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THE NEXUS BETWEEN UNEMPLOYMENT AND ECONOMIC GROWTH IN SERBIA: DOES OKUN'S LAW HOLD?

Povezanost nezaposlenosti i privrednog rasta u Srbiji – da li važi Okunov zakon?

Abstract

Starting from the empirically-based postulate that economic growth, through increasing labour demand and employment, reduces the unemployment rate, this study investigates the relationship between real GDP growth and the unemployment rate in the Republic of Serbia. The analysis is motivated by the fact that the unemployment rate in Serbia has significantly decreased over the last decade (especially after 2014), despite relatively modest rates of economic growth. These tendencies indicate the possibility of a nonlinear (asymmetric) relationship between the two variables, which has important implications for designing a more efficient economic and employment policy. Applying both linear and nonlinear Autoregressive Distributed Lags models (ARDL and NARDL) to quarterly data in the 2008-2019 period reveals that the relationship between economic growth and unemployment rate is negative, as suggested by Okun's law, but also that there is a profound asymmetry in this relationship. Namely, a 1% increase in the real output leads to a 4.74% decrease in the unemployment rate, whereas a decrease in output by the same percentage increases the unemployment rate by only 1.52%. Further analysis, based on investigating the relationship between GDP decomposed by the expenditure and production approach, and the unemployment rate, indicates that Okun's law asymmetry in the economy of Serbia is most affected by domestic demand, primarily private and government expenditures on the products of labour-intensive activities, such as services, agriculture, and industry.

Keywords: *unemployment rate, output, nonlinear ARDL model, asymmetry, economic policy.*

Sažetak

Polazeći od empirijski fundiranog postulata da ekonomski rast, preko povećanja tražnje za radom i zapošljavanja, dovodi do smanjenja stope nezaposlenosti, u ovoj studiji se ispituje odnos između rasta realnog BDP-a i stope nezaposlenosti u Republici Srbiji. Opređenjenje za navedenu analizu motivisano je činjenicom da je stopa nezaposlenosti u Srbiji značajno smanjena tokom poslednje decenije (naročito nakon 2014. godine) uprkos relativno skromnim stopama privrednog rasta. Navedene tendencije ukazuju na mogućnost nelinearne (asimetrične) veze između ovih veličina, što ima važne implikacije za dizajniranje efikasnije ekonomske politike i politike zapošljavanja. Primenom linearnog i nelinearnog autoregresivnog modela raspoređenih doznji (ARDL i NARDL) na kvartalne podatke u periodu od 2008. do 2019. godine pokazano je da je veza između privrednog rasta i stope nezaposlenosti negativna, kao što predviđa Okunov zakon, ali i da postoji izražena asimetrija u ovom odnosu. Naime, povećanje realnog outputa za 1% dovodi do smanjenja stope nezaposlenosti za 4,74%, dok smanjenje outputa u istom procentu povećava stopu nezaposlenosti za svega 1,52%. Dodatna analiza, koja stavlja u odnos komponente BDP-a prema rashodnom i proizvodnom pristupu i stopu nezaposlenosti, ukazuje da najveći efekat na asimetriju Okunovog zakona u privredi Srbije ima domaća tražnja, primarno lična i javna potrošnja usmerena na proizvode radno intenzivnih delatnosti, poput sektora usluga, poljoprivrede i industrije.

Ključne reči: *stopa nezaposlenosti, output, nelinearni ARDL model, asimetrija, ekonomska politika.*

Introduction

The negative relationship between output changes (economic growth) and the unemployment rate is one of the most sustainable postulates in macroeconomics. It is called Okun's law, after the economist Arthur Okun, who unveiled this relationship in the U.S. economy [34]. Okun's main conclusion is that a 1% reduction in the unemployment rate is associated with a 3% increase in the output. A number of empirical studies confirm Okun's law validity, at least the presence of a negative relationship between the two variables [8], [31], [34], [49]. There are, however, studies that challenge the universality of Okun's law, focusing on its stability, direction of causality, and the value of Okun's coefficient [12], [21], [42]. These controversies lead to Okun's law being constantly analysed and reassessed.

Empirical research to date has been directed primarily to advanced market economies, although in the last two decades the focus of a number of studies has been moved to the emerging and transition economies [2], [6] [14], [26]. A common finding from these studies is as follows: a trade-off between the output and unemployment in developed economies differs quantitatively and qualitatively compared with developing economies. The qualitative differences, which stem dominantly from the extent of market economy postulates, can be reduced to the qualitative ones, represented by the value of Okun's coefficient. It is emphasised that Okun's coefficient tends to be higher in more developed countries, primarily as a corollary of improved labour market flexibility [11]. Some authors even use the validity of Okun's law as an indicator that the transition process is finished [20].

A negative relationship between output and unemployment rate does not necessarily assume that the value of absolute change in the unemployment rate is identical in contractionary and expansionary periods. In other words, the value of Okun's coefficient could differ depending on whether the real output increases or decreases. This asymmetry in Okun's law has been a subject of intensive empirical research in the last two decades [12], [44], [53]. The results of the econometric analysis commonly suggest that the reaction of unemployment to the output changes is more intensive in economic contraction than in economic

expansion. This finding is often referred to as "jobless recovery" or "jobless growth", since the unemployment rates exhibit some hysteresis (inertia) when the economy recovers and they are expected to decline more. Yet, there is some evidence that supports the opposite case, when the unemployment rates respond more to positive changes in the output (in the economic expansion) rather than to negative ones (in contraction). This hypothesis is usually called "labour hoarding" and its occurrence can be seen in some transition economies, often due to administrative constraints aimed at stopping the firing [11], [14], or in the case when the firms are reluctant to fire trained workers [32]. By all means, the valid empirical evidence about the asymmetric trade-off between output growth and the unemployment rate has important implications for designing more efficient economic policy measures in which intensity should be adjusted to different phases of the economic cycle. Albeit these implications are more significant for emerging and transition economies, there are still relatively few empirical studies dealing with these economies (some exceptions include, inter alia, [13], [14], [15] [25]).

Accordingly, this study tries to add to the empirical literature about Okun's law by assessing its validity in the context of Serbia's economy and the presence of asymmetry in this relationship. The aim is to reveal the value and the sign of Okun's coefficient and to explain its association with the specificities of Serbia's economy. The main motivation for analysing data for the Republic of Serbia (RS) lies in two facts: first, since the Great Recession, the unemployment rate in Serbia has been reduced significantly (Labour Force Survey data), whereas the data for empirical dynamics of real GDP do not indicate that economic growth corresponded to the observed decrease in unemployment, and second, according to the best of our knowledge, the presence of asymmetry in Okun's law for Serbia has not been investigated to date, although it can ameliorate the understanding of the relationship between the economic growth and the labour market.

In line with the aforementioned, in this paper the following research hypotheses are tested:

H1: The relationship between the real output growth and the unemployment rate in the Republic of Serbia is

negative and statistically significant in the analysed time period.

H2: Okun's coefficient in Serbia's economy has a different value in expansionary and contractionary periods, indicating the presence of asymmetry in the linkage between the economic growth and the unemployment rate changes.

The formulated hypotheses are evaluated by means of empirical research based on quarterly data about real GDP and the unemployment rate in the RS. An econometric methodology consists of a Nonlinear Autoregressive Distributed Lag (NARDL) approach, developed by Shin, Yu, and Greenwood-Nimmo [43], which allows joint investigation of cointegration and long- and short-run asymmetry in one model.

The rest of the paper is organised as follows. The second section presents the referent empirical studies about Okun's law, whereas the third explains the research methodology and dataset. The empirical results and discussion are presented in the fourth section. The fifth section contains an additional analysis of the impact of changes in GDP components on Okun's law asymmetry, whereas the last section concludes.

Overview of the relevant empirical literature about Okun's law

Bearing in mind there are numerous empirical studies about Okun's law validity, especially for developed economies, in this section, we focus on some of the recent research. Particular attention is directed to studies dealing with output-unemployment trade-off in emerging and transition economies, and the presence of asymmetry in this relationship.

Valadkahi and Smith [49] investigate Okun's law stability in the United States (US) in the period after World War II. They find evidence that the relationship between unemployment and output is stable over time and that it has asymmetric features. Similar findings for the US and the United Kingdom are reported by Beldi and Franch [8], who stress that unemployment responds more strongly to contractions rather than expansions in output. Economou and Psarinos [18] conclude that Okun's law

in 13 EU countries is stable and that the impact of output on unemployment is weaker for countries with increased labour market protection expenditures, and vice versa. In contrast, Rahman and Mustafa [42] provide evidence on Okun's law validity only in two out of 13 selected developed countries over the 1970-2013 period.

Dixon et al. [17] analyse Okun's relationship in 20 OECD countries over the 1985-2013 period, and reveal that the share of temporary workers could explain the Okun's coefficient changes. Novák and Darmo [34] confirm the validity of Okun's law in EU28 in the 2000-2014 period. In addition, they reveal that Okun's coefficient has a higher value in the post-crisis period (2008-2014).

Ibragimov and Ibragimov [26] find that the effect of economic growth on changes in unemployment in the Commonwealth of Independent States (CIS) is stable over time. Dajcman [16] investigates whether Okun's law holds for Slovenia and the national and regional levels. The analysis based on panel data provides evidence in favour of Okun's law validity in six out of twelve regions in Slovenia. Ball et al. [4] investigate the validity of Okun's law in 29 advanced and 42 developing countries and unveil that Okun's coefficient is about half as large in developing as in advanced economies. They also stress that the value of Okun's coefficient depends on the share of services in GDP: when the share of services is higher, the reaction of employment to the changes in the output will be more profound. Andonova and Petrovska [2] confirm the presence of a negative relationship between output and unemployment in North Macedonia. By applying the expenditure approach to GDP decomposition, they also reveal that domestic demand has a stronger impact on the unemployment rate. By means of Autoregressive Distributed Lag (ARDL) model, Tumanoska [48] also finds evidence to support Okun's law validity in this country: a 1% of economic growth leads to a 2.57% decrease in the unemployment rate.

During the last two decades, a growing body of literature has dealt with the problem of the asymmetric relationship between the output changes and unemployment. Harris and Silverstone [23] find evidence on Okun's law asymmetry in seven OECD countries. Silvapulle et al. [44] analyse post-war U.S. data and demonstrate that

the short-run cyclical unemployment is more sensitive to negative than to positive cyclical output, which indicates asymmetry in their relationship. Applying the ARDL approach to Okun's law estimation, Canarella and Miller [12] evince that in the post-Great Recession regime Okun's law breaks down as a linear relationship, and that it rather follows a more complex nonlinear asymmetric dynamics. By means of NARDL modelling, Tang and Bethencourt [46] demonstrate that Okun's law in the majority of the Eurozone countries is asymmetric. Zwick [53] analyses an asymmetry between unemployment and output for twelve Eurozone countries and reveals that, in most cases, the output is more sensitive to negative than to positive changes in cyclical unemployment.

Caraiani [13] documents that the relationship between the industrial production index and the unemployment rate between January 1991 and December 2009 in Romania is asymmetric and that Okun's coefficient is higher during a recession and lower during expansion. Similarly, Cevik et al. [14] reveal that cyclical unemployment is more sensitive to cyclical output in downswing regimes than in upswing regimes in nine transition countries. Karfakis et al. [28] find evidence on Okun's law asymmetry in Greece in the 2000-2012 period. These results for the same country are reconfirmed by Koutroulis et al. [29] for the 1990-2014 period. Bođa et al. [10] examine Okun's law validity and the presence of asymmetries between output and unemployment for the four Visegrád Group countries. Albeit the negative relationship between these variables is confirmed in all countries, this relationship is asymmetric only for Slovakia. Bariş-Tüzemen and Tüzemen [6] investigate the association between the unemployment rate and manufacturing industry growth in Turkey. They evince that direction of causality goes from unemployment to the manufacturing industry, but only in the case of negative shocks, whereas the symmetric test detects no causality at all. Similar findings of the presence of asymmetry among GDP growth, unemployment, and employment in Turkey can be found in Coşar and Yavuz [15]. They reveal that the response of labour market variables to GDP changes is more profound during recessions.

Having in mind the empirical studies to date, this paper contributes to the referent literature at least in two

aspects: first, the analysis is based on data for the Republic of Serbia and could provide additional evidence about the characteristics of output-unemployment relationship in an economy still in the transition process, and second, this study employs a relatively novel econometric methodology that allows joint estimation of the long- and short-run asymmetries in Okun's law, thus providing a better understanding of the interaction between economic growth and the labour market. Additional contribution lies in applying the NARDL model to estimate the impact of separate GDP components, obtained using both the expenditure and production approach.

Research methodology and data

Methodological background of Okun's law

The observed negative relationship between unemployment and economic growth, i.e., Okun's law, is based on the fact that economic expansion leads to labour market demand increases that intensify the employment process and reduce the unemployment rate. In the case of an economic recession, this process is the opposite. In its original form, Okun's law can be expressed as follows [9, p. 208]:

$$u_t - u_{t-1} = -b(g_{yt} - \bar{g}_y) \quad (1)$$

where u_t and u_{t-1} denote unemployment rate in the periods t and $t-1$, respectively; b is Okun's coefficient, g_{yt} refers to the growth rate of output from year to year t , whereas \bar{g}_y stands for the normal or "natural" growth rate (the output growth rate necessary to neither increase nor decrease the unemployment rate). Okun's coefficient actually indicates the unemployment rate sensitivity to the real output growth changes.

This "textbook version" of Okun's law exhibits some limitations when one tries to empirically estimate the value of Okun's coefficient. The main reason reflects the fact that the exact value of the natural growth of output can hardly be calculated. Therefore, the estimation of the relationship between unemployment and output in the empirical literature is commonly based on one of two forms: the gap model that encompasses the nexus between the output gap and unemployment gap and the model with first-differences of the output and unemployment

rate. The gap model of Okun's law can be presented in the following form:

$$\mu_t = a + bx_t + \varepsilon_t \quad b < 0 \quad (2)$$

where: $\mu_t = u_t - u^*$ and $x_t = y_t - y^*$; represents a constant, b is Okun's coefficient, μ_t and x_t refer to the unemployment gap and the output gap, respectively, u_t and y_t are actual unemployment rate and real output in period t , whereas u^* and y^* denote the natural rate of unemployment and the potential output, respectively. This version of Okun's law, albeit considered to be more general [22], can include the state of an economy relative to its trend or natural growth rate, which is usually the main motivation to use it in empirical research [23], [44], [53]. However, this approach shares the same limitations with Okun's law relation given by Equation (1), since neither the natural rate of unemployment nor the potential output is directly observable.

The first-difference version of Okun's law includes the rates of change in observed variables ($\Delta u_t = u_t - u_{t-1}$); $\Delta y_t = y_t - y_{t-1}$) and can be formulated as follows:

$$\Delta u_t = a + b\Delta y_t + \varepsilon_t \quad b < 0 \quad (3)$$

where u_t and y_t are unemployment rate and real output, respectively, and ε_t represents the error term. In empirical research, the models (2) and (3) of Okun's law are used with almost equal frequency, whereas some studies implement both versions in order to get more robust results [14], [37].

In this paper, like in a number of empirical studies [1], [5], [34], [46], the analysis of Okun's law validity is based on the first-difference model, for at least two reasons: first, the gap model parameters' estimation assumes the natural rate of unemployment and the long-run output growth rate to be constant [5], which is not always the case, and second, the values of the unemployment gap and output gap (which are not directly observable) depend on the time series decomposition model applied [44].

Econometric model

Starting from Equation (3), one can obtain the model that represents better the dynamics of the relationship between economic growth and unemployment rate change, by using their lagged values as regressors. In that way, the ARDL model of Okun's law can be formulated.

By including both short- and long-run coefficients in the same equation, the ARDL model in the error correction form can be obtained [38]:

$$\Delta u_t = \alpha_0 + \beta_1 u_{t-1} + \beta_2 y_{t-1} + \beta_3 \pi_{t-1} + \sum_{i=1}^m \gamma_i \Delta u_{t-i} + \sum_{i=0}^n \delta_i \Delta y_{t-i} + \sum_{i=0}^p \theta_i \Delta \pi_{t-i} + \varepsilon_t \quad (4)$$

where α_0 is the constant, β_1, β_2 , and β_3 represent the long-run coefficients, γ_i, δ_i , and θ_i are the short-run coefficients, and m, n , and p denote lag length. It should be noted that the inflation (π_t), as the third variable, is of auxiliary character in modelling as it is used to reduce the problem of suspected causal effects due to the non-inclusion of important variables in the analysed relationship. The research priority is still the relationship between the unemployment rate and economic growth. In order to test the first research hypothesis, the parameters of the model (4) are estimated. More precisely, the value of the long-run parameter measuring the impact of output growth on the unemployment rate change (L_y) is calculated, as follows: $L_y = -\beta_2/\beta_1$ [43]. The negative value of this parameter indicates the economic growth and unemployment rate move in opposite directions in the long-run.

In order to test the second research hypothesis, the nonlinear (asymmetric) ARDL model that discovers the presence of asymmetry in the economic growth-unemployment relationship, is formulated. Following the approach developed by Shin et al. [43], the changes in real output (y_t) are decomposed into the increasing and decreasing partial sums, i.e., $y_t = y + y_t^+ + y_t^-$, where y_t^+ and y_t^- represent the partial sums of positive and negative changes in the real output, respectively, as follows:

$$y_t^+ = \sum_{i=0}^t \Delta y_i^+ = \sum_{i=0}^t \max(\Delta y_i, 0); \quad (5)$$

$$y_t^- = \sum_{i=0}^t \Delta y_i^- = \sum_{i=0}^t \max(\Delta y_i, 0) \quad (6)$$

By substituting y_t by variables y_t^+ and y_t^- in the model (4), we get the NARDL model in the form:

$$\Delta u_t = \alpha_0 + \beta_1 u_{t-1} + \beta_2^+ y_{t-1}^+ + \beta_2^- y_{t-1}^- + \beta_3 \pi_{t-1} + \sum_{i=1}^m \gamma_i \Delta u_{t-i} + \sum_{i=0}^n (\delta_i^+ \Delta y_{t-i}^+ + \delta_i^- \Delta y_{t-i}^-) + \sum_{i=0}^p \theta_i \Delta \pi_{t-i} + \varepsilon_t \quad (7)$$

where β_2^+ and β_2^- denote the long-run coefficients, whereas δ_i^+ and δ_i^- represent the short-run coefficients of positive and negative changes in the output, respectively.

For the presentation of cumulative effects of changes in the real output on the unemployment from short- to long-run, the so-called dynamic multipliers are applied,

indicating the effects of unit changes in y_t^+ and y_t^- on u_t , by using the following formula [43]:

$$m_{h1}^+ = \sum_{j=0}^{h1} \frac{\partial u_{t+j}}{\partial y_t^+}, m_{h1}^- = \sum_{j=0}^{h1} \frac{\partial u_{t+j}}{\partial y_t^-}, h = 0,1,2... \quad (8)$$

As the number of observations tends to infinity ($h_1 \rightarrow \infty$), the multiplier values incline to values of the long-run parameters of the positive (L_y^+) and negative (L_y^-) changes in the real output, i.e., $m_{h1}^+ \rightarrow L_y^+$ and $m_{h1}^- \rightarrow L_y^-$, where $L_y^+ = -\beta_2^+/\beta_1$ and $L_y^- = -\beta_2^-/\beta_1$, as suggested by [43].

The presence of the long-run relationship (cointegration) between dependent and explanatory variable is checked by testing the null hypothesis of no cointegration $H_0: \beta_1 = \beta_2 = 0$ and $H_0: \beta_1^+ = \beta_2^+ = 0$ in Equations (4) and (7), respectively [38].

The long-run asymmetry is investigated by testing the null hypothesis of symmetry $H_0: -\beta_2^+/\beta_1 = -\beta_2^-/\beta_1$ in Equation (7), as suggested by [43] and [46]. The short-run asymmetry is checked by testing the null hypothesis $H_0: \sum_{i=0}^n \delta_i^+ = \sum_{i=0}^n \delta_i^-$. For analysis of asymmetries and cointegration, the standard Wald test is applied, as a common approach in empirical research.

Dataset

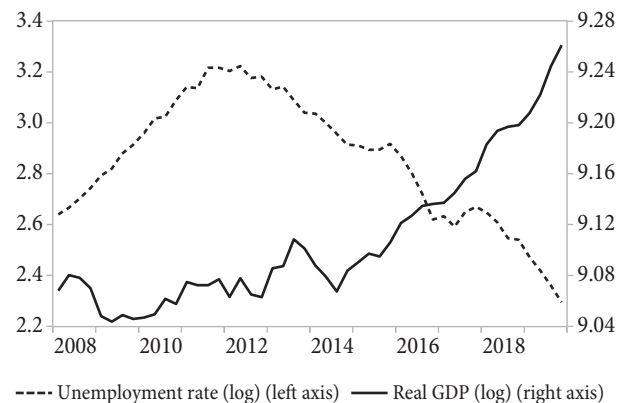
This study uses quarterly data about real GDP, unemployment rate, and inflation. The analysed time span is from the first quarter of 2008 to the fourth quarter of 2019 (48 observations). Real GDP is calculated by dividing nominal GDP in euros with the price index (implicit deflator, 2015=100) and transformed into a logarithmic form. The inflation is measured by a Consumer Price Index (CPI). The data are collected from the Eurostat database [19]. The unemployment rate is measured as a share of unemployed persons in the total labour force. The data are obtained from the Statistical Office of the Republic of Serbia (Labour Force Survey) [45].

The comparability of data about the unemployment in the RS is aggravated by the fact that the methodology for calculation of the labour market indicators was changed in 2015. It certainly requires caution in interpreting the estimation results. Notwithstanding, this change in methodology didn't result in the structural break (see Figure 1 and the last column in Table 2) and the time

series about unemployment rates can be used for analysis; the NARDL model for sub-period 2012Q1-2019Q4 is also estimated in order to get more robust results. The starting point for this sub-sample is chosen following Petrović et al. [40]. In addition, bearing in mind that the data about the unemployment rate in the 2008-2013 period were released two times a year (in April and October), the conversion to quarterly data was implemented. The unemployment data from the April release in each year of the mentioned period were assigned to the first and the second quarter of the current year, whereas the data about the unemployment rate from the October release were assigned to the third and the fourth quarter of the current year.

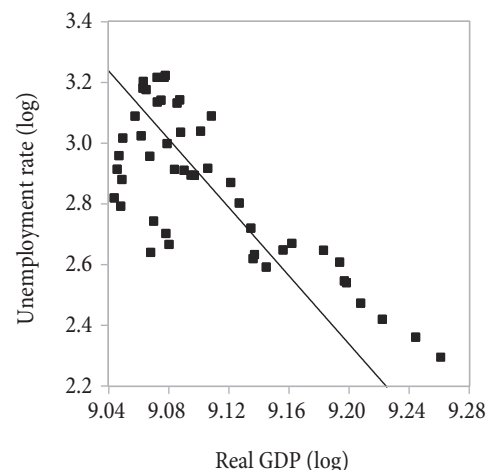
The empirical dynamics of the unemployment rates and real GDP (Figure 1) can provide a preliminary insight

Figure 1: Empirical dynamics of the unemployment rates and real GDP in Serbia in the period 2008Q1-2019Q4



Source: Author.

Figure 2: The scatter diagram for the relationship between the real output and unemployment rate



Source: Author.

into the nexus between these variables in the RS. It is evident that the relationship is negative, especially after 2012. The decrease in the unemployment rates after 2015 is more prominent, which could be, inter alia, a result of a change in the methodology for tracking the number of employed and unemployed persons. Additional insight into the relationship between unemployment and real output could be obtained by a scatter diagram (Figure 2). A negatively-sloped regression line indicates that, generally, the increases in the real output in the observed period are associated with unemployment decreases. It could be an initial signal that Okun's law in Serbia's context is valid.

Results and discussion

In order to conduct the econometric analysis which is in accord with the NARDL approach and formulated research hypotheses, some important preconditions must be fulfilled. First of all, the variables included into analysis should be stationary in levels and/or in the first differences, but none of them should be integrated of order I(2). Second, bearing in mind that Okun's law does not entail a causal relationship but only a simple correlation, the classification of variables into the explanatory and dependent ones should be confirmed by the causality test.

Accordingly, several unit root tests are performed. Table 1 reports the results of the Ng-Perron unit root test, which is considered more accurate comparing with other stationarity tests [33]. The results suggest that all variables are stationary in the first differences. The parametric Augmented Dickey-Fuller (ADF) test and nonparametric Phillips-Perron (PP) test, presented in Table 2, reconfirm the previous results, indicating that the NARDL model could be implemented. However, since the presence of structural break in time series can lead to biased results, as suggested by Baum [7], the Zivot-Andrews test is also conducted [52]. It is evident that the results are mixed, however, it can be concluded that all variables are stationary in level and/or in the first difference.

Prior to the models' estimation, in line with the second precondition, the causality analysis is applied. It is based on the Granger non-causality test. However, since the unit root tests indicate that the time series are not integrated of the same order (some of them are stationary in levels and others in the first difference), the standard F-statistic for testing the Granger causality may be misleading since the test does not have a standard distribution, as suggested by [47]. Hence, the Toda-Yamamoto approach to Granger causality is applied. It is based on a modified Wald test, which tests for the causality of time series in levels, thus

Table 1: Results of the Ng-Perron unit root test

Variable	MZa	MZt	MSB	MPT
y	0.245	0.084	0.340	12.912
u	-4.331	-1.459	0.337	5.678
π	0.412	0.302	0.734	36.244
Δy	-16.879***	-2.904***	0.172***	1.454***
Δu	-22.750***	-3.347***	0.147***	1.165***
$\Delta \pi$	-15.782***	-2.788***	0.177**	1.631***

Note: The results denoted with *, **, and *** are statistically significant at the levels of 10%, 5%, and 1%, respectively.
Source: Author.

Table 2: Results of the time series stationarity tests

Variable	ADF test		PP test		Zivot-Andrews test	
	Constant	Constant and Trend	Constant	Constant and Trend	t-statistic	Break date
y	3.38	-0.38	2.99	0.07	-2.82	2015Q2
u	1.23	-1.75	-0.02	-1.67	-4.09**	2011Q3
π	-1.85	-1.15	-2.38	-0.87	-2.87*	2010Q3
Δy	-5.59***	-5.61***	-5.66***	-6.87***	-6.42*	2013Q4
Δu	-1.94	-5.69***	-3.83***	-5.83***	-5.34***	2017Q1
$\Delta \pi$	-3.81***	-4.18**	-3.63***	-3.86**	-6.22***	2013Q4

Note: The results denoted with *, **, and *** are statistically significant at the levels of 10%, 5%, and 1%, respectively.
Source: Author.

reducing the risk of wrong identification of time series order of integration [50]. The relationship between the real output and unemployment rate is presented by transforming the time series in the standard vector autoregressive (VAR) model. The optimal lag length selection is based on the Schwarz information criterion, which is the most accurate for quarterly VAR models and sample sizes smaller than 120 observations [27]. According to the unit root tests, the maximal order of integration of time series is 1. In addition, taking into account that in the NARDL model the time series for positive and negative changes in the real output serve as regressors, the causality analysis includes these variables in the form of the asymmetric Granger non-causality test, as suggested by Hatemi-J [24]. The results are reported in Table 3.

The presence of unidirectional causality which goes from the real output to the unemployment rate is confirmed. The positive changes in real GDP (y^+) also represent an important determinant of the future unemployment rate dynamics, whereas the negative changes (y^-) have no statistically significant causal impact on unemployment. Notwithstanding, the postulated relationship between the real output as an explanatory variable and the unemployment rate is appropriate in the case of Serbia's economy.

Table 4 reports the exact specification of the ARDL and NARDL models of Okun's law in Serbia. It is obtained by successive trimming of insignificant time lags, starting from 4 lags [46]. The residual diagnostics tests (for normality, autocorrelation, heteroscedasticity, dynamic stability, and functional form) all indicate that all models are well specified and stable. The results of the cointegration test in the bottom row of Table 4 (F_{pss}) confirm the presence of the long-run relationship between the unemployment rate and real output in all cases. As for the ARDL model specification, the value of the long-run parameter measuring the impact of the real output on

the unemployment rate is negative (-2.95) and statistically significant, indicating an inverse relationship between these variables. Its value suggests that a 1% increase in the real output leads to a 2.95% decrease in the unemployment rate, and vice versa. This finding, therefore, represents the confirmation of the first research hypothesis. According to the coefficient of determination (R^2) value, the changes in the real output can explain about 58% of variations in the unemployment rate.

However, the NARDL model specification indicates that Okun's coefficient has a different value depending on whether the real output increases or decreases. In other words, the trade-off between the real output and unemployment rate is different in the expansionary and contractionary periods. The values of the long-run parameters for positive (L_y^+) and negative (L_y^-) changes in the real output are -4.74 and -1.52, respectively. These results indicate that a 1% increase in the real output leads to a 4.74% decrease in the unemployment rate, whereas a 1% decrease in the real output leads to a 1.52% increase in the unemployment rate. Therefore, it is a sign that the relationship between these variables in Serbia's economy is asymmetric. Indeed, the results of the Wald test confirm that there is not only a long-run asymmetry in Okun's law (W_{LR}) but also a short-run asymmetry (W_{SR}). Accordingly, the second research hypothesis is accepted.

An insight into the cumulative impact of the positive and negative changes in the real output on the unemployment rate, as well as the adjustment from the initial shock towards the long-run equilibrium, can be obtained by means of the dynamic multipliers [43]. The negative changes in the real output (dashed grey line in Figure 3) lead to the unemployment rate increase. This impact is more prominent in the short-run (approximately 8 quarters after the initial shock) and gradually decreases towards the long-run equilibrium. The positive changes

Table 3: The results of the Granger non-causality test for the ARDL and NARDL models

ARDL model		NARDL model Positive changes in real GDP		NARDL model Negative changes in real GDP	
H_0	χ^2	H_0	χ^2	H_0	χ^2
$y \nrightarrow u$	6.64*	$y^+ \nrightarrow u$	9.18**	$y^- \nrightarrow u$	1.89
$u \nrightarrow y$	3.96	$u \nrightarrow y^+$	4.38	$u \nrightarrow y^-$	1.63

Note: The symbol \nrightarrow means "does not Granger cause"; the results denoted with *, **, and *** are statistically significant at the levels of 10%, 5%, and 1%, respectively.
Source: Author.

in the real output (continuous grey line) lead to a more pronounced reduction in the unemployment rate. The dashed black line represents the difference between the effects of positive and negative changes in the real output, that is, asymmetry. It is presented along with the black dashed lines denoting the 95% confidence interval. If the zero line is inside the confidence interval, then there is no asymmetry. The dynamic multipliers in Figure 3 indicate both short- and long-run asymmetry, which is

Table 4: Estimation results for the ARDL and NARDL models

Variable	ARDL model		NARDL model		NARDL model 2012Q1-2019Q4	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
α_0	3.95	0.00	0.38	0.00	0.45	0.04
u_{t-1}	-0.12	0.00	-0.15	0.00	-0.18	0.01
y_{t-1}	-0.35	0.01	-	-	-	-
y_{t-1}^+	-	-	-0.70	0.00	-0.74	0.00
y_{t-1}^-	-	-	-0.22	0.07	-0.25	0.12
π_{t-1}	-0.01	0.00	-0.01	0.74	0.00	0.73
Δu_{t-1}	-	-	0.08	0.61	0.13	0.43
Δu_{t-2}	0.25	0.08	0.24	0.09	0.19	0.21
Δy_t	-0.19	0.45	-	-	-	-
Δy_{t-1}	-	-	-	-	-	-
Δy_{t-2}	0.51	0.03	-	-	-	-
Δy_{t-2}^+	-	-	-1.25	0.03	-1.32	0.04
Δy_{t-2}^-	-	-	-0.56	0.17	-1.06	0.06
$\Delta \pi_{t-2}$	0.02	0.01	0.02	0.02	0.02	0.01
L_y	-2.95	0.00	-	-	-	-
L_y^+	-	-	-4.74	0.00	-4.15	0.00
L_y^-	-	-	-1.52	0.01	-1.38	0.15
R ² (Adjusted)	0.58		0.66		0.39	
JB test	0.51	0.78	1.35	0.51	1.43	0.49
BG LM test	0.58	0.56	0.38	0.69	0.54	0.59
BPG test	1.66	0.15	1.69	0.13	1.59	0.17
Cusum test	Stable		Stable		Stable	
Cusum Squared test	Stable		Stable		Stable	
RESET test	0.14	0.71	0.03	0.88	0.71	0.41
W_{LR}	-	-	18.14	0.00	12.62	0.00
W_{SR}	-	-	5.63	0.02	6.84	0.01
F_{PSS}	6.85	0.00	7.05	0.00	6.41	0.00

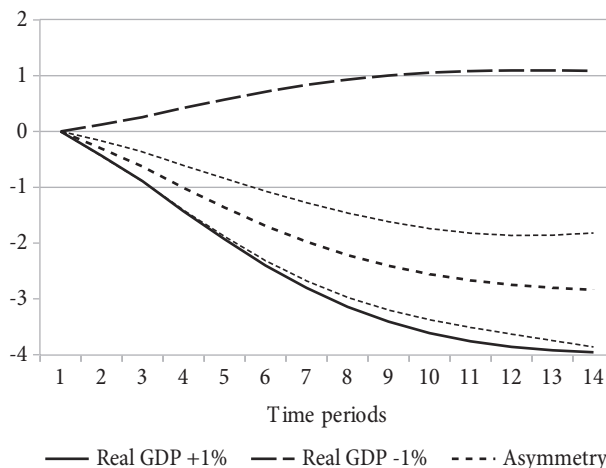
Notes: JB, BG LM, and BPG denote Jarque-Bera test for normality, Breusch-Godfrey test for autocorrelation and Breusch-Pagan-Godfrey test for heteroscedasticity of residuals, respectively; Cusum (Cusum Squared) refers to the cumulative sum of residuals (squared residuals) test; W_{LR} and W_{SR} denote the results of the short- and long-run asymmetry Wald tests, respectively; F_{PSS} refers to the F-statistic of the Bounds test for cointegration [38].
Source: Author.

in accord with the results of the Wald test from Table 4. Although unemployment reacts relatively strongly to the output changes in the short-run, it takes much more time to establish the long-run equilibrium.

In order to get the more robust results, and, at the same time, to use the time series that is long enough, the NARDL model is estimated for a sub-period starting from the first quarter of 2012, as suggested by Petrović et al. [40]. As presented in the last two columns of Table 4, the same direction of the long- and short-run asymmetry is still present, as Wald test indicates, although the long-run parameter of negative changes in the real output (L_y^-) is not statistically significant. Having all that in mind, one may conclude that the necessary robustness of econometric results is confirmed.

If one observes the direction of asymmetry, it appears that the nexus between real GDP and unemployment rate is not in line with the “jobless growth”, but rather with the “labour hoarding” hypothesis. Albeit that hypothesis has been confirmed in empirical studies for transition economies [14], [32], a caution is needed in regard to the interpretation of the empirical results in the case of the RS. The mechanical interpretation of the empirical findings, without the relation with an actual context, could lead to the wrong conclusions. Namely, these results could indicate that economic growth reduces unemployment significantly, whereas a decrease in the real output leads to only a slight increase in unemployment. However,

Figure 3: Dynamic multipliers for the impact of positive and negative shocks in output on unemployment



Source: Author.

bearing in mind that the real output is the only explanatory variable in the estimated models (except inflation, but which has only auxiliary character), the changes in the unemployment rate can likely be a result of some other factors, not included in the analysis. For instance, the change in the methodology of tracking of either unemployed or employed persons might result in an unemployment rate reduction. Addressing this question from the aspect of the number of employed persons, Kovačević et al. [30] and Arandarenko and Aleksić [3] point out that including labour market characteristics such as “non-standard employment” and “labour underutilisation” can explain the significant employment growth which coexists with relatively modest economic growth. A likely corollary of this point could be a more significant decrease in the unemployment rate. There are some other views that should be mentioned, for instance in Petrović et al. [40], which essentially dispute the validity of the Labour Force Survey data.

An additional factor that could explain the significant reduction of the unemployment rate is associated with the emigration flows from the Republic of Serbia. According to the OECD database, in the 2007-2017 period, about 460 thousand persons left Serbia [35]. These migration flows have led, inter alia, to the reduction of the number of unemployed persons, which resulted in an unemployment rate decrease. Indeed, the impact of emigration flows on the source country's unemployment rate reduction has been confirmed in a number of studies [41], [51].

Although either of these factors could potentially explain the source of observed Okun's law asymmetry in the RS, the analysis of their impact is beyond the scope of this study. Rather, the further analysis is based on the effects of GDP components on the unemployment rate, in order to reveal whether the relationship between these components and unemployment can explain Okun's law asymmetry in the RS.

Changes in GDP components as drivers of Okun's law asymmetry

Now we turn to the analysis of potential causes of observed asymmetry between the changes in output and

unemployment rate in the RS. The focus is on the different components of GDP and its particular long-run impact on the unemployment rate. GDP is decomposed using both the expenditure and production approach. More precisely, starting from Equation (3), the relationship between the unemployment rate and the changes in disaggregated GDP (expenditure approach) can be expressed as follows:

$$\begin{aligned}\Delta u_t &= a + b(\lambda_C \Delta C_t + \lambda_I \Delta I_t + \lambda_G \Delta G_t \\ &\quad + \lambda_{EX} \Delta EX_t - \lambda_{IM} \Delta IM_t) + \varepsilon_t \\ &= a + \sum_i b_i \Delta y_{i,t} \lambda_i + \varepsilon_t,\end{aligned}\quad (9)$$

where C_t denotes private consumption, I_t stands for investments, G_t is the final consumption expenditure of the general government, whereas EX_t and IM_t refer to exports and imports of goods and services, respectively. Coefficient λ_i measures the moving-average weight of each individual component in GDP. In further analysis, following Anderton et al. [1], the separate coefficients for each component (b_i) are estimated. Since the aim is to investigate the effects of changes in GDP components on the overall Okun's law asymmetry, the nonlinear behaviour of these components is analysed as well, applying the NARDL model. For instance, the estimated NARDL model for the private consumption that includes the positive and negative changes in this variable and their impact on the unemployment rate in the long- and short-run can be formulated as follows:

$$\begin{aligned}\Delta u_t &= \alpha_0 + \beta_1 u_{t-1} + \beta_2^+ \lambda_C C_{t-1}^+ + \beta_2^- \lambda_C C_{t-1}^- + \sum_{i=1}^m \gamma_i \Delta u_{t-i} + \\ &\quad \sum_{i=0}^n (\delta_i^+ + \lambda_C \Delta C_{t-i}^+ + \delta_i^- \lambda_C \Delta C_{t-i}^-) + \varepsilon_t.\end{aligned}\quad (10)$$

The NARDL models for the rest of the GDP components are formulated in an analogous manner. In addition, GDP is disaggregated using the production approach, thus separating the gross value added in the agriculture (*Agr*), construction (*Con*), industry (*Ind*), and the sector of services (*Ser*). The relationship between the unemployment rate and the changes in disaggregated GDP then can be presented as:

$$\begin{aligned}\Delta u_t &= a + b(\lambda_{Agr} \Delta Agr_t + \lambda_{Con} \Delta Con_t \\ &\quad + \lambda_{Ind} \Delta Ind_t + \lambda_{Ser} \Delta Ser_t) + \varepsilon_t \\ &= a + \sum_i b_i \Delta y_{i,t} \lambda_i + \varepsilon_t\end{aligned}\quad (11)$$

For each of these GDP components, the separate NARDL model is estimated, like the model given by Equation (10).

Table 5 reports the long-run elasticity of unemployment to the components of GDP that are disaggregated by the expenditure approach. The unemployment elasticity is calculated by multiplying the values of the long-run coefficients for the positive and negative changes in each component with its average weight in the total GDP. The long-run parameters are obtained by dividing the values of unemployment elasticity with the long-run coefficient for unemployment rate with one time lag (u_{t-1}), which is estimated for each NARDL model separately (not presented in the table due to space limitations). Finally, the last column contains the results of the Wald test for the long-run asymmetry, obtained by testing the null hypothesis that the long-run parameters for each component are equal.

The values of the long-run parameters from Table 5 reveal that the unemployment rate dominantly responds to the positive changes in private consumption, and then to the positive changes in imports and exports, as well as to the positive changes in the government expenditure. The negative relationship between the import growth and unemployment appears to indicate that the direction of causality might be opposite than in the model (7) and that the reduction of the number of unemployed supports the consumption of the import products. The impact of investment changes on the unemployment rate is relatively modest, indicating mostly the capital-intensive character of the production processes in which it is invested.

By all means, the relatively high values of the long-run parameters in the model with total GDP (Equation (7)) are largely due to the changes in private consumption, as the

largest component of GDP. In addition, the main impact on Okun's law asymmetry stems from the asymmetry in private consumption, as well as in government expenditure, as indicated by the Wald test. For instance, a 1% increase (decrease) in private consumption leads to a 9.78% decrease (a 3% increase) in the unemployment rate.

Using the production approach, the impact of GDP components on the unemployment rate is presented in Table 6. Unemployment exhibits the largest elasticity to the positive changes in the value of total services, which is not the case when one observes the negative changes. The asymmetric relationship with unemployment is particularly present in agriculture, as the cycle-sensitive and labour-intensive activity. In addition, the positive and negative changes in the value of industrial production also have an asymmetric impact on the unemployment rate, thus contributing to the overall asymmetry in Okun's law.

The cumulative impact of changes in GDP components is presented by dynamic multipliers (in the Appendix). It is evident that the long-run asymmetries are in line with the results from Tables 5 and 6 about the impact of components that primarily induce the overall Okun's law asymmetry. There are also significant short-run asymmetries in most cases, whereas a relatively long period of time is necessary for establishing the new long-run equilibrium.

As far as for the values of the long-run parameters, some parallels between the results from Table 5 and Table 6 could be drawn. For instance, it is apparent that the domestic demand in the RS (private and government consumption) is linked with labour-intensive production

Table 5: Long-run unemployment elasticity to GDP components – expenditure approach

GDP component	The long-run coefficient	Average weight of GDP component	Unemployment elasticity to GDP component	Long-run parameters		Long-run asymmetry (Wald test F-statistic)
				L^+	L^-	
$\lambda_c C_{t-1}^+$	-1.19*	0.74	-0.88	L_c^+	-9.78**	4.61**
$\lambda_c C_{t-1}^-$	-0.37		-0.27	L_c^-	-3.00	
$\lambda_I I_{t-1}^+$	-0.38**	0.20	-0.08	L_I^+	-0.62***	1.04
$\lambda_I I_{t-1}^-$	-0.25*		-0.05	L_I^-	-0.38**	
$\lambda_G G_{t-1}^+$	-0.79	0.17	-0.13	L_G^+	-1.86*	5.16**
$\lambda_G G_{t-1}^-$	0.64		0.11	L_G^-	1.57	
$\lambda_{EX} EX_{t-1}^+$	-0.32*	0.41	-0.13	L_{EX}^+	-1.63***	0.21
$\lambda_{EX} EX_{t-1}^-$	-0.59		-0.24	L_{EX}^-	-2.87	
$\lambda_{IM} IM_{t-1}^+$	-0.46***	0.52	-0.24	L_{IM}^+	-2.06***	0.18
$\lambda_{IM} IM_{t-1}^-$	-0.27		-0.14	L_{IM}^-	-1.20	

Notes: The results denoted with *, **, and *** are statistically significant at the levels of 10%, 5%, and 1%, respectively. The long-run parameters for the positive and negative changes in GDP components are calculated as L^+ and L^- , respectively.
Source: Author.

processes, mainly with services, industry, and agriculture. In other words, it appears that the input of labour dominates in the sector of services and that it is mainly correlated with private and government consumption in the domestic market. The impact of the value-added in industry and agriculture on the unemployment reduction is also in line with the effect of the export growth on unemployment, bearing in mind the significant share of products from these activities in the total exports.

In addition, these findings coincide well with some of the recent empirical studies. For instance, Anderton et al. [1] find that unemployment in 17 euro area countries is most sensitive to changes in private consumption, which reflects the highly labour-intensive nature of the services as the largest component of consumer expenditure. Similar results for Lithuania are reported by Pesliakaitė [39], who finds that domestic demand components (in the case of expenditure approach to GDP decomposition), as well as services, agriculture, and construction (the production approach) all have a significant impact on the unemployment rate movement. The results of a study for North Macedonia by Andonova and Petrovska [2] also support these findings.

Conclusion

This study investigated the nexus between real GDP and the unemployment rate in the RS in order to reveal whether Okun’s law is valid in the context of the RS economy. Although the estimated results suggest that

the relationship between these variables is negative and in line with Okun’s law, there is also evidence in favour of asymmetry between output and unemployment. The empirical analysis has unveiled that the unemployment rate responds more significantly to the positive rather than to the negative changes in the real output. In contrast to the “jobless growth” hypothesis, these findings seem to indicate that the “labour hoarding” hypothesis is more appropriate for the relationship between the economy and the labour market in the RS.

Additional analysis based on GDP components has indicated that Okun’s law asymmetry is most likely a corollary of the asymmetric relationship between private consumption (as the component with the largest share in GDP) and unemployment rate, albeit the government expenditure also has a certain effect. Therefore, an asymmetry in the nexus between the real output and unemployment rate is dominantly due to the aggregate demand dynamics. According to the gross value added approach, agriculture and industry are GDP components with the strongest effect on Okun’s law asymmetry. The sector of services, although the component with the largest gross value added, does not contribute to the overall asymmetry between real GDP and unemployment rate.

As for the economic policy implications, the analysis demonstrated that the economic policy measures should be directed to the aggregate demand management, bearing in mind that domestic demand induces the largest extent of asymmetries between real GDP and unemployment. In addition, active labour market policies should tackle the

Table 6: Long-run unemployment elasticity to GDP components – production approach

	The long-run coefficient	Average weight of GDP component	Unemployment elasticity to GDP component	Long-run parameters		Long-run asymmetry (Wald test F-statistic)
$\lambda_{Agr} \Delta Agr_{t-1}^+$	-0.53**	0.08	-0.04	L_{Agr}^+	-0.44***	6.15**
$\lambda_{Agr} \Delta Agr_{t-1}^-$	-0.12		-0.01	L_{Agr}^-	-0.11	
$\lambda_{Con} \Delta Con_{t-1}^+$	-0.31**	0.05	-0.02	L_{Con}^+	-0.18***	2.38
$\lambda_{Con} \Delta Con_{t-1}^-$	-0.21*		-0.01	L_{Con}^-	-0.09**	
$\lambda_{Ind} \Delta Ind_{t-1}^+$	-0.72*	0.26	-0.19	L_{Ind}^+	-2.71*	3.99*
$\lambda_{Ind} \Delta Ind_{t-1}^-$	-0.24		-0.06	L_{Ind}^-	-0.86	
$\lambda_{Ser} \Delta Ser_{t-1}^+$	-0.84*	0.61	-0.51	L_{Ser}^+	-5.67**	0.19
$\lambda_{Ser} \Delta Ser_{t-1}^-$	-0.16		-0.10	L_{Ser}^-	-1.11	

Notes: The results denoted with *, **, and *** are statistically significant at the levels of 10%, 5%, and 1%, respectively. The long-run parameters for the positive and negative changes in GDP components are calculated as L^+ and L^- , respectively.
Source: Author.

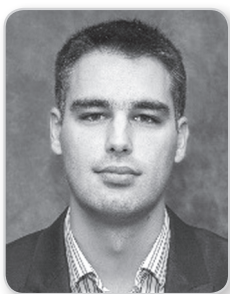
sectors which could potentially reduce the asymmetric features of Okun's law, such as agriculture, industry, but also services, as the sector with the largest share in GDP.

There are at least two limitations of the research that should be mentioned. First, the changes in the methodology of tracking the number of employed and unemployed persons required the application of approximated values for the unemployment rates in the 2008Q1-2013Q1 period; although the robustness check indicated that there are no significant changes in the estimation results, using more reliable data would improve the validity of empirical findings. Second, the analysed time span covers twelve years (48 observations), which is a relatively small sample. Undoubtedly, including more observations would enlighten the relationships among analysed variables in a more complete way. In addition, the tendency of a significant reduction of the unemployment rate in the RS could be better explained by including into analysis the variables connected with emigration flows, demographic changes, and so on. That should certainly be a part of some future research.

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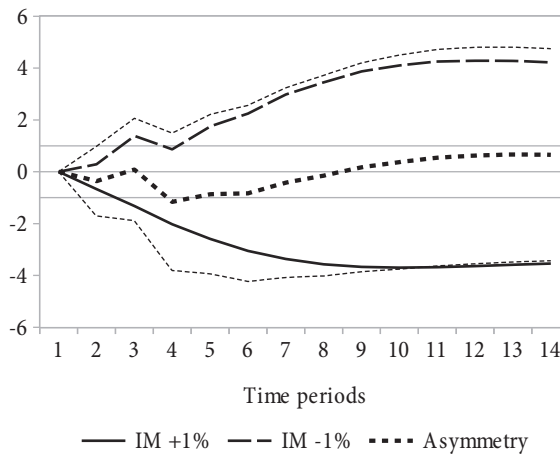
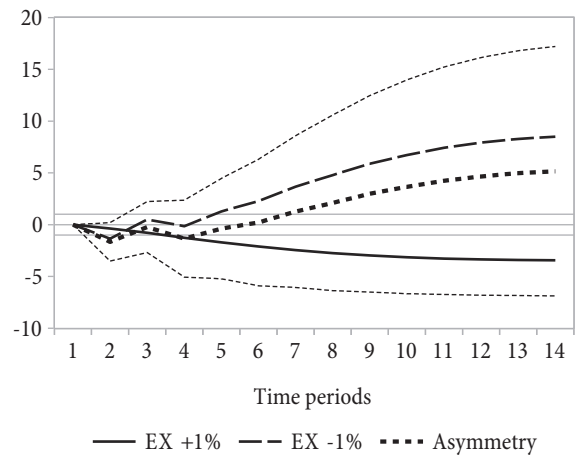
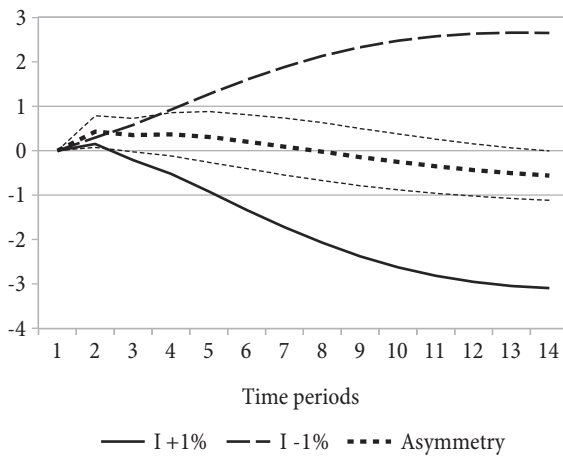
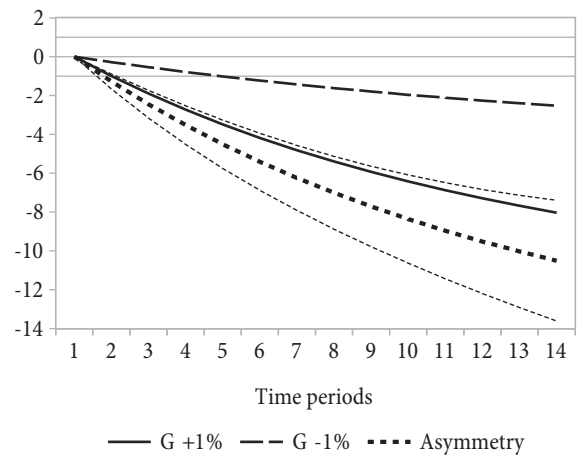
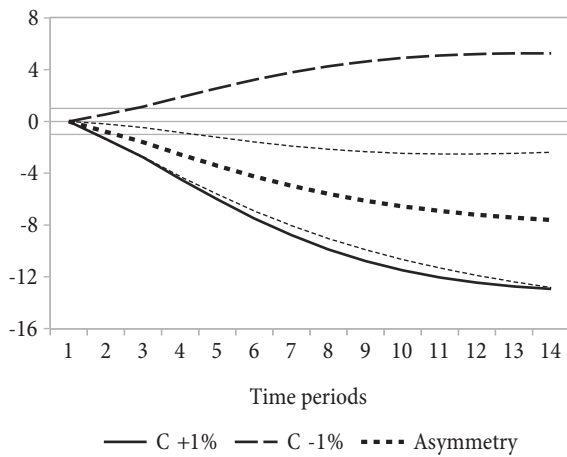
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APPENDIX

Dynamic multipliers for the impact of positive and negative shocks in GDP components on unemployment

(a) Expenditure approach



(b) Production approach

