0|N:162)	0.0002 (L:7|N:152)	0.0000 (L:1|N:160)	0.0000 (L:3|N:159)	0.0012 (L:0|N:162)
New Zealand	NZ	Developed	0.1913 (L:2|N:136)	0.9690 (L:0|N:133)	0.0012 (L:1|N:135)	0.0000 (L:0|N:132)	0.0024 (L:2|N:136)	0.0008 (L:0|N:134)
Norway	NW	Developed	0.1718 (L:2|N:160)	0.4662 (L:1|N:161)	0.0000 (L:1|N:159)	0.0000 (L:0|N:160)	0.0145 (L:0|N:162)	0.0005 (L:1|N:161)
Paraguay	PA	Frontier	0.1416 (L:2|N:128)	0.9216 (L:1|N:161)	0.0000 (L:0|N:127)	0.0000 (L:0|N:160)	0.0019 (L:2|N:128)	0.0041 (L:1|N:161)
Peru	PE	Emerging	0.2056 (L:1|N:118)	0.0991 (L:4|N:115)	0.0000 (L:0|N:117)	0.0017 (L:3|N:114)	0.0055 (L:1|N:118)	0.0033 (L:0|N:119)
Poland	PO	Emerging	0.0014 (L:2|N:124)	0.9835 (L:0|N:126)	0.0888 (L:1|N:123)	0.0000 (L:0|N:125)	0.0056 (L:2|N:124)	0.0000 (L:0|N:126)
Portugal	PT	Developed	0.5188 (L:2|N:148)	0.0141 (L:0|N:150)	0.0008 (L:1|N:147)	0.0006 (L:2|N:147)	0.0186 (L:2|N:148)	0.0024 (L:0|N:150)
Russia	RS	Emerging	0.2411 (L:1|N:121)	0.7223 (L:3|N:119)	0.0000 (L:0|N:120)	0.0088 (L:2|N:118)	0.0050 (L:1|N:121)	0.0005 (L:3|N:119)
Saudi Arabia	SU	Emerging	0.0132 (L:4|N:115)	0.9311 (L:5|N:151)	0.0010 (L:4|N:114)	0.0000 (L:4|N:150)	0.0000 (L:4|N:115)	0.0001 (L:5|N:151)
Slovakia	SX	Frontier	0.1612 (L:8|N:99)	0.5274 (L:0|N:111)	0.0081 (L:4|N:98)	0.0000 (L:0|N:110)	0.0160 (L:8|N:99)	0.0067 (L:0|N:111)
Slovenia	SJ	Frontier	0.8203 (L:0|N:98)	0.2778 (L:1|N:101)	0.0000 (L:0|N:97)	0.0000 (L:0|N:100)	0.0976 (L:0|N:98)	0.0226 (L:1|N:101)
South Africa	SA	Emerging	0.6414 (L:0|N:162)	0.9915 (L:1|N:161)	0.0000 (L:0|N:161)	0.0000 (L:0|N:160)	0.0007 (L:0|N:162)	0.0000 (L:2|N:160)
South Korea	KO	Developed	0.0129 (L:1|N:151)	0.0004 (L:0|N:162)	0.0000 (L:0|N:150)	0.0000 (L:0|N:161)	0.0001 (L:1|N:151)	0.0000 (L:3|N:159)
Spain	ES	Developed	0.0819 (L:5|N:157)	0.6315 (L:3|N:159)	0.0402 (L:4|N:156)	0.0538 (L:2|N:158)	0.0000 (L:4|N:157)	0.0002 (L:3|N:159)
Sweden	SD	Developed	0.2576 (L:1|N:161)	0.9587 (L:0|N:162)	0.0000 (L:0|N:160)	0.0000 (L:1|N:160)	0.0017 (L:1|N:161)	0.0000 (L:3|N:159)
Switzerland	SW	Developed	0.1389 (L:2|N:160)	0.9128 (L:1|N:161)	0.0007 (L:1|N:159)	0.0000 (L:0|N:160)	0.0000 (L:1|N:161)	0.0002 (L:1|N:161)
Thailand	TH	Emerging	0.0004 (L:1|N:161)	0.0595 (L:0|N:162)	0.0000 (L:1|N:160)	0.0000 (L:0|N:161)	0.0000 (L:1|N:161)	0.0017 (L:0|N:162)
Turkey	TK	Emerging	0.2426 (L:1|N:161)	0.8197 (L:0|N:162)	0.0000 (L:0|N:160)	0.0000 (L:3|N:161)	0.0002 (L:1|N:161)	0.0002 (L:0|N:162)
United Kingdom	UK	Developed	0.1189 (L:1|N:161)	0.5365 (L:1|N:161)	0.0312 (L:0|N:160)	0.0000 (L:0|N:160)	0.0000 (L:1|N:161)	0.0001 (L:2|N:160)
United States	US	Developed	0.0568 (L:1|N:161)	0.2841 (L:2|N:160)	0.0000 (L:0|N:160)	0.0000 (L:1|N:160)	0.0006 (L:1|N:161)	0.0003 (L:2|N:160)
Uruguay	UR	Emerging	0.2966 (L:1|N:121)	0.2894 (L:0|N:162)	0.0000 (L:0|N:120)	0.0000 (L:0|N:161)	0.0000 (L:1|N:120)	0.0000 (L:3|N:159)

Notes: The numbers in the table are rejection probabilities of the null hypothesis of ADF test including intercept. Probabilities below 0.10 denote rejection of the null hypothesis, thus, confirm stationarity of the U (unemployment), Y (real output), U-U* (unemployment gap), and Y-Y* (real output gap) series of related countries. The lag and observation parameters are presented in the parentheses where "L" and "N" denote lag length and observation number respectively. The lag length is determined by Schwarz Information Criterion (SIC) under maximum lag length specification of 13. Country classifications follow the S&P Global Market Classification framework (www.spglobal.com/spdji/en/landing/topic/market-classification).