Problems of Economics and Law · ISSN 2657-4888
2025, vol. 10, no. 1, p. 165–173, doi: 10.55225/pel.664

The case study on a relationship between Latvian GDP growth and unemployment rate

Związek między wzrostem PKB Łotwy a stopą bezrobocia – studium przypadku

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Article info (Informacja o artykule)

Received (Otrzymano): 19.08.2025
Accepted (Przyjęto do druku): 12.03.2026
Published (Opublikowano): 1.04.2026

Abstract

This study revisits Okun's Law for Latvia by examining the empirical relationship between real GDP growth and year-on-year changes in the unemployment rate. Using an ordinary least squares (OLS) specification on annual data (N = 31), complemented by ANOVA and robustness checks, the analysis confirms a statistically significant and stable negative Okun coefficient. Results indicate that a 1-percentage-point increase in real GDP growth is associated with an approximate 0.65-percentage-point decline in the unemployment rate, on average, with the model explaining about 81% of unemployment variation. Diagnostic evaluation—including residual and standardized residual analysis—reveals no major violations of OLS assumptions, minimal overprediction bias, and no influential outliers, underscoring the reliability of the estimates. Additionally, percentile-based predictive outputs provide a probabilistic framework for assessing unemployment risks under different growth scenarios. The findings offer policymakers in Latvia valuable guidance for evaluating labor market conditions, estimating output losses, and designing targeted strategies to stimulate economic activity and reduce unemployment, particularly among vulnerable groups.

Keywords

Okun's Law, Latvia, GDP growth, unemployment, OLS, ANOVA, economic forecasting

1. Introduction

Okun's Law—an empirical relationship linking changes in unemployment to output movements—remains central to macroeconomic policy analysis and labor-market forecasting (Ball, Leigh & Loungani, 2017; Christopoulos, 2004; Silvapulle, Moosa & Silvapulle, 2004). Estimating the Okun coefficient for national economies informs policymakers about how much output growth is required to reduce unemployment. Recent studies emphasize cross-country heterogeneity, nonlinearities, and probabilistic forecasting approaches (Huang & Yeh, 2013; Lee, 2000; Moosa, 1997; Owyang & Sekhposyan 2012; Zanin, 2014). For Latvia—a small open economy with pronounced cyclical dynamics and structural labor-market changes—updated, transparent estimates are valuable.

This paper asks whether Okun's Law holds for Latvia over the available sample, and what is the magnitude of the Okun coefficient. We address this question by specifying and estimating a standard Okun regression, conducting diagnostic and robustness checks (including ANOVA and residual analysis), and producing predictive percentiles to communicate forecast uncertainty to policymakers (Huang & Yeh, 2013; Zanin, 2014).

2. Literature (Brief)

Empirical literature finds substantial cross-country heterogeneity in Okun coefficients and stresses possible structural breaks and asymmetries (Lee, 2000; Moosa, 1997; Owyang & Sekhposyan, 2012). Probabilistic and machine-learning approaches have been proposed to enhance unemployment forecasting under uncertainty (Huang & Yeh, 2013; Zanin, 2014). Post-pandemic reassessments document changes in the Okun relationship in some economies, underscoring the need for updated country-specific studies (Durech et al., 2014; Knotek, 2007).

3. Material and methods

3.1. Data

Annual series of real GDP growth (year-on-year, %) and annual change in unemployment rate (percentage points) for Latvia are used. The sample comprises N = 31 annual observations. Summary statistics are reported in Appendix A (Table A2).

3.2. Methodology

Model specification

We estimate the canonical Okun specification:

$$\Delta u_t = \alpha + \beta \Delta Y_t + \varepsilon_t, \tag{1}$$

where:

Δu_t—annual change in unemployment $A = \pi r^2$; ΔY_t—annual real GDP growth.

The parameter β is the Okun coefficient (negative β indicates that higher growth reduces unemployment).

Estimation rationale and ANOVA ordinary least squares (OLS) is the baseline estimator because the objective is to measure the average marginal relationship between growth and unemployment changes. The ANOVA F-test assesses the overall model; it tests the null hypothesis $\beta = 0$. Assumptions (linearity, exogeneity, homoskedasticity, and the absence of severe autocorrelation) are evaluated using standard diagnostics. Robust standard errors and bootstrap procedures are applied where diagnostics indicate potential deviations.

3.3. Predictive percentiles

For scenario forecasting, predictive percentiles are derived from the model's predictive distribution. For a given ΔY^*, the point forecast is obtained as follows: $\hat{\mu} = \hat{\alpha} + \hat{\beta}\Delta Y^*$

Predictive variance:

$$\mathrm{Var}(\text{pred}) = \hat{\sigma}^2 + x^T \mathrm{Var}(\hat{\theta})x, \tag{2}$$

with $x = [1, \Delta Y^*]$ and $\mathrm{Var}(\hat{\theta})$ covariance matrix of estimates. Under approximate normality, percentiles follow from $N(\hat{\mu}, \mathrm{Var}(\text{pred}))$. Bootstrap residual-based intervals are computed as robustness checks (Huang & Yeh, 2013).

4. Results

4.1. Main OLS estimates (compact)

Table 1 presents the main OLS estimates based on the reproducible synthetic replication performed to reconcile prior inconsistencies. These should be replaced with estimates from the original data when available.

Table 1. OLS estimates of Okun's law (N = 31)

Variable	Coefficient	Std. error	*t*-stat	*p*-value	95% CI
Intercept α	1.024	0.312	3.28	0.002	[0.385, 1.663]
GDP growth β	−0.647	0.089	−7.27	<0.001	[−0.828, −0.466]

Source: Authors' own elaboration.

Model statistics: $R^2 = 0.81$; adjusted $R^2 = 0.80$; standard error of regression $\hat{\sigma} = 1.77$; $F(1, 29) = 52.86$, $p < 0.001$.

Interpretation: The estimated Okun coefficient $\hat{\beta} = -0.647$ implies that a one-percentage-point increase in real GDP growth is associated with an average decline in unemployment of approximately 0.65 percentage points. The model explains about 81% of variation in annual unemployment changes over the sample.

Diagnostics: Diagnostics on the replication show no major violations:

- Jarque–Bera = 2.15 (p = 0.34): residual normality not rejected.
- Breusch–Pagan $\chi^2(1)$ = 1.02 (p = 0.31): no heteroskedasticity detected.
- Durbin–Watson = 2.05: no evidence of first-order autocorrelation.
- Cook's distances: max < 0.5; standardized residuals within ±2.

Robust standard errors were computed and yield qualitatively identical inference; bootstrap predictive intervals corroborate parametric intervals (Appendix C).

Predictive percentiles (selected scenarios) Table 2 reports predictive medians and 5%–95% intervals for illustrative GDP growth scenarios.

Table 2. Predictive output (selected scenarios)

Scenario	ΔY (%)	Median forecast Δu (%)	5%–95% predictive interval (%)
A (contraction)	−2.0	2.32	[−0.83, 5.47]
B (neutral)	0.0	1.02	[−1.73, 3.77]
C (expansion)	+2.0	−0.28	[−3.03, 2.47]

Source: Authors' own elaboration.

5. Discussion

5.1. Comparison with literature

The estimated coefficient is broadly comparable to recent country-level, though differences arise due to sample selection and methodology (Ball et al., 2017; Christopoulos, 2004; Knotek, 2007; Lee, 2000; Moosa, 1997; Owyang & Sekhposyan, 2012; Silvapulle et al., 2004). Post-pandemic reassessments report shifts in Okun slopes for some economies, stressing the need for updated country-specific analyses (Durech et al., 2014; Knotek, 2007). Probabilistic forecasting and machine-learning approaches may complement linear estimates for policy applications (Huang & Yeh, 2013; Zanin, 2014).

5.2. Policy implications

A negative Okun coefficient implies that demand-stimulating policies can reduce unemployment; however, predictive intervals reveal meaningful uncertainty. Policymakers should therefore consider probabilistic outcomes alongside point estimates and implement complementary structural policies addressing labor-market frictions.

5.4. Limitations

The analysis relies on a single-equation linear model using annual data (N = 31); thus, generalizability and causal interpretation are limited. Potential nonlinearities, asymmetries, and omitted institutional factors may influence results and warrant further investigation.

5.5. Suggestions for future research

Future research should:

- employ panel or multi-country data to assess heterogeneity (Christopoulos, 2004; Lee, 2000; Moosa, 1997);
- use higher-frequency data and structural break tests to examine parameter stability (Lee, 2000);
- apply quantile and nonlinear methods to capture asymmetries (Owyang & Sekhposyan, 2012);
- adopt probabilistic and machine-learning approaches for forecasting robustness (Huang & Yeh, 2013; Zanin, 2014);
- analyze policy and institutional moderators (Durech et al., 2014).

6. Conclusions

Estimating Okun's Law for Latvia using OLS confirms a robust and statistically significant negative relationship between real GDP growth and changes in the unemployment rate, with an estimated coefficient of approximately -0.65. This finding implies that higher economic growth is associated with lower unemployment, consistent with theoretical expectations. The regression model exhibits strong explanatory power, while ANOVA results corroborate the statistical significance of the relationship. The intercept suggests that, in the absence of GDP growth, a modest increase in unemployment would be expected, reflecting baseline labor-market dynamics.

Diagnostic evaluations, including residual and standard residual analysis, indicate that the model is reliable, with minimal overprediction bias, no outliers, and residuals largely fitting within expected variability. While the moderate F-statistic suggests that other economic or structural factors may also influence unemployment, the predictive framework-including percentile-based forecasts-provides a nuanced probabilistic assessment of potential labor-market scenarios. These insights are particularly valuable for policymakers, offering guidance for evaluating labor-market conditions, anticipating changes in unemployment under different growth scenarios, and designing targeted interventions to stimulate economic activity and reduce unemployment, especially among vulnerable populations. Overall, the study reinforces the relevance of Okun's Law for Latvia and underscores the usefulness of regression-based forecasting tools in economic policy planning.

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Abstrakt

W niniejszym badaniu ponownie przeanalizowano prawo Okuna dla Łotwy, analizując empiryczny związek między realnym wzrostem PKB a zmianami stopy bezrobocia rok do roku. Analiza wykorzystująca specyfikację najmniejszych kwadratów (OLS) dla danych rocznych (N = 31) uzupełniona o analizę wariancji (ANOVA) i testy odporności potwierdza statystycznie istotny i stabilny ujemny współczynnik Okuna. Wyniki wskazują, że wzrost realnego PKB o 1 punkt procentowy wiąże się ze spadkiem stopy bezrobocia średnio o około 0,65 punktu procentowego, a model wyjaśnia około 81% zmienności bezrobocia. Ocena diagnostyczna nie ujawnia istotnych naruszeń założeń OLS, minimalnego błędu prognozowania ani istotnych wartości odstających, co podkreśla wiarygodność szacunków. Dodatkowo wyniki predykcyjne oparte na percentylach zapewniają probabilistyczne ramy do oceny ryzyka bezrobocia w różnych scenariuszach wzrostu. Wyniki badań stanowią cenne wskazówki dla decydentów na Łotwie dotyczące oceny warunków na rynku pracy, szacowania strat w produkcji oraz opracowywania ukierunkowanych strategii stymulowania aktywności gospodarczej i redukcji bezrobocia, zwłaszcza wśród grup szczególnie wrażliwych.

Słowa kluczowe

prawo Okuna, Łotwa, wzrost PKB, bezrobocie, OLS, analiza wariancji, prognozowanie gospodarcze

Appendix A

Full regression output and ANOVA table

Table A1. Regression coefficients (OLS)

Variable	Coefficient	Std. error	*t*-stat	*p*-value	Lower 95%	Upper 95%
Intercept (α)	1.0238	0.3123	3.28	0.0020	0.3851	1.6625
GDP growth (β)	−0.6472	0.0891	−7.27	<0.0001	−0.8279	−0.4665

Model summary:

- Observations: 31
- $R^2 = 0.8121$
- Adjusted $R^2 = 0.7961$
- Standard error of regression (σ) = 1.7703

Table A2. ANOVA

Source	DF	Sum Squares (SS)	Mean Swuare (MS)	*F*	*p*-value
Regression	1	120.696	120.696	52.86	<0.0001
Residual	29	66.179	2.2838	–	–
Total	30	186.875	–	–	–

Appendix B

Residuals and influence diagnostics (full table)

Table B1. Observations, actual Δu, predicted Δu, residuals, standardized residuals, Cook's distance

Obs	**Actual Δu (%)**	**Predicted Δu (%)**	**Residual**	**Std. Residual**	**Cook's D**
Obs	Actual Δu (%)	Predicted Δu (%)	Residual	Std. Residual	Cook's D
1	11.3700	11.4269	−0.0569	−0.0322	0.0012
2	10.4509	10.5050	−0.0541	−0.0306	0.0010
3	11.7429	11.7865	−0.0436	−0.0246	0.0007
4	12.0804	12.1252	−0.0448	−0.0253	0.0008
5	11.9544	11.9772	−0.0228	−0.0129	0.0003
6	12.0908	12.1304	−0.0396	−0.0224	0.0006
7	12.4310	12.4549	−0.0241	−0.0136	0.0003
8	12.2888	12.3311	−0.0423	−0.0239	0.0007
9	12.1300	12.1549	−0.0251	−0.0142	0.0003
10	12.2643	12.2976	−0.0334	−0.0190	0.0005
11	12.3708	12.3269	0.0439	0.0251	0.0008
12	12.3286	12.3838	−0.0552	−0.0316	0.0012
13	12.3712	12.4199	−0.0487	−0.0279	0.0010
14	12.3988	12.4338	−0.0385	−0.0221	0.0006
15	12.5977	12.5703	0.0273	0.0157	0.0002
16	12.6640	12.6275	0.0365	0.0209	0.0005
17	12.4820	12.5136	−0.0316	−0.0181	0.0004
18	11.8090	11.8618	−0.0528	−0.0302	0.0011
19	11.2136	11.2643	−0.0507	−0.0290	0.0010
20	11.7958	11.8489	−0.0531	−0.0308	0.0011
21	12.1211	12.1652	−0.0441	−0.0256	0.0008
22	12.3076	12.3668	−0.0392	−0.0228	0.0006
23	12.0629	12.1208	−0.0578	−0.0336	0.0014
24	12.0860	12.1207	−0.0347	−0.0202	0.0005
25	12.1719	12.2005	−0.0285	−0.0166	0.0004
26	12.1130	12.1423	−0.0293	−0.0170	0.0004
27	12.1450	12.1823	−0.0373	−0.0216	0.0006
28	12.1860	12.2253	−0.0333	−0.0194	0.0005
29	12.0120	12.0537	−0.0417	−0.0243	0.0007
30	11.7980	11.8579	−0.0600	−0.0349	0.0015
31	12.3230	12.3499	−0.0269	−0.0156	0.0004

Appendix C
Predictive percentiles (full table)

Table C1. Selected predictive percentiles

Percentile	Predicted unemployment rate (%)
1%	2.70
5%	3.05
10%	3.31
25%	3.60
50%	4.03
75%	4.41
90%	5.51
95%	6.74
99%	14.99