8. OKUN'S LAW (A)SYMMETRY IN SEE COUNTRIES: EVIDENCE FROM NONLINEAR ARDL MODEL

Vladimir MIHAJLOVIĆ[1]
Aleksandra FEDAJEV[2]

Abstract

Despite relatively strong output growth in recent years, unemployment in many South-eastern European (SEE) countries remains high and persistent. The common assumption of Okun's law symmetry, i.e., *that expansions and contractions in output exert the same absolute effect on unemployment, could hardly offer any additional knowledge about this poor employment content of economic growth. Therefore, this study focuses on asymmetric effects in the unemployment-output relationship in SEE countries and its policy implications, employing a nonlinear ARDL approach (NARDL). The results reveal Okun's law asymmetry (either long-run or short-run) in five out of eight observed countries, indicating unemployment reaction is more pronounced in economic downswings than in upswings. Further analysis confirms that identifying the correct inherent characteristics of the unemployment-output trade-off could be useful for both structural policies (*e.g., *labor market reforms) and stabilization policies, especially in SEE transition economies.*

Keywords: unemployment-output trade-off, asymmetry, NARDL model, dynamic multipliers, labour market, SEE countries

JEL Classification: B41, C32, E32, J64

1. Introduction

Unemployment represents one of the major problems of contemporary economies. Among many factors that can alleviate this phenomenon, economic growth is most often discussed. The proper insight into the characteristics of unemployment-output trade-off can improve understanding of the interaction between economic growth factors and the labour market. Accordingly, Okun's law, as an inverse association between the unemployment rate and output first reported by Okun (1962), is often empirically studied (e.g. Ball et al., 2015; Valadkahani and Smyth, 2015; Grant, 2018). This line of research mainly confirms the

[1] *University of Kragujevac, Faculty of Economics, Kragujevac, Serbia. Corresponding Author. E-mail:vmihajlovic@kg.ac.rs*

[2] *University of Belgrade, Technical Faculty in Bor. Bor, Serbia. E-mail: afedajev@tfbor.bg.ac.rs*

presence of this regularity, indicating that high rates of output growth are likely to produce a significant reduction in unemployment rates.

However, in most South-eastern European (SEE) countries economic growth rates were above the EU average in recent years, but the unemployment rates in some of them are still relatively high (International Monetary Fund, 2019). It is especially true for SEE transition economies (e.g. Montenegro, North Macedonia, Serbia, Bosnia and Herzegovina). Yet, some other SEE countries, like Greece, are also faced with persistent and high unemployment. So, it is interesting to reveal the main sources of low employment content of economic growth in these countries. Insufficient labour market flexibility can be a potential source of these tendencies, and estimation of Okun's coefficients might point to the presence of this problem. The proper functioning of the labour market is particularly important for SEE countries, especially for those which strive to become members of the eurozone (Croatia, Bulgaria, and Romania). This membership implies the loss of monetary sovereignty and reliance primarily on the labour market as the mechanism for absorbing economic shocks. Therefore, the flexibility of the labour market is crucial, not just for these economies but also for EU candidates, such as Montenegro, North Macedonia, and Serbia. Furthermore, an understanding of unemployment-output linkage over the business cycles could improve the policymaking process in these countries and the preparedness for additional shocks emanating from EU and eurozone enlargement.

A common approach for Okun's law estimation is based on the implicit assumption of symmetry (linearity), in the sense that expansions and contractions in output have the same absolute effect on unemployment (Ball et al., 2015; Belaire-Franch and Peiró, 2015; Kargi, 2016; Economou and Psarianos, 2016; Rahman and Mustafa, 2017; Ibragimov and Ibragimov, 2017; Novák and Darmo, 2019). In other words, Okun's coefficient, as a measure of the responsiveness of unemployment to changes in output, has about the same value in the case of economic upturn and downturn. However, this method could hardly offer any additional knowledge about the direction and extent of potential asymmetries in Okun's law as an important input for designing of efficient economic policy measures, especially in observed SEE countries.

In many of recent research, the importance of nonlinearity (asymmetry) of the real output-unemployment nexus is stressed, as a better way to model Okun's law in real economies (e.g. Silvapulle et al., 2004; Caraiani, 2012; Cevik et al., 2013; Canarella and Miller, 2016). The main conclusion of these studies is as follows: positive and negative changes in the real output exert a different absolute effect on unemployment. Empirical findings commonly underpin the theoretically established fact that unemployment reacts more intensively to the negative changes in the output (in recessions) than to the output increases in expansion (Harris and Silverstone, 2001; Boeri and Garibaldi, 2006; Caraiani, 2012; Tang and Bethencourt, 2017).

This study aims to add further to this empirical literature, by focusing on the investigation of potential asymmetries in Okun's law in the SEE countries and their sources as the potential factors of low employment content of growth. Notwithstanding the large body of empirical literature about Okun's law, there are relatively few studies for this group of countries, especially for the Western Balkan states, characterized by disappointingly high unemployment rates (for instance, Izyumov and Vahaly, 2002; Caraiani, 2006; Caraiani, 2012; Cevik et al., 2013; Karfakis et al. 2014; Tumanoska, 2019). The insight into the unemployment-output trade-off in SEE economies with relatively low unemployment rates (Romania, Slovenia, Bulgaria, Croatia) can also give significant findings of its dynamics and presence of asymmetric effects. Revealing these asymmetries is important to understand how the labour market responds in the long- and short-run to the positive and negative output shocks and can improve the efficiency of economic policy measures in these countries.

To this end, we employ the nonlinear (asymmetric) autoregressive distributed lag approach (hereafter: NARDL) developed by Shin et al. (2014). This method is suitable for relatively small samples and allows one to analyze both the cointegration dynamics and long- and short-run asymmetries by applying an unrestricted error correction model, regardless of the integration order in time series (I(0) or I(1)) (Pesaran et al., 2001). It also enables one to capture the dynamics in the unemployment and real output nexus, the property which cannot be observed by static specifications of Okun's law (Canarella and Miller, 2016). An additional contribution of this study is in the calculation of the dynamic multipliers, which represent the cumulative effects of asymmetric output shocks on labour markets in observed SEE countries. This approach allows an understanding of the labour market adjustment process, covering the initial state of disequilibrium unemployment-output relationship towards new long-run equilibrium.

The rest of the paper is structured as follows. The second section presents the relevant empirical literature, third explains the econometric methodology and dataset while the fourth contains estimation results and discussion. The last section concludes with some policy implications for observed SEE countries.

2. Overview of the Empirical Literature

Since the seminal paper of Okun (1962), a large body of literature has been devoted to the empirical investigation of the output-unemployment relationship. In this section, some of the contemporary research will be presented, especially those which contained new evidence supporting the nonlinearity of Okun's law.

In recent study, Ball et al. (2017) analyze the stability of Okun's law in the United States and in 20 advanced economies. Their findings demonstrate the relative stability of the output-unemployment nexus in most countries over time. In addition, they note that the Okun's coefficient is larger in recessions than during expansions. Similar findings were reported by Valadkahani and Smyth (2015) and Belaire-Franch and Peiró (2015) for the United Stated and by Kargi (2016) for OECD countries. In contrast, Grant (2018) demonstrates that there is a significant time variation in the Okun's coefficient in the United States from 1948Q1 to 2016Q, especially after the Great Recession, since a given unemployment gap has been associated with a smaller output gap. A similar conclusion was made in an earlier study for the United States by Owyang and Sekhposyan (2012). By means of the bivariate error-correction model, Rahman and Mustafa (2017) demonstrate that Okun's law is quite valid in two out of 13 selected developed countries over the 1970-2013 period (the USA and South Korea).

Ibragimov and Ibragimov (2017) find that Okun's law in the Commonwealth of Independent States (CIS) is stable over time and that it successfully describes the average effects of economic growth on unemployment. Novák and Darmo (2019) conclude that Okun's law in EU28 is higher in post-crisis period (2008-2014) than in the period before crisis (2001-2007). Economou and Psarianos (2016) analyze quarterly data about output and unemployment rate for 13 EU countries in period 1993-2014 by using panel data techniques and Mundlak decomposition models. Their research confirms the stability of Okun's law. They also reveal that the higher labour market protection expenditures, the weaker the effect of output changes on unemployment rates.

Harris and Silverstone (2001) discover the asymmetric output-unemployment relationship in seven OECD countries. In a similar vein, analyzing the post-war US data, Silvapulle et al. (2004) show that the negative cyclical output has a more significant short-run impact on cyclical unemployment than the positive one. Canarella and Miller (2016) apply the ARDL approach to Okun's law estimation (the difference version) for three different periods (regimes) in a total time span of 1948Q1-2015Q4 for the United States. They found that after the Great Recession the relationship between output and unemployment has nonlinear (asymmetric) features. The research by Tang and Bethencourt (2017), based on the NARDL modelling, confirms the Okun's law asymmetry in most Eurozone countries.

Caraiani (2012) investigate the existence of asymmetries in the Okun coefficient in the Romanian economy by applying a Markov regime-switching model on monthly data. According to his findings, Okun coefficient is higher during a recession and lower during expansion. Cevik et al. (2013) show that cyclical unemployment in nine transition countries responds more significantly to economic downswings than to upswings, whereas the values of Okun's coefficients depend on the observed regime and country. Karfakis et al. (2014) reveal the asymmetry in Okun's law in Greece in the period 2000-2012. By means of the ARDL model, Tumanoska (2019) shows that Okun's law in North Macedonia had been valid in the period 1991-2017, but her analysis is not focused on the analysis of potential asymmetries.

Although the validity of Okun's law is a subject of numerous empirical studies, few of them are focused on SEE countries, especially on the group of SEE-6 (Western Balkan States). Accordingly, this study fills the gap in the empirical literature, analyzing Okun's law asymmetry in the majority of these countries. The knowledge about the characteristics of the unemployment-output trade-off, particularly in SEE transition economies, as well as the presence of asymmetric effects, certainly improves forecasting of the structural and stabilisation policies effects.

3. Methodology and Data

3.1 Econometric Model

In the relevant literature, the main approaches to the estimation of Okun's are based on the first-difference model and the gap model. The difference version represents a linear relationship between the first differences of the logs of output and the unemployment rate (i.e. their growth rates):

$$\Delta u_t = a + b\Delta y_t + \varepsilon_t, \quad b < 0 \tag{1}$$

where Δ represents difference operator, a denote constant, b is the "Okun's coefficient", u_t and y_t refer to unemployment rate and real output and ε_t is the error term. The gap version actually can be considered as a more general version of Okun's law (Guisinger *et al.*, 2015). This is the relationship between the output gap (difference between actual and potential log output) and the unemployment gap (difference between the actual and natural rate of unemployment) (Grant, 2018) and can be presented as follows:

$$\mu_t = a + bx_t + \varepsilon_t, \quad b < 0 \tag{2}$$

where: $\mu_t = u_t - u^*$ and $x_t = y_t - y^*$. μ_t and x_t denote unemployment gap and output gap, while u^* and y^* refer to the natural rate of unemployment and the potential output, respectively. Unlike the difference version, the gap version takes into account the state of the economy compared with its trend or natural state. However, as stated by Ball *et al.* (2015), the estimation of Equation (2) could be problematic due to implicit assumptions of a constant natural rate of unemployment and a constant long-run growth rate of output which may not always be appropriate. Another problem arises pertaining to the choice of the decomposition (or detrending) method, which produces different estimates of the trends and cycles (Silvapulle *et al.*, 2004). For these reasons, we focus on the first-difference model of Okun's law (1) and estimate the gap model only in case when employing difference model is inadequate. Accordingly, in this section, we construct models for both versions of Okun's law.

Since the static specification given by Equation (1) ignore dynamics between output and unemployment, we extend this relation by including past changes in the unemployment rate and real output, in order to get the dynamic specification of Okun's law. That procedure also helps to eliminate serial correlation in the error terms (Moosa, 1997).

Following Pesaran *et al.* (2001), we use Equation (1) to construct the symmetric ARDL (p, q) model in the error correction form:

$$\Delta u_t = \alpha_0 + \alpha_1 u_{t-1} + \vartheta y_{t-1} + \sum_{i=1}^{p} \kappa_i \, \Delta u_{t-i} + \sum_{i=0}^{q} \delta_i \Delta y_{t-i} + \varepsilon_t, \tag{3}$$

where α_0 denotes constant, α_1 and ϑ refer to long-run coefficients, κ_i and δ_i represent the short-run coefficients, whereas p and q refer to lag length.

In order to investigate the presence of asymmetry in Okun's law, as suggested by Shin *et al.* (2014), we must introduce the short- and long-run nonlinearities in the positive and negative partial sum decompositions of the independent variables. To this end, we start from Equation (1) and formulate the asymmetric long-run regression of the nexus between unemployment and output:

$$u_t = a + b^+ y_t + b^- y_t + \varepsilon_t, \tag{4}$$

where y_t is decomposed as k x 1 vector of regressors $y_t = y_0 + y_t^+ + y_t^-$; y_t^+ and y_t^- represent the partial sum process of the positive and negative changes in y_t, generated as follows:

$$y_t^+ = \sum_{i=1}^{t} \Delta y_i^+ = \sum_{i=1}^{t} max(\Delta y_i, 0); \;\; y_t^- = \sum_{i=1}^{t} \Delta y_i^- = \sum_{i=1}^{t} min(\Delta y_i, 0). \tag{5}$$

By extending Equation (4) into the nonlinear ARDL model in the error correction form, we obtain the partial asymmetry cointegration equation or NARDL model:

$$\Delta u_t = \alpha_0 + \alpha_1 u_{t-1} + \vartheta^+ y_{t-1}^+ + \vartheta^- y_{t-1}^- + \sum_{i=1}^{p} \kappa_i \, \Delta u_{t-i} + \sum_{i=0}^{q} (\delta_i^+ \Delta y_{t-i}^+ + \delta_i^- \Delta y_{t-i}^-) + \varepsilon_t \tag{6}$$

In a similar way, we use Equation (2) to obtain the linear ARDL (m, n) model with the output gap (x_t) as an independent variable:

$$\Delta \mu_t = \beta_0 + \beta_1 \mu_{t-1} + \gamma x_{t-1} + \sum_{j=1}^{m} \rho_j \, \Delta \mu_{t-j} + \sum_{j=0}^{n} \tau_j \Delta x_{t-j} + \varepsilon_t, \tag{7}$$

where β_0 is the constant, β_1 and γ represent the long-run coefficients, ρ_j and τ_j are the short-run coefficients while m and n denotes lag length.

The asymmetric long-run regression of the unemployment gap-output gap trade-off can be defined as:

$$\mu_t = a + b^+ x_t + b^- \Delta x_t + \varepsilon_t, \tag{8}$$

where: x_t is decomposed as a ***z*** x 1 vector of regressors $x_t = x_0 + x_t^+ + x_t^-$; x_t^+ and x_t^- are the partial sum process of the positive and negative changes in x_t, generated as follows:

$$x_t^+ = \sum_{j=1}^{t} \Delta x_j^+ = \sum_{j=1}^{t} max(\Delta x_j, 0)\,; \;\; x_t^- = \sum_{j=1}^{t} \Delta x_i^- = \sum_{j=1}^{t} min(\Delta x_j, 0). \qquad (9)$$

Using Equation (8), we can formulate the NARDL model in the error correction form:

$$\Delta\mu_t = \beta_0 + \beta_1\mu_{t-1} + \gamma^+ x_{t-1}^+ + \gamma^- x_{t-1}^- + \sum_{j=1}^{m} \rho_j\, \Delta\mu_{t-j} + \sum_{j=0}^{n}\left(\tau_j^+ \Delta x_{t-j}^+ + \tau_j^- \Delta x_{t-j}^-\right) + \varepsilon_t. \quad (10)$$

The long-run asymmetry is checked by testing the hypotheses H0: $-\vartheta^+/\alpha_1 = -\vartheta^+/\alpha_1$ and H0: $-\gamma^+/\beta_1 = -\gamma^-/\beta_1$ in Equations (6) and (10), respectively. Similary, the null hypotheses H0: $\sum_{i=0}^{q} \delta_i^+ = \sum_{i=0}^{q} \delta_i^-$ and H0: $\sum_{j=0}^{n} \tau_j^+ = \sum_{j=0}^{n} \tau_j^-$ are tested in order to investigate the short-run asymmetry. The analysis is conducted using the Wald test, as in numerous studies (e.g. Bildirici and Özaksoy, 2016; Tang and Bethencourt, 2017; Kobbi and Gabsi, 2017).

In addition, as in Shin ***et al.*** (2014), we estimate the cumulative dynamic multipliers effects of a unit change in y_t^+ and y_t^- on u_t, as well as of a unit change in x_t^+ and x_t^- on μ_t:

$$m_{h_1}^+ = \sum_{j=0}^{h_1} \frac{\partial u_{t+j}}{\partial y_t^+},\; m_{h_1}^- = \sum_{j=0}^{h_1} \frac{\partial u_{t+j}}{\partial y_t^-}, h = 0,1,2... \qquad (11)$$

$$m_{h_2}^+ = \sum_{j=0}^{h_2} \frac{\partial \mu_{t+j}}{\partial x_t^+},\; m_{h_2}^- = \sum_{j=0}^{h_2} \frac{\partial \mu_{t+j}}{\partial x_t^-}, h = 0,1,2... \qquad (12)$$

Note that as $h_1 \to \infty$, then $m_{h_1}^+ \to L_y^+$ and $m_{h_1}^+ \to L_y^-$ (Equation 11) and as $h_2 \to \infty$, then $m_{h_2}^+ \to L_x^+$ and $m_{h_2}^+ \to L_x^-$ (Equation 12), where L_y^+, L_y^-, L_x^+, and L_x^- are the asymmetric long-run coefficients calculated as follows: $L_y^+ = -\vartheta^+/\alpha_1$ and $L_y^- = -\vartheta^-/\alpha_1$ (Equation 6); $L_x^+ = -\gamma^+/\beta_1$ and $L_x^- = -\gamma^-/\beta_1$ (Equation 10).

Prior to the models' estimation, the causality analysis based on the asymmetric Granger non-causality test was conducted, following Hatemi-J (2012). However, when the time series are integrated of different orders (as the unit root tests in our study demonstrated) it is preferable to test the presence of causality between time series in levels to prevent the problem of using incorrect order of integration (Wolde-Rufael, 2005). For that reason, we apply the Toda-Yamamoto approach to Granger causality based on a modified Wald test (Toda and Yamamoto, 1995). The linkages between unemployment and real output, as well as the unemployment gap and output gap, are given as the standard vector autoregressive (VAR) model. For example, the causality between unemployment and real output (symmetric case) is tested using the system:

$$u_t = a_0 + \sum_{i=0}^{k} a_{1i} u_{t-i} + \sum_{j=k+1}^{d\max} a_{2j}\, u_{t-j} + \sum_{i=0}^{k} b_{1i} y_{t-i} + \sum_{j=k+1}^{d\max} b_{2j}\, y_{t-j} + e_{1t} \qquad (13)$$

$$y_t = c_0 + \sum_{i=0}^{k} c_{1i} y_{t-i} + \sum_{j=k+1}^{d\max} c_{2j}\, y_{t-j} + \sum_{i=0}^{k} d_{1i} u_{t-i} + \sum_{j=k+1}^{d\max} d_{2j}\, u_{t-j} + e_{2t}, \qquad (14)$$

where *k* represents optimal lag length, while $d_{\max}$ denotes the maximal order of integration in time series. For optimal lag selection, Schwarz information criterion (Schwarz, 1978) is applied (Ivanov and Kilian, 2005). According to the unit root tests, the maximal order of integration of time series is 1.

The Granger causality from y_t to u_t in Equation (13) exists if $b_{1i} \neq 0\ \forall i$, and in Equation (14) from u_t to y_t if $d_{1i} \neq 0\ \forall i$. Similar to equations (13) and (14), we tested for causality the relation between the output gap and unemployment gap. Following Hatemi-J (2012), we also investigate the presence of causality between positive and negative changes in the real output (output gap) and unemployment rate (unemployment gap) in order to reveal the asymmetries in their relationships.

3.2 Data

This study uses quarterly data about real GDP and the unemployment rate in eight South-Eastern European countries: Bulgaria, Croatia, Greece, Montenegro, North Macedonia, Romania, Serbia, and Slovenia. The selection of countries and the analyzed time span have been determined by data availability. The analyzed time span is from the first quarter of 2000 to the first quarter of the 2019 (77 observations) for all countries, except for Montenegro (2010Q1-2019Q1, 37 obs.), North Macedonia (2005Q1-2019Q1, 57 obs.) and Serbia (2008Q1-2019Q1, 45 obs.). The data are collected from Eurostat. Time series are seasonally adjusted and transformed into logs. The output is measured by the real GDP (GDP in current prices deflated by a Consumer Price Index), whereas the unemployment rate represents the share of unemployed persons in the total labour force. For the gap version of the Okun's law, the output gap values are calculated as a log ratio of actual to potential real output, which was obtained via Hodrick-Prescott (HP) filter (Hodrick and Prescott, 1997), as suggested by numerous researchers (Neiss and Nelson, 2005; Caraiani, 2006; Ball et al., 2017). The smoothness parameter λ in the HP filter takes the value of 1600, as a standard for quarterly data (Flashel et al., 2008). In a similar way, the unemployment gap was obtained as a log ratio of the actual unemployment rate to the natural rate of unemployment calculated by means of the HP filter.

The dynamics of the analyzed time series (in a logarithmic form) is presented in Figure 1. In most countries, the negative trade-off between the unemployment rate and real output is apparent. The adverse effect of the Great Recession of 2008 on unemployment growth is also obvious. Therefore, we introduce the dummy variable capturing the effects of the crisis in time series, which mainly takes the value of 0 for time periods before the 2008Q1, and the value of 1 afterward, as suggested by Tang and Bethencourt (2017).

Notwithstanding the fact the observed countries are different in many aspects (for instance, Slovenia and Greece are in European Monetary Union, Bulgaria and Romania joined the EU in 2007 and Croatia in 2013, while Montenegro, North Macedonia, and Serbia are EU candidate countries and also transition economies), they still have important similarities in the unemployment-output trade-off dynamics. This makes them suitable for joint analysis of Okun's law validity.

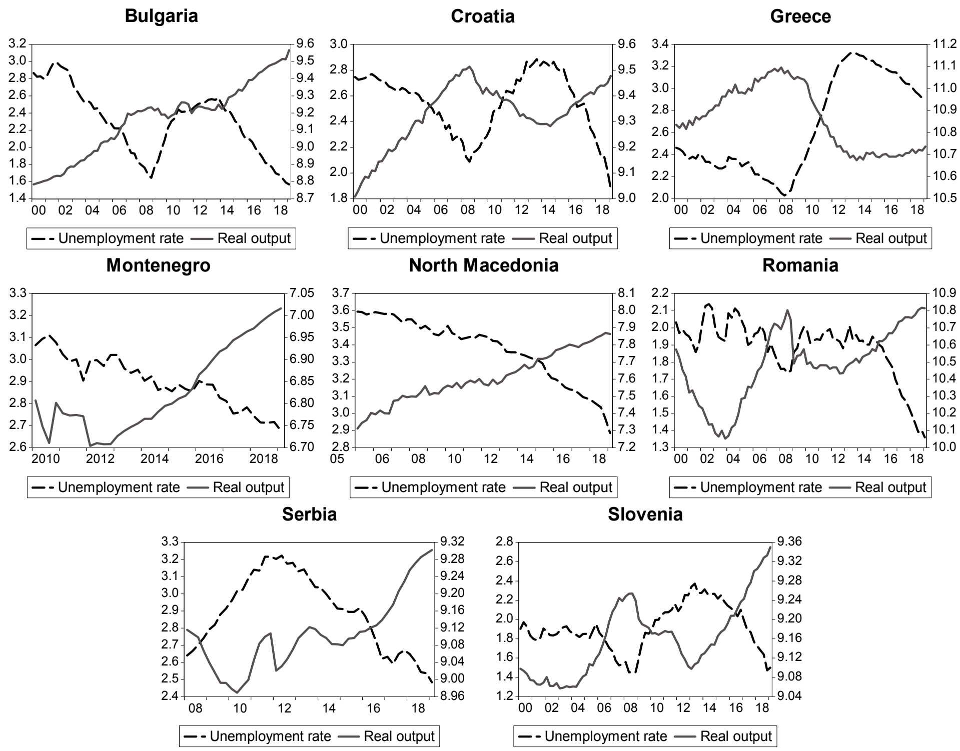
4. Results and Discussion

For correct specification of the ARDL and NARDL models, all variables should be integrated of order I(0) or I(1) or mutually integrated (Shin et al., 2014). Therefore, we conduct the unit root testing in the first place. The results of the parametric Augmented Dickey-Fuller (ADF) test and non-parametric Phillips-Perron (PP) test for stationarity are reported in Table 1. Despite mixed results, one can conclude that all variables are stationary in level and/or in the first difference.

The next step assumes the investigation of a long-run relationship between output (output gap) and unemployment (unemployment gap). The bounds-testing, following Pesaran et al. (2001), and Shin et al. (2014) is applied. The lag length selection is based on the Akaike information criterion. Table 2 reports the F-statistic for symmetric and asymmetric ARDL models. As for the gap version of Okun's law, cointegration is confirmed in all cases. However, in the difference model for Croatia and Romania, there is no cointegration at all, whereas in Greece and Montenegro the cointegration is confirmed only in the asymmetric ARDL model. These findings could indicate that the nature of the unemployment rate-real output nexus is most likely nonlinear.

Figure 1

Unemployment rate and real output dynamics in observed countries



Source: Authors' calculations based on the Eurostat database

Table 1

Results of the unit root tests (intercept and no trend)

	Bulgaria		Croatia		Greece		Montenegro	
	ADF	PP	ADF	PP	ADF	PP	ADF	PP
y	-0.08 (0)	-0.13 [3]	-2.02 (0)	-1.84 [5]	-2.28 (2)	-2.09 [6]	0.49 (0)	0.59 [1]
u	-1.77 (3)	-0.97 [6]	-1.21 (3)	-0.52 [6]	-1.52 (2)	-0.86 [6]	-0.51 (0)	-0.51 [0]
x	-3.32^{b} (3)	-3.45^{b} [5]	-2.98^{b} (0)	-3.19^{b} [3]	-2.08 (0)	-2.25 [3]	-3.79^{a} (0)	-3.85^{a} [2]
μ	-3.97^{a} (3)	-2.54 [5]	-1.76 (0)	-1.82 [5]	-2.03 (1)	-1.97 [5]	-3.81^{a} (0)	-3.86^{a} [2]
Δy	-8.27^{a} (0)	-8.34^{a} [3]	-3.92^{a} (1)	-7.70^{a} [5]	-2.41 (1)	-5.43^{a} [5]	-6.81^{a} (0)	-6.88^{a} [3]
Δu	-2.31 (2)	-4.51^{a} [5]	-1.58 (2)	-6.78^{a} [6]	-3.43^{b} (0)	-3.27^{b} [4]	-7.95^{a} (0)	-8.05^{a} [1]
Δx	-9.35^{a} (0)	-9.36^{a} [1]	-9.79^{a} (0)	-9.78^{a} [1]	-9.60^{a} (0)	-9.55^{a} [2]	-7.49^{a} (0)	-7.49^{a} [0]
$\Delta \mu$	-5.74^{a} (0)	-5.93^{a} [4]	-3.89^{a} (2)	-9.21^{a} [4]	-5.48 (0)	-5.49^{a} [3]	-8.01^{a} (0)	-8.02^{a} [0]
	N. Macedonia		Romania		Serbia		Slovenia	
	ADF	PP	ADF	PP	ADF	PP	ADF	PP
y	-0.55 (0)	-1.55 [0]	-0.74 (1)	-0.84 [4]	0.80 (0)	0.15 [2]	-0.77 (2)	-0.07 [6]
u	3.65 (0)	4.61 [7]	0.36 (0)	0.08 [1]	-2.41 (7)	-0.68 [5]	-1.65 (3)	-1.14 [5]
x	-4.36^{a} (0)	-4.34^{a} [2]	-2.98^{b} (1)	-2.84^{c} [3]	-4.22^{b} (2)	-2.49 [1]	-3.29^{b} (1)	-2.77^{c} [4]

	Bulgaria		Croatia		Greece		Montenegro	
	ADF	PP	ADF	PP	ADF	PP	ADF	PP
μ	-4.90[a] (1)	-2.58 [7]	-3.44[b] (0)	-3.44[b] [0]	-2.03 (0)	-2.20 [2]	-2.53 (0)	-2.72[c] [3]
Δy	-9.31[a] (0)	-9.36[a] [0]	-6.14[a] (0)	-6.26[a] [4]	-4.13[a] (0)	-4.12[a] [0]	-2.88[c] (1)	-5.02[a] [5]
Δu	-4.21[a] (0)	-4.09[a] [4]	-6.96[a] (0)	-6.96[a] [0]	-2.15 (1)	-3.99[a] [4]	-6.68[a] (0)	-6.85[a] [4]
Δx	-9.52[a] (0)	-10.66[a] [5]	-7.20[a] (0)	-7.19[a] [1]	-4.85[a] (3)	-4.40[a] [3]	-5.75[a] (0)	-5.76[a] [0]
$\Delta \mu$	-7.16[a] (1)	-6.49[a] [31]	-7.21[a] (3)	-7.51[a] [4]	-4.64[a] (3)	-6.12[a] [2]	-8.27[a] (0)	-8.28[a] [1]

Notes: the significance levels: a – 0.01, b – 0.05, c – 0.1; Δ is the first difference operator; for ADF test, the numbers in parenthesis indicate the lag order selected (Akaike information criterion). For PP test, the numbers in brackets indicate the truncation for the Bartlett Kernel, as suggested by the Newey-West test (1987). The one-sided p-values are calculated for PP test.

Table 2

Bounds test for cointegration in ARDL and NARDL specifications for SEE countries

	Difference version of the Okun's law							
	Bulgaria		Croatia		Greece		Montenegro	
	ARDL (4,3)	NARDL (4,1,3)	ARDL (4,3)	NARDL (4,3,0)	ARDL (2,4)	NARDL (2,2,4)	ARDL (2,0)	NARDL (1,4,4)
F-stat.	12.84	18.36	1.31	4.43	4.10	5.88	5.03	8.02
Cointegration	Yes	Yes	No	No	No	Yes	No	Yes
	N. Macedonia		Romania		Serbia		Slovenia	
	ARDL (3,1)	NARDL (3,0,1)	ARDL (2,0)	NARDL (2,1,0)	ARDL (3,3)	NARDL (1,3,0)	ARDL (1,0)	NARDL (1,0,2)
F-stat.	6.65	5.23	2.11	3.39	9.79	14.81	20.06	6.62
Cointegration	Yes	Yes	No	No	Yes	Yes	Yes	Yes
	Gap version of the Okun's law							
	Bulgaria		Croatia		Greece		Montenegro	
	ARDL (4,1)	NARDL (4,1,0)	ARDL (4,1)	NARDL (4,1,0)	ARDL (4,2)	NARDL (4,1,0)	ARDL (1,0)	NARDL (1,1,0)
F-stat.	11.31	19.68	12.95	8.98	7.01	5.27	9.97	7.88
Cointegration	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N. Macedonia		Romania		Serbia		Slovenia	
	ARDL (4,2)	NARDL (4,4,3)	ARDL (4,1)	NARDL (4,1,2)	ARDL (3,3)	NARDL (1,3,0)	ARDL (1,4)	NARDL (1,0,4)
F-stat.	9.58	7.12	17.97	13.47	7.96	5.79	16.48	12.99
Cointegration	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The F-statistic was calculated using Wald test for the null hypothesis of no cointegration $\alpha_1 = \vartheta = 0$ (symmetric ARDL) and H_0: $\alpha_1 = \vartheta^+ = \vartheta^- = 0$ *(asymmetric ARDL) for a difference version of the Okun's law, and $\beta_1 = \gamma = 0$ (symmetric ARDL) and $\beta_1 = \gamma^+ = \gamma^- = 0$ (asymmetric ARDL) for a gap version. The critical values are obtained from Pesaran et al. (2001), Case III: Unrestricted intercept and no trend, level of significance 5%: I(0) = 4.94, I(1) = 5.73 (for symmetric ARDL), and I(0) = 3.79, I(1) = 4.85 (for asymmetric ARDL). The numbers in parenthesis denote selected lag order, whereas exact specification of the NARDL models is reported in Table 4.*

Since the presence of cointegration provides no information about the direction of causality between the variables, the application of causality tests is required. Following Hatemi-J (2012), the causality analysis is based on the Granger non-causality test for symmetric and asymmetric cases, using the Toda-Yamamoto procedure (Table 3). In most cases, the causality between the real output and unemployment rate is unidirectional, and taking the real output (output gap) as an explanatory variable is fairly justified. For Croatia and Romania, the absence of cointegration in difference version of Okun's law suggests that the gap version should be estimated. In the case of difference model for North Macedonia, the direction of causality does not support Okun's law, so we also estimate the gap version. In all other countries, the proper direction of causality is revealed in both the difference and gap versions of Okun's law, but we estimate the difference model due to the reasons stated in Section 3.1.

Table 3

Granger non-causality test of the Okun's Law (Toda-Yamamoto procedure)

Difference model						Gap model					
Symmetric case		Asymmetric (+) case		Asymmetric (-) case		Symmetric case		Asymmetric (+) case		Asymmetric (-) case	
H_0	χ^2	H_0	χ^2	H_0	χ^2	H_0	χ^2	H_0	χ^2	H_0	χ^2
Bulgaria											
$y \nrightarrow u$	18.64[a]	$y^+ \nrightarrow u$	14.79[a]	$y^- \nrightarrow u$	6.79[b]	$x \nrightarrow \mu$	16.27[b]	$x^+ \nrightarrow \mu$	7.55[b]	$x^- \nrightarrow \mu$	7.01[b]
$u \nrightarrow y$	3.53	$u \nrightarrow y^+$	2.51	$u \nrightarrow y^-$	2.99	$\mu \nrightarrow x$	2.78	$\mu \nrightarrow x^+$	3.34	$\mu \nrightarrow x^-$	0.54
Croatia											
$y \nrightarrow u$	17.39[a]	$y^+ \nrightarrow u$	16.26[a]	$y^- \nrightarrow u$	8.45[b]	$x \nrightarrow \mu$	10.61[a]	$x^+ \nrightarrow \mu$	7.83[b]	$x^- \nrightarrow \mu$	0.53
$u \nrightarrow y$	2.87	$u \nrightarrow y^+$	3.44	$u \nrightarrow y^-$	4.59	$\mu \nrightarrow x$	2.35	$\mu \nrightarrow x^+$	0.23	$\mu \nrightarrow x^-$	8.57[b]
Greece											
$y \nrightarrow u$	12.09[a]	$y^+ \nrightarrow u$	14.42[a]	$y^- \nrightarrow u$	14.09[a]	$x \nrightarrow \mu$	5.99[c]	$x^+ \nrightarrow \mu$	5.42[c]	$x^- \nrightarrow \mu$	6.99[b]
$u \nrightarrow y$	11.89[a]	$u \nrightarrow y^+$	8.07[b]	$u \nrightarrow y^-$	6.06[b]	$\mu \nrightarrow x$	15.03[a]	$\mu \nrightarrow x^+$	3.46	$\mu \nrightarrow x^-$	1.44
Montenegro											
$y \nrightarrow u$	7.35[b]	$y^+ \nrightarrow u$	19.09[a]	$y^- \nrightarrow u$	11.33[b]	$x \nrightarrow \mu$	2.95[c]	$x^+ \nrightarrow \mu$	11.21[b]	$x^- \nrightarrow \mu$	0.79
$u \nrightarrow y$	3.71	$u \nrightarrow y^+$	2.65	$u \nrightarrow y^-$	8.83	$\mu \nrightarrow x$	8.30[a]	$\mu \nrightarrow x^+$	9.71[b]	$\mu \nrightarrow x^-$	7.54[b]
North Macedonia											
$y \nrightarrow u$	3.13	$y^+ \nrightarrow u$	4.61	$y^- \nrightarrow u$	0.09	$x \nrightarrow \mu$	7.77[b]	$x^+ \nrightarrow \mu$	6.35[b]	$x^- \nrightarrow \mu$	6.12[b]
$u \nrightarrow y$	6.76[b]	$u \nrightarrow y^+$	1.73	$u \nrightarrow y^-$	2.77	$\mu \nrightarrow x$	1.14	$\mu \nrightarrow x^+$	0.19	$\mu \nrightarrow x^-$	2.43
Romania											
$y \nrightarrow u$	4.69	$y^+ \nrightarrow u$	1.47	$y^- \nrightarrow u$	3.08	$x \nrightarrow \mu$	13.64[a]	$x^+ \nrightarrow \mu$	11.55[b]	$x^- \nrightarrow \mu$	0.53
$u \nrightarrow y$	3.72	$u \nrightarrow y^+$	5.60[c]	$u \nrightarrow y^-$	0.21	$\mu \nrightarrow x$	7.29	$\mu \nrightarrow x^+$	16.65[a]	$\mu \nrightarrow x^-$	4.68[c]
Serbia											
$y \nrightarrow u$	6.72[c]	$y^+ \nrightarrow u$	3.04[c]	$y^- \nrightarrow u$	11.08[c]	$x \nrightarrow \mu$	4.31	$x^+ \nrightarrow \mu$	6.17[b]	$x^- \nrightarrow \mu$	2.83
$u \nrightarrow y$	6.48[c]	$u \nrightarrow y^+$	0.05	$u \nrightarrow y^-$	8.07	$\mu \nrightarrow x$	8.17[b]	$\mu \nrightarrow x^+$	2.07	$\mu \nrightarrow x^-$	1.17
Slovenia											
$y \nrightarrow u$	24.18[a]	$y^+ \nrightarrow u$	17.51[a]	$y^- \nrightarrow u$	22.18[a]	$x \nrightarrow \mu$	43.14[a]	$x^+ \nrightarrow \mu$	8.89[b]	$x^- \nrightarrow \mu$	20.74[a]
$u \nrightarrow y$	1.34	$u \nrightarrow y^+$	3.24	$u \nrightarrow y^-$	0.75	$\mu \nrightarrow x$	0.39	$\mu \nrightarrow x^+$	0.99	$\mu \nrightarrow x^-$	13.88[a]

Notes: sign "$\nrightarrow$" means "does not Granger cause". The significance levels: [a] - 0,01; [b] - 0,05; [c] - 0,1. y^+, y^-, x^+, and x^- denote partial sums of positive and negative changes in the output and the output gap, respectively.

Table 4 reports the exact specification of the NARDL model for observed countries. The results of residual diagnostic tests, as well as the tests for dynamic stability and functional form, indicate that all models are well specified.

Since the cointegration between time series is confirmed, we first focus on the long-run relationship. In all countries except Croatia, the long-run coefficients of negative changes in the real output (L_y^-) are higher (in absolute terms) than those for positive changes (L_y^+). However, the Wald test confirms the long-run asymmetry in three of them. More precisely, a 1% increase in output leads to the 2.82% decrease in unemployment rate in Bulgaria, 0.69% in Greece, and 3.64% in Slovenia, whereas a 1% decrease in output leads to the 4.29%, 1.85%, and 5.45% increase in unemployment, respectively.

These findings indicate that, in the long run, the unemployment rate in these three countries responds more significantly in contractionary periods (when output decreases), whereas the unemployment reduction (employment growth) is less pronounced when the economy recovering. That might partially explain the relatively high and persistent unemployment rates in Greece, as well as the inability to return to the pre-crisis levels. Apart from the Great Recession, the euro area debt crisis of 2012 also aggravated the unemployment-output nexus in this country. In addition, the values of the long-run coefficients are relatively low, which could be an indicator of insufficient labour market flexibility in this country. Indeed, Moosa (1997) documents that the Okun's coefficient is higher in economies with a more flexible labour market, and *vice versa*.

In the case of Bulgaria and Slovenia, the observed direction of asymmetry could be a result of a profound rise in unemployment due to the crisis along with the relatively modest decline in the real output (especially in Bulgaria), as well as the relatively high economic growth rates in the post-crisis period which are accompanied by a less pronounced fall in unemployment. Indeed, the impact of the Great Recession on the structural changes in these two economies is confirmed since the dummy variables are statistically significant. However, the labour market in these countries cannot be described as inflexible, given the relatively high values of the long-run coefficients.

The short-run asymmetry is confirmed for Bulgaria, Greece, Montenegro, Serbia, and Slovenia, although the short-run coefficients for Montenegro and Serbia are mainly with a positive sign, which is not in line with Okun's law. More precisely, in the short-run, positive changes in the real output lead to the increase in the unemployment rate in Montenegro and Serbia, and this impact lasts for two or three quarters, which affects the short-term dynamics between these two variables. Although less pronounced, this effect is present in North Macedonia, as well. This could be due to model specification issues as some of the short-run coefficients are not statistically significant, but also a fact that these are transition economies that are amid large structural reforms that might affect the unemployment-output relationship. In addition, it is evident from Table 4 that the long-run coefficients, especially for North Macedonia and Montenegro are relatively low, indicating that unemployment is less responsive to economic growth than in other SEE countries, probably due to a limited labour market flexibility. Further, these findings could indicate that unemployment in these countries is mainly structural, as stated by Botrić (2011). Accordingly, efficient labour market reforms and active labour policies are of particular importance. Of course, these measures must be tailored to the characteristics of the labour market in a particular country. Given the relatively high unemployment in these economies, the cautious designing of policy measures is highly important since expansionary economic policy could lead to a short-run increase in the unemployment rate.

Table 4

Nonlinear ARDL estimation results for Okun's Law in SEE Countries

Difference version						Gap version			
Variable	BUL	GRE	MON	SER	SLO	Variable	CRO	NMC	ROM
Constant	1.12[a]	0.32[a]	2.21[a]	0.68[a]	0.41[a]	*Constant*	-0.03[a]	0.02	-0.04[b]
u_{t-1}	-0.40[a]	-0.17[a]	-0.79[a]	-0.25[a]	-0.25[a]	μ_{t-1}	-0.16[a]	-0.79[a]	-0.82[a]
y_{t-1}^{+}	-1.13[a]	-0.09[b]	-0.73[a]	-0.53[a]	-0.90[a]	x_{t-1}^{+}	-1.39[a]	-0.36[b]	-1.13[a]
y_{t-1}^{-}	-1.72[a]	-0.25[a]	-0.95[b]	-0.55[c]	-1.35[a]	x_{t-1}^{-}	-1.34[a]	-0.37[b]	-1.28[a]
Δu_{t-1}	0.35[a]	0.30[a]	-	-	-	$\Delta\mu_{t-1}$	-0.23[c]	0.92[a]	0.52[a]
Δu_{t-2}	0.12	-	-	-	-	$\Delta\mu_{t-2}$	-0.31[a]	-0.20	0.43[a]
Δu_{t-3}	0.43[a]	-	-	-	-	$\Delta\mu_{t-3}$	0.23[b]	0.45[b]	0.29[b]
Δy_{t}^{+}	-0.45	-0.52	1.31	0.09	-	Δx_{t}^{+}	0.14	0.10	0.16
Δy_{t-1}^{+}	-	0.79[b]	1.62	1.06	-	Δx_{t-1}^{+}	-	0.48[c]	-
Δy_{t-2}^{+}	-	-	0.56	1.92[b]	-	Δx_{t-2}^{+}	-	-0.22	-
Δy_{t-3}^{+}	-	-	1.19[a]	-	-	Δx_{t-3}^{+}	-	0.29	-
Δy_{t}^{-}	-1.76[a]	-1.71[a]	-1.92[a]	-	-1.09	Δx_{t}^{-}	-	0.11	-0.64
Δy_{t-1}^{-}	-0.12	-1.21[b]	-0.75	-	-2.12[c]	Δx_{t-1}^{-}	-	0.01	1.38[b]
Δy_{t-2}^{-}	-1.31[b]	-0.85[c]	-0.36	-	-	Δx_{t-2}^{-}	-	0.46[b]	-
Δy_{t-3}^{-}		-1.39[a]	-0.19[b]	-	-	-	-	-	-
D	0.16[a]	0.03	-0.01	-0.07[a]	0.07[b]	D	0.14	-0.01	0.03
L_{y}^{+}	-2.82[a]	-0.69[a]	-0.92[a]	-2.17[a]	-3.64[a]	L_{x}^{+}	-8.49[b]	-0.45[b]	-1.38[a]
L_{y}^{-}	-4.29[a]	-1.85[a]	-1.20[c]	-2.25[b]	-5.45[a]	L_{x}^{-}	-8.17[b]	-0.47[b]	-1.55[a]
Adj. R^2	0.69	0.76	0.51	0.59	0.40	Adj. R^2	0.33	0.48	0.36
JB test	0.91 (0.633)	1.50 (0.472)	0.31 (0.856)	0.07 (0.965)	0.45 (0.797)	JB test	1.62 (0.444)	1.77 (0.413)	0.26 (0.877)
BG LM	1.36 (0.264)	1.89 (0.161)	1.68 (0.217)	0.72 (0.496)	0.29 (0.748)	BG LM	1.04 (0.359)	0.46 (0.633)	0.36 (0.702)
ARCH	0.20 (0.657)	0.19 (0.663)	0.02 (0.895)	0.05 (0.822)	0.32 (0.573)	ARCH	1.48 (0.234)	0.414 (0.523)	0.14 (0.707)
Cusum	Stable	Stable	Stable	Stable	Stable	Cusum	Stable	Stable	Stable
Cusum Sq.	Stable	Stable	Stable	Stable	Stable	Cusum Sq.	Stable	Stable	Stable
RESET	2.21 (0.143)	0.55 (0.460)	0.25 (0.622)	0.88 (0.356)	1.74 (0.184)	RESET	0.22 (0.642)	0.01 (0.939)	3.33 (0.026)
W_{LR}	15.06 (0.000)	9.53 (0.003)	0.24 (0.629)	0.02 (0.891)	8.58 (0.005)	W_{LR}	1.09 (0.300)	0.20 (0.656)	1.22 (0.273)
W_{SR}	8.60 (0.005)	22.85 (0.000)	15.07 (0.001)	16.79 (0.000)	6.55 (0.013)	W_{SR}	0.04 (0.838)	0.02 (0.903)	0.19 (0.659)

Notes: The significance levels: [a] - 0,01; [b] - 0,05; [c] - 0,1. D refers to dummy variable capturing effects of the Great Recession of 2008. L_y^+ and L_y^- (L_x^+ and L_x^-) denote estimated long-run coefficients of positive and negative changes in the real output (output gap). JB, BG LM and ARCH denote Jarque-Bera test for normality, Breusch Godfrey test for higher-order autocorrelation and test for autoregressive conditional heteroskedasticity, respectively. Cusum and Cusum Squared are tests of dynamic stability based on cumulative sums of residuals. Ramsey RESET tests the null hypothesis of no functional form misspecification. W_{LR} and W_{SR} denote Wald tests for a null hypothesis of long-run and short-run symmetry. The values in parenthesis denote p – values.

An insight into the cumulative effects of asymmetric output shocks on unemployment can be acquired by means of the dynamic multipliers (Figure 2). It is evident that the dynamic multipliers are mainly consistent with identified short- and long-run asymmetry presented in Table 4. The difference curve (dashed blue line) reflects the asymmetry between the impact of positive and negative changes in output on the unemployment rate and is displayed together with its lower and upper bands (dashed red lines) at the 95% confidence interval. In the case when the zero line is located between these bands, then the asymmetric effects of the output are not significant at the 5% level (Shahzad *et al.*, 2017). Apparently, labour markets respond quickly to the output shocks in the short-run in all countries except in Croatia, North Macedonia, and Romania, which is in line with the values of the short-run coefficients reported in Table 4. The impact of negative changes in output (dashed black line) is generally more pronounced than of the positive changes (continuous black line), especially in Bulgaria, Greece, and Slovenia. Approximately, it takes about six to ten quarters to correct the short-run disequilibrium, but the full adjustments towards the new long-run equilibrium take a very long time.

Interestingly, the dynamic multipliers for the three SEE transition economies (Montenegro, North Macedonia, and Serbia) are quite similar. Positive shock in real output (output gap in N. Macedonia) in the short-run actually increases unemployment, as positive values of short-run coefficients for these countries (Table 4) also confirm. In other words, short-run expansion has an unexpected effect on unemployment in these countries, which could be explained by the term “productivity enhanced job destruction”, as stated by Boeri and Garibaldi (2006) in their analysis of transition economies. The improvement of productivity level results in higher growth rates but might lead to cutting off some obsolete occupations, which increases unemployment in the short run.

When it comes to the dynamic multipliers for Greece, it is evident that the positive shock has a very low effect (with an unexpected positive impact on the unemployment 1-2 quarters after the shock), whereas the short-run disequilibrium is dominated by the negative shock which reaches the peak around the fourth quarter. The short-run coefficients of negative changes in output are higher than those in the long run, which accounts for the diminishing impact of the recession starting from the short-run to the long run. Similarly, in the case of Bulgaria, the multiplier in the medium term (5-12 quarters) exceeds the long-run multiplier, as the cumulative effect of the negative and positive changes in output from short to medium run overreach the long-run effect. This could be due to the fact the labour market in Bulgaria is absorbing the majority of these shocks on the path from the medium to the long run. Accordingly, the effects of economic growth on unemployment in this country would be at their highest in the medium term. A similar conclusion could be made for Romania since the multipliers in the medium term (approximately 5-9 quarters after the shock) exceed the long-run multipliers.

All in all, our findings unveil relatively low employment content of economic growth in the analyzed period in five out of eight observed SEE countries. As such, the results coincide well with studies which confirm this kind of asymmetry in Okun’s law in developed countries (Silvapulle et al., 2004; Holmes and Silverstone, 2006; Tang and Bethencourt, 2017), as well as in new EU member states (Boeri and Garibaldi, 2006, Gabrisch and Buscher, 2006). There is also empirical evidence which confirms that phenomenon in transition countries, as a result of labour market inflexibility (e.g. Cevik et al. 2013; Ibragimov and Ibragimov, 2017), wage rigidity in labour market (Babecky et al., 2010), or the productivity-enhancing policy (Boeri and Garibaldi, 2006; Gabrisch and Buscher, 2006).

Figure 2

Dynamic multipliers for unemployment-output trade-off in SEE countries

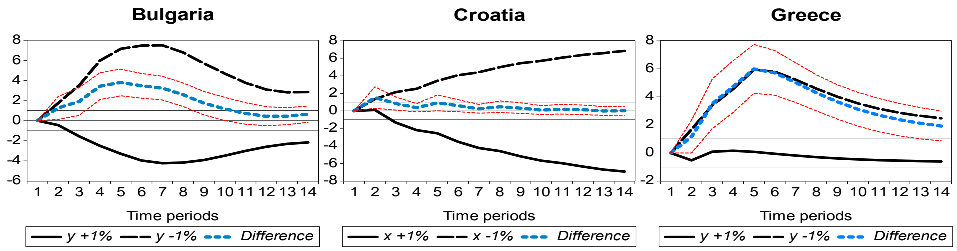
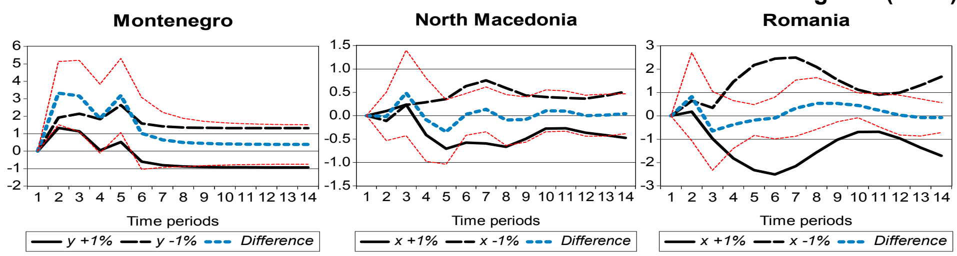
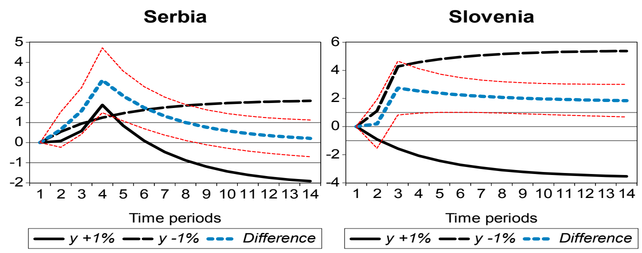


Figure 2(cont.)





Source: Own calculation.

The estimation results for individual economies in this paper also coincide with some of the previous studies. For instance, the direction of asymmetry in Slovenia and Greece has already confirmed in Cevik *et al.* (2013), Karfakis *et al.* (2014), and Tang and Bethencourt (2017). On the other hand, Caraiani (2012) finds evidence for Okun's law asymmetry in Romania in the 1991-2009 period, while our study indicates the short- and long-run symmetry. Apart from the differences in employed methodology, the observed time span could probably be the main reason for these divergent results.

5. Conclusion and Policy Implications

The presence of asymmetry in Okun's law means that changes in output might cause different absolute changes in unemployment in the short- and long-run. The knowledge about this feature provides policy-makers with a benchmark to measure the relative cost of output in terms of the unemployment rate nonetheless the level of economic development of a particular country. By means of a nonlinear ARDL approach, this study has found evidence on Okun's law asymmetry in five out of eight observed SEE countries. In three of them, namely in Bulgaria, Greece, and Slovenia, the positive output shocks exhibit weaker long-run impact on unemployment compared with the negative ones, indicating the long-run asymmetry. Albeit in the reported empirical literature this feature is connected to high structural unemployment and low labour market flexibility, this might not be true in all cases. For instance, high values of the long-run coefficients in Slovenia indicate that the labour market is relatively flexible. In Greece, unemployment is high, while these coefficients are much lower, indicating that measures enhancing labour market flexibility could reduce asymmetric effects in Okun's law. This enables the labour market to become the main mechanism for absorbing shocks, given the inability to use the exchange rate and monetary policy in EMU member countries. Further, the results appear to indicate that labour market in Bulgaria also should react more flexible to output changes. Accordingly, the same policy recommendations hold for this country since it strives to EMU membership in future, together with Romania and Croatia.

The short-run asymmetry consistent with the negative relationship between output and unemployment is detected in Bulgaria, Greece, Montenegro, Serbia, and Slovenia. In addition, dynamic multipliers indicate that labour markets respond quickly to the output shocks in the short-run in all countries except in Croatia, North Macedonia, and Romania and that it takes about six to ten quarters to correct the short-run disequilibrium. Yet, the full adjustments towards the new long-run equilibrium take a very long time. This emphasizes the importance of cautiously designing structural reforms aimed at the reduction of asymmetric effects since the reforms that are effective in the short-run might cause opposite or zero effects in the long-run.

According to the results of the short-run trade-off between unemployment and output, the observed transition SEE economies (Montenegro, North Macedonia, and Serbia) are in a particularly difficult position. The values of short-run coefficients suggest that output expansion would increase the unemployment rate in the first two to three quarters before the decline in unemployment could be expected. Given the relatively high unemployment rates in these countries, economic growth is likely to produce a significant long-run increase in employment, provided it does not lead to fiscal imbalances. However, relatively low values of the long-run coefficients, especially for North Macedonia and Montenegro, suggest that it could be a sign of labour market rigidity. Yet, since these countries are amid structural reforms inherent to the process of transition to a market economy, the unemployment-output trade-off is still qualitatively different than in developed economies. Therefore, the more complex analysis would likely point to the crucial factors of that trade-off and recommend proper labour market reforms and stabilisation policies.

Finally, the analysis in this study unveils that the nonlinear model of Okun's law mainly overperforms the linear one, given the cointegration test estimates and the results of diagnostic tests. Therefore, it is clear that macroeconomic forecasting could benefit from a better understanding of structural breaks and asymmetries in Okun's law, resulting in a decrease in forecasting errors and enhancing the efficiency of economic policy.

References

Babecky, J., Du Caju, P., Kosma, T., Lawless, M., Messina, J. and Room, T., 2010. Downward nominal and real wage rigidity: Survey evidence from European firms. *Scandinavian Journal of Economics*, 112(4), pp.884-910.

Ball, L., Jalles, J.T. and Loungani, P., 2015. Do forecasters believe in Okun's Law? An assessment of unemployment and output forecasts. *International Journal of Forecasting*, 31, pp.176-184.

Ball, L., Leigh, D., Loungani, P., 2017. Okun's Law: Fit at 50? *Journal of Money, Credit and Banking*, 49(7), pp.1413-1441.

Belaire-Franch, J. and Peiró, A., 2015. Asymmetry in the relationship between unemployment and the business cycle. *Empirical Economics*, 48(2), pp.683-697.

Bildirici, M. and Özaksoy, F., 2016. Non-linear analysis of Post Keynesian Phillips curve in Canada labor market. *Procedia Economics and Finance*, 38(2016), pp.368-377.

Boeri T. and Garibaldi, P. 2006. Are labour markets in the new member states sufficiently flexible for EMU? *Journal of Banking & Finance*, 30(5), pp.1393-1407.

Botrić, V., 2011. Structural unemployment and its determinants in Southeast Europe. *Economic Though and Practice*, 1, pp.81-100.

Canarella, G. and Miller, S. M., 2017. Did Okun's law die after the Great Recession? *Business Economics*, 52(4), pp.216-226.

Caraiani, P., 2006. Alternative Methods of Estimating the Okun Coefficient. Applications for Romania. *Romanian Journal of Economic Forecasting*, 7(4), pp.82-89.

Cevik, E.I., Dibooglu, S. and Barisik, S., 2013. Asymmetry in the Unemployment-Output Relationship over the Business Cycle: Evidence from Transition Economies. *Comparative Economic Studies*, 2013, 1-25.

Economou, A. and Psarianos, I.N., 2016. Revisiting Okun's Law in European Union Countries. *Journal of Economic Studies*, 43(2), pp.275-287.

Flashel, P., Groh, G., Proaňo, C. and Sammler, W., 2008, *Topics in Applied Macrodynamic Theory*, Springer-Verlag, Berlin, Germany.

Gabrisch, H. and Buscher, H. 2006. The Relationship between Unemployment and Output in Post-communist Countries. *Post-Communist Economies*, 18(3), pp.261-276.

Grant, A.L., 2018. The Great Recession and Okun's law. *Economic Modelling*, 69,pp.291-300.

Guisinger, A., Hernandez-Murillo, R., Owyang, M. Sinclair, T., 2015. A state-level analysis of Okun's law. *Federal Reserve Bank of St. Louis Working Paper*.

Harris, R. and Silverstone, B., 2001. Testing for asymmetry in Okun's law: A cross-country comparision, *Economic Bulletin*, 5(2), pp.1-13.

Hatemi-J, A., 2012. Asymmetric causality tests with an application. *Emprirical economics*, 43(1), pp.447-456.

Hodrick, R.J. and Prescott, E.C., 1997. Postwar U.S. Business Cycles: An Empirical Investigation. *Journal of Money, Credit and Banking*, 29, pp.1-16.

Holmes, M.J. and Silverstone, B., 2006. Okun's law, asymmetries and jobless recoveries in United States: A Markov-switching approach. *Economic Letters*, 92, pp.293-299.

Ibragimov, M. and Ibragimov, R., 2017. Unemployment and output dynamics in CIS countries: Okun's law revisited, *Applied Economics*, 49(34), pp.3453-3474.

International Monetary Fund, 2019. World Economic Outlook: Global Manufacturing Downturn, Rising Trade Barriers. Washington, DC, October.

Ivanov, V. and Kilian, L., 2005. A practitioner's guide to lag order selection for VAR impulse response analysis. *Studies in Nonlinear Dynamics & Econometrics*, 9(1), pp.1-34.

Izyumov, A., and Vahaly, J., 2002. The Unemployment-Output Tradeoff in Transition Economies: Does Okun's Law Apply? *Economics of Planning*, 35, pp.317-331.

Karfakis, C., Katrakilidis, C. and Tsanana, E., 2014. Does output predict unemployment? A look at Okun's law in Greece, *International Labour Review*, Vol. 153(3), pp.421-433.

Kargi, B., 2016. Okun's Law and Long-term Co-integration Analysis for OECD Countries (1987-2012). *Emerging Markets Journal*, 6 (1), pp.38-46.

Kobbi, I. and Gabsi, F.B., 2017. The nonlinearity of the New Keynesian Phillips curve: the case of Tunisia. *Economies*, 24 (5), pp.1-12,

Moosa, I.A., 1997. A cross-country comparison of Okun's Coefficient. *Journal of Comparative Economics*, 24(3), pp.335–356.

Neiss, K. S. and Nelson, E., 2005. Inflation dynamics, marginal cost, and the output gap: evidence from three countries. *Journal of Money, Credit and Banking*, 37(6), pp.1019-1045.

Newey, W. and West, K., 1987. A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica*, 55, pp.703-708.

Novák, M. and Darmo, L., 2019. Okun's law over the business cycle: does it change in the EU countries after the financial crisis? *Prague Economic Papers*, 28(2), pp.235-254.

Okun, A. M., 1962. Potential GNP: Its measurement and significance. Proceedings of the Business and Economic Statistics Section of the American Statistical Association, pp.98-104.

Owyang, M. T. and Sekhposyan, T., 2012. Okun's Law over the Business Cycle: Was the Great Recession All That Different? *Federal Reserve Bank of St. Louis Review*, 94(5), pp.399-418.

Pesaran, M.H., Shin, Y. and Smith, R.J., 2001. Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16, pp.289–326.

Rahman, M. and Mustafa, M., 2017. Okun's law: evidence of 13 selected developed countries. *Journal of Economics and Finance*, 41(2), pp.297-310.

Schwarz, G.E., 1978. Estimating the dimension of a model. *Annals of Statistics*, 6(2), pp.461–464.

Shahzad, S.J.H., Nor, S.M., Ferrer, R. and Hammoudeh, S., 2017. Asymmetric determinants of CDS spreads: U.S. industry-level evidence through the NARDL approach. *Economic Modelling*, 60(2017), pp.211-230.

Shin, Y., Yu, B., and Greenwood-Nimmo, M., 2014. Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In: Sickles R., Horrace W. (eds). *Festschrift in honor of Peter Schmidt*, Springer, pp.281–314.

Silvapulle, P., Moosa, I.A. and Silvapulle, M.J., 2004. Asymmetry in Okun's Law. *The Canadian Journal of Economics*, 37(2), pp.353-374.

Tang, B. and Bethencourt, C., 2017. Asymmetric unemployment-output tradeoff in the Eurozone. *Journal of Policy Modeling*, 39, pp.461-481.

Toda, H. Y., and Yamamoto, T., 1995. Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics*, 66(1-2), pp.225-250.

Tumanoska, D., 2019. The Validity of Okun's Law in North Macedonia. *Business and Economic Research*, 9(2), pp.160-168.

Valadkahani, A. and Smith, R., 2015. Switching and asymmetric behaviour of the Okun coefficient in the US: Evidence for the 1948-2015 period, *Economic Modelling*, 50(November), pp.281-290.

Wolde-Rufael, Y., 2005. Energy demand and economic growth: The African experience. *Journal of Policy Modeling*, 27(8), pp.891-903.