sciendo

UDK: 338.22(497.7)
DOI: 10.2478/jcbtp-2019-0009

Journal of Central Banking Theory and Practice, 2019, 1, pp. 183-207
Received: 24 November 2017; accepted: 26 february 2018

Danica Unevska Andonova*
Magdalena Petrovska**

* National Bank of the Republic of Macedonia, Skopje, Macedonia

Email:
UnevskaD@nbrm.mk

** National Bank of the Republic of Macedonia, Skopje, Macedonia

Email:
PetrovskaM@nbrm.mk

Disaggregating Okun's Law: A Case-Study for Macedonia[1]

Abstract: Okun's law is one of the most widely-known stylized facts in the macroeconomic literature and policy. In this paper we study several aspects of Okun's law in Macedonia between 2004 and 2016. Aggregate indicators show a link between output and unemployment that is in line with other emerging markets and regional peers. We also find that the relationship has been somewhat weaker in recent years, which might be related to the recent job-intensive growth in the wake of structural reforms after the global financial crisis and particularly the subsequent European debt crisis. When investigating whether various expenditure components of GDP may cause different unemployment reactions, an important issue that has not been sufficiently addressed in the literature,we find that domestic demand has a stronger effect. We also provide several robustness checks to our main findings, and illustrate how they might be used to improve forecasting.

Keywords: Disaggregated Okun's law, unemployment, expenditure components of GDP

JEL classifications: E2, E24, C22

[1] The responsibility for this paper lies solely with the individual authors. The views expressed herein do not necessarily represent those of the National Bank of the Republic of Macedonia.

1. Introduction

In 1962, Arthur Okun reported an empirical regularity: a negative short-run relationship between unemployment and output[2]. Since then, many studies have confirmed this finding. Consequently, Okun's law has become a constituent in macroeconomic textbooks, along with the Phillips curve, as models in which shifts in aggregate demand cause changes in output, which in turn lead firms to hire and fire workers. According to these models, when unemployment is high, it can be reduced through demand stimulus. However, it may more accurately be referred to as a "rule of thumb", because it is more of a statistical relationship rather than a theoretically founded concept or a structural feature of the economy.

Okun's law represents a statistical relationship between unemployment and GDP that is most commonly used for evaluating the unemployment rate - why it might be at a specific level or where it might be drifted, for instance. The most common form of Okun's law, known as the difference or growth rate form of Okun's law, relates changes in output to changes in unemployment. In addition, the gap form that accounts for the relationship between unemployment and GDP gaps also enjoys considerable empirical support (e.g. International Monetary Fund - IMF (2012) and Ball, Leigh and Loungani (2013)). The idea is that when output is growing below its potential (i.e. long-run trend), a negative gap opens up, which should put upward pressure on the unemployment gap (and opposite for positive gaps). We use this approach in the case of Macedonia, employing the quarterly data between 2004 and 2016. By using a version of the regression that embodies gaps, we basically allow for changes in the trend output and the trend unemployment rate, which is particularly important in an environment of continuous structural changes and considerable shocks during the analyzed period in Macedonia[3]. Since trend GDP and unemployment are not directly observable, we use the Hodrick-Prescott filter for de-trending the data.

The research on Okun's law in Macedonia is very limited, pointing to a gap in the literature that our study aims to address. After investigating the link between unemployment and GDP growth in Macedonia, we extend the analysis in several

---

[2] Originally, it suggested that a change in the unemployment rate (measured in points) between any two periods should approximate one-third of the change in the percentage gap between potential and actual GNP (Okun, 1962).

[3] More information on Macedonian business cycle facts as well as an overview of the mix of macroeconomic indicators that could summarize and predict business cycle patterns in Macedonia can be found in Petrovska, Krstevska and Naumovski (2016).

aspects that might be important both from a research and policy perspective. For instance, we use rolling regressions to analyze whether the Okun's coefficient from the benchmark model has changed significantly after the most recent global financial crisis and particularly after the subsequent European debt crisis. Further, in line with the recent literature, we analyze possible differential impacts of the individual expenditure categories gaps (consumption, investment, government expenditure, exports and imports) on changes in the unemployment rate gap. Indeed, addressing the possible links between particular components of GDP and unemployment, which might go beyond the link to overall GDP, is one of the main contributions of this paper. In order to check the robustness of our results, we use alternative specifications of Okun's law. Finally, time-variation notwithstanding, Okun's law can still be useful as a forecasting tool. Therefore, we also address the effects of aggregation and disaggregation within the context of accurate forecasting.

The remainder of this paper is structured as follows. Section 2 provides a brief literature review. This is followed by a short section on stylized facts. Methodology and data are outlined in Section 4. Section 5 contains baseline results, as well as several extensions and robustness checks. The final section concludes.

2. Literature review

Due to its importance for economic policy, Okun's Law is always an absorbing topic, so a considerable body of literature deals with this issue. As Okun himself was working with U.S. data, most of the studies examine the validity and stability of Okun's law for the U.S. or advanced countries with longer time series. However, the IMF has also produced some research work that includes developing and emerging economies (e.g. IMF, 2013).

A recent stream of papers points out that Okun's Law is unstable, i.e. that the nature of the relationship between output and unemployment has changed over time. Knotek (2007) claims that the instability in Okun's coefficients is related to the business cycle, reflecting the fact that unemployment reacts to output very differently during expansions than it does in recessions (i.e. in expansions, Okun's coefficient is smaller than during recessions). These findings are based on an OLS estimation of difference and dynamic forms of Okun's law on quarterly US data between 1948 and 2007. It also uses rolling OLS regressions to analyze patterns in the Okun's coefficient behavior over time, where it finds that the contemporaneous correlation has decreased over time, while the correlation with the lagged values of output growth has increased. Further, Owyang and Sekhposyan

(2012) estimate three various specifications of Okun's law (difference, gap and dynamic-distributed lag version), using quarterly US data between 1949 and 2011 to analyze whether Okun's law has changed significantly during the past three US recessions. Their findings suggest that each of the last three recessions was followed by a "jobless recovery" in which unemployment did not fall as much as Okun's law predicted. Related to this, based on estimations of dynamic difference specifications for 21 advanced countries for a 20-year period, the IMF (2010) finds that during recessions, unemployment rises beyond the levels predicted by Okun's law. As far as reasons for this weakening of Okun's law are concerned, McKinsey Global Institute (2011) argues that Okun's law has broken down because of problems in the labor market, such as the mismatch between workers and jobs. They actually recognize labor market policies such as job training, and not the demand stimulus, as the key to reducing unemployment. Similarly, using ARDL on UK quarterly data between 1973 and 2003, Petkov (2008) finds that factors possibly playing a major role in labor market's reaction to changes in output include the supply and demand for labor, alterations in labor productivity such as the efficiency in the use of workers, characteristics of the added workers, the variability of average hours worked, as well as institutional changes.

On the other hand, there is a strand in the literature that actually confirms the stability of Okun's coefficient over time. For instance, Ball et al. (2013) find that changes in the coefficient during the Great Recession are modest in size and short-lived. They estimate both gap and difference forms of Okun's law using OLS on US data starting from 1960,as well as a gap form on 20 advanced economies separately(in this case, the sample starts in 1980). As a conclusion, they point out a strong and stable relationship in most of the analyzed countries, which did not change substantially during the Great Recession. Additionally, findings by Daly, Fernald, Jordà and Nechio (2014) show that, during the recent global crisis, Okun's coefficient remained remarkably similar to the one observed in previous deep US recessions, thus rejecting the rumors of the death of Okun's law during the Great Recession as greatly exaggerated. Their findings are based on US annual data for the period 1959-2013, using a classical OLS estimate of the difference version of Okun's law. Further, using OLS regressions in gap and difference form for each of the three Baltic States, Ebeke and Everaert (2014) find relatively high Okun's coefficients. In addition, their rolling regressions show that Okun's coefficient is trending down, and that there is no strong indication of a break since the 2008/2009 crisis.

An important aspect is that the various expenditure components of GDP may embody different (un)employment reactions. This issue of the estimation of disaggregated Okun's law started to gain attention in the empirical literature only

recently, with some of the most important studies including those of the European Central Bank - ECB (2012a), Anderton, Aranki, Bonthuis and Jarvis (2014), and Pesliakaitė (2015). The ECB (2012a) and Anderton et al. (2014) with a panel fixed effects estimation on the euro area countries and Pesliakaitė (2015) with an OLS analysis on Lithuania find that unemployment is particularly sensitive to movements in the consumption component of GDP, while movements in foreign trade (exports and imports) have a much lower impact on unemployment developments, primarily as a reflection of the highly labour-intensive nature of services, which represent the bulk of consumers' expenditure. Additionally, Anderton et al. (2014) compare the effectiveness of the disaggregated versus the aggregated Okun's relationship in a forecast precision framework. In this regard, their findings point out to the disaggregated model as notably better at predicting unemployment, particularly for the period covering the most recent global crisis and the subsequent rebound in economic activity.

The research on Okun's law in Macedonia is very limited, pointing to a gap in the literature that our study aims to address. We could highlight the IMF's staff work examining, among other things, the Macedonian labour market circumstances (IMF, 2013). Within this study, there is a brief analytical section on Okun's coefficients in Western Balkan countries, obtained by using an OLS estimation technique. The authors find a widespread dispersion of elasticities among the analysed countries, showing that Okun's relationship in these countries is not clear-cut. When zooming into this specific relationship for Macedonia over the past 15 years, the study concludes that unemployment and economic output are rather de-linked, suggesting a weak contemporaneous relationship between them. A similar exercise on the New EU Member States (NMS) clearly shows that the labour market in these countries is much more reactive to shifts in the business cycle than it is in the Western Balkans (IMF, 2013). In this context, Kovtun, Cirkel, Murgasova, Smith and Tambunlertchai (2014) underline the structural nature of the long-lasting labour market weaknesses in the Western Balkans such as the institutional setup of labour markets, labour cost factors, and especially the unfinished transition process.

3. Stylized facts

Since achieving independence in early 1990s, there were several distinct stages in economic movements of economic growth and unemployment in Macedonia (Figure 1). In the beginning of the transition process, the total economic activity experienced a significant fall against the backdrop of regional conflicts and external blockades. With the regional and domestic political and economic stabili-

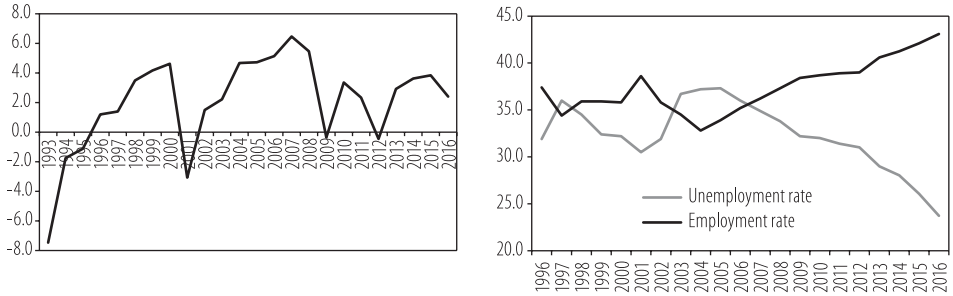
zation in early 2000s and in a favourable global economic environment, positive growth rates were generated, reaching an average of around 5% between 2004 and 2008. After the economic fall in 2009, as a result of the global financial crisis, followed by negative implications of the euro area debt crisis in 2012, the economy continued to grow[4] albeit at a slower pace (averaging around 3% between 2010 and 2016).

In the pre-crisis period, positive developments in economic activity had not fully reflected on the labour market. The inherited high unemployment rate from the transition remained at a high level of over 30%. Positive developments were registered after 2006 when a downward trend in the unemployment rate began, continuing during and after the global crisis and the European debt crisis. This positive trend largely reflected on the intensive job creation in the Macedonian economy, which to a great extent was a result of the structural reforms undertaken as the Government's response to the global financial crisis, and most notably to the subsequent European debt crisis. The main pillars of this employment-friendly policy include the extensive agricultural subsidy schemes, the comprehensive institutional support of micro and small businesses, various infrastructural projects, several types of active labour market measures, productivity enhancement packages, as well as the FDI attraction policy and the building of Technological-Industrial Development Zones (TIDZ). Consequently, the number of employees increased, particularly in services sectors. The biggest increase was registered in transport and storage and construction, as well as in manufacturing and agriculture. Significant increases were also noticed in administrative and support services, public administration and defence and information and communication services. The increased labour demand was mostly met by unemployed persons, which ultimately led to a reduction of the unemployment rate. Indeed, since 2013, the unemployment rate was constantly below 30%, and at the end of 2016 it was 23.1%.

Consequently, when considering the reaction of the labour market to the changes in the real output, data show an obvious adjustment delay in the unemployment rate to changes in economic activity, a factuality taken into account in our estimations.

[4] With 2012 as an exception to this general trend.

Figure 1: Annual real GDP growth rate (left) and the employment and unemployment rates (right), in %



Source: State statistical office (SSO) of Republic of Macedonia.

4. Methodology and data

The original article laying out Okun's law (Okun, 1962) is based on two simple empirical equations that link economic growth and the unemployment rate. These two relationships arise from the observation that more labour is typically required to produce more goods and services within an economy. More labour can come through a variety of forms, such as having employees work longer hours or hiring more workers. To simplify the analysis, Okun assumed that the unemployment rate can serve as a useful summary of the amount of labour being used in the economy. However, as with any statistical relationship, it may be subject to changes in an ever-changing economy. Moreover, Okun himself noted that the simplicity of these equations could potentially be problematic. So, from this time-distance we can map a number of variations on Okun's original relationships, which have been used in various empirical studies (as surveyed above), and which we also use below to investigate Okun's law in Macedonia.

The gap or level version of Okun's law is used to determine the relationship between output and unemployment gaps. It can be captured by the following equation:

$$u_t - u_t^* = \beta(y_t - y_t^*) + \varepsilon_t \tag{1}$$

where u_t is the unemployment rate, y_t is the logarithm of real GDP, and the variables marked with * are their long-term levels, that is, the natural rate of un-

employment and potential GDP, respectively. The parameter β is often called "Okun's coefficient." The main assumption behind Equation1 is that shifts in aggregate demand cause fluctuations in output, which in turn causes firms to hire or fire workers, i.e. unemployment to change. The error term captures other factors that may shift the unemployment-output relationship, such as unusual changes in labour productivity or in labour force participation. It should also be noted that there is much uncertainty in estimating the gap version of Okun's law, since both output and unemployment gaps are not observable variables and therefore should be estimated. In this paper, as a benchmark specification we adopt the gap definition of Okun's law given under Equation 1.

The **difference version** of Okun's law focuses on the relationship between the change in the unemployment rate and the change in real GDP, as described in the following equation:

$$u_t - u_{t-1} = \alpha + \beta(y_t - y_{t-1}) + \omega_t \quad \text{or} \quad \Delta u_t = \alpha + \beta \Delta y_t + \omega_t \tag{2}$$

where u_{t-1} and y_{t-1} are the rate of unemployment and the real GDP from the previous period, respectively. Equation 2 is derived from Equation 1 and assumes that the natural rate of unemployment is unchanged and potential GDP grows at a constant rate. Under these assumptions, Equation 1 yields Equation 2 with $\alpha=-\beta\Delta y^{\star}$, where $\Delta y^{\star}$ is the constant growth rate of potential output, and $\omega t = \Delta \varepsilon t$. However, assuming a constant growth rate of potential GDP or a fixed natural rate of unemployment may be very unrealistic for developing and emerging economies, bearing in mind the scale and the effects of the structural changes in these countries. Nevertheless, one can still think of Equation 2 as a separate and simpler way of modelling the data that avoids some of the problems inherent for Equation 1, particularly regarding the estimation of trend or potential values.

The **dynamic version** of Okun's law is partly based on one of Okun's observations that both past and current output can impact the current level of unemployment (Knotek, 2007). Commonly, on the right-hand side of the equation both contemporaneous and lagged values of GDP growth and the lagged value of the change in the unemployment rate are included (Equation 3). Adding lagged values of the dependent variable allows the serial correlation in the error terms to be eliminated. The dynamic version of Okun's law defined in this way bears some resemblance to the original difference version of this law. However, it is still fundamentally distinct since it no longer only captures the contemporaneous correlation between changes in the unemployment rate and real output growth.

Consequently, this relationship does not have the same simple interpretation as the original difference version of Okun's law.

$$\Delta u_t = \alpha + \beta \Delta y_t + \gamma \Delta y_{t-1} + \delta \Delta u_{t-1} + \omega_t \quad (3)$$

Some important methodological contributions regarding Okun's law have been recently provided in the empirical literature. In particular, the **disaggregated Okun's relationship** has started to attract increasing empirical interest. This approach in fact takes a fuller account of the different reactions of unemployment to movements of the various expenditure components of GDP. For instance, Anderton et al. (2014) augment the standard Okun's specification, as given in Equation 2, by using the accounting approximation in Equation 4 below, which decomposes changes in aggregate GDP (Y) into changes of its constituent expenditure components (GDP_g): private consumption (*con*), government spending (*gov*), investment (*inv*), exports (*exp*) and imports (*imp*):

$$\Delta Y = \Delta \Sigma GDP_g \approx \sum_g (GDP_g / \sum_g GDP_g) \Delta GDP_g \equiv \sum_g \lambda_g \Delta GDP_g \quad (4)$$

where λ_g gives the weight of each component as a share in total GDP.

Substituting (4) into (2) yields:

$$\Delta u_t = \alpha + \sum_g \beta_g \lambda_g \Delta GDP_{g,t} + \varepsilon_t \quad (5)$$

Thus, by introducing the term $\lambda_g \Delta GDP_g$, separate $ß_g$ coefficients for each component of GDP are estimated, representing the differential unemployment responsiveness ("the unemployment intensity") of each institutional sector to aggregate demand. In addition, the product of $ß_g \lambda_g$ is also important as it represents the differential "component elasticities" – i.e., the proportional responsiveness of unemployment to movements in each GDP component (which partly reflects the weight of the expenditure component in GDP). The sum of these elasticities ($\sum_g ß_g \lambda_g$) should be roughly equivalent to the Okun's coefficient estimated from an aggregate specification.

The data set used in our analysis consists of quarterly seasonally adjusted figures for the unemployment rate, the real GDP and its expenditure components between 2004 Q1 and 2016 Q4, as quarterly data for unemployment for the period prior to 2004 are not available. We calculate the gaps by using the Hodrick-Prescott (HP) filter, with λ=1600, in line with the standard practice for quarterly

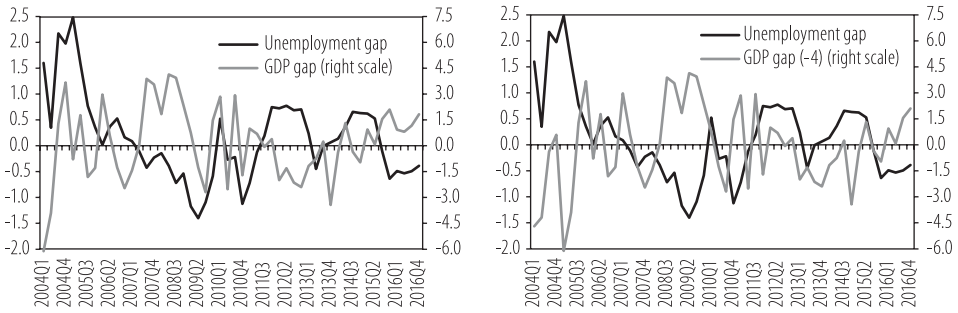
data. In order to avoid the end-point bias of the HP filter, the gaps of all series are calculated using the figures covering the period 1998 Q1 - 2017 Q2[5].

5. Results

5.1. Baseline results

Before launching the analysis, it is useful to first exploit the existing institutional knowledge embedded in the National Bank of the Republic of Macedonia - NBRM small-scale calibrated New Keynesian Monetary Policy Analysis Model (MAKPAM) (described in detail in Hlédik, Bojceva Terzijan, Jovanovic and Kabashi (2016)). A previous version of this model included a modification of Okun's law in gap form to provide a forecast of unemployment[6]. The unemployment reaction to changes in economic activity in this model is calibrated to be delayed for a year. Figure 2 lends considerable support to this, indicating a relatively delayed effect of economic growth and unemployment, whereas Table 1 in the Appendix (the correlation matrix) provides additional details.

Figure 2: GDP gap and unemployment rate gap developments



Source: SSO of Republic of Macedonia, authors' calculations.

[5] Since quarterly unemployment is unavailable before 2004, we use quarterly figures derived from a standard method for temporal disaggregation applied on the annual readings (a method primarily concerned with movement preservation, which in parallel does not involve usage of one or more high frequency indicator series). In addition, the severity of the end-point bias of the HP filter is underscored by simply extending the estimation sample (that ends in 2016) with actual figures for two adjacent quarters (i.e. actual readings for 2017 Q1 and Q2). Using forecasts for the real GDP can be considered an alternative option for reducing the bias of the trend estimates at the end of the sample. To this end, just for an illustration, a very useful compendium of the class of models suitable for GDP short-term forecasting in small and open economies is presented in Poghosyan (2016).

[6] The current MAKPAM version only includes relations between employment and GDP.

Our methodology broadly follows Ball et al. (2013). We start with the gap form of Okun's relationship (Equation 1 in Section 4), which is estimated using OLS on aggregate data covering the full-sample (Table 1). Results show that the slope coefficient is both negative and significant at 1 percent level. In other words, the full-sample estimation results show that an increase in the output gap by 1 percentage point reduces the unemployment gap by 0.18 percentage points after a year. Our results corroborate the IMF (2012) findings that the average coefficient in the gap version of the Okun's law for developing and emerging countries equals -0.17. In addition, a coefficient with a similar magnitude has been estimated for Balkan countries by IMF (2013) and Kovtun et al. (2014).

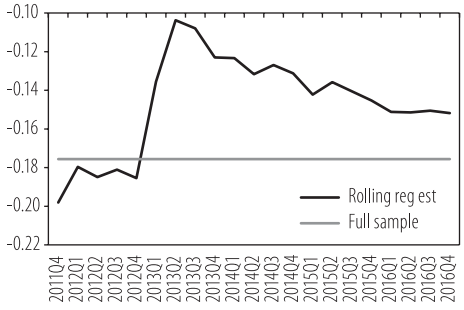
Table 1: Estimation of aggregate Okun's law (gap specification)

Dependent variable: Unemployment gap	
Explanatory variable	Coefficient
GDP gap (-4)	-0.176***
	(0.043)
Sample: 2004Q1 2016Q4	
Adjusted R-squared	0.223
Jarque Bera test p-value	0.064

*, ** and *** refers to 10%, 5% and 1% significance, accordingly.
Coefficient standard errors are given in parentheses.
Source: Authors' calculations.

One of our key interests is to analyse whether Okun's coefficient has changed significantly after the most recent global financial crisis and, particularly, after the subsequent European debt crisis. Therefore, in order to analyse statistically the degree of variation in the Okun's relationship, we proceed with the rolling regression technique, where Okun's coefficients are estimated on the basis of a moving sample. Put differently, the aggregate specification of Okun's relationship in a gap form was estimated over a stream of sliding sample windows. This process produces a sequence of estimated Okun's coefficients. If the relationship is stable over time, then the estimated coefficients should be relatively similar between each other. On the other hand, variations in the relationship will appear as sizable movements in the estimated set of coefficients. In this particular case, we consider all possible 8-year sub-samples starting at the beginning of our full data sample and moving sequentially by one time period. Results are shown in Figure 3, where the reported date corresponds to the end of the respective 8-year sub-sample.

Figure 3: Okun's coefficients estimated via rolling regression (gap specification)



Source: Authors' calculations.

Figure 3 shows that Okun's law in the gap form yields greater stability starting from mid-2013. A significant shift in the slope coefficient has occurred around this period, and afterwards this coefficient does not change a lot, i.e. it appears to be changing in a rather smooth manner.

In addition, one can notice a decline in responsiveness of the unemployment rate gap to changes in the output gap in the period following mid-2013. This largely reflects the observed intensive job creation that the Macedonian economy experiences during this time span i.e. a decline in the unemployment rate that has been quicker than its historical norm – a process which, due to its structural nature, reduced the equilibrium (potential) level of the unemployment rate. The structural changes can be highlighted as one of the factors that have improved the efficiency of the labour market as well, as indicated by Beveridge curve developments (see Figure 1 in the Appendix). In particular, starting from 2012 Q1 until 2013 Q2, an inward shift in the Beveridge curve is observed, with a positive structural shock inducing falls in both vacancy and unemployment rates. Such a trajectory suggests a growing matching efficiency of the labour market, i.e. closer matching of labour supply and demand. It is significant that the influence of the improvements in the economic cycle registered throughout the period 2012-2016 can also be seen on the Beveridge curve. In addition, another element linked to the observed changing cyclical responsiveness of the unemployment could be the following: the job-intensive growth, supported by fiscal policy, might cause the labour market to react more rapidly to the changes in the economic activity. In other words, such a policy-induced change in the transmission time might be a possible reason behind the reduced sensitivity of unemployment to output from 2013 onwards[7].

Beyond the aggregate Okun's specification, we are also interested in possible differential impacts of the individual expenditure categories gaps (consumption, investment, government expenditure, exports and imports) on changes in the

[7] Of course, the most correct way to check whether the transmission time of the effect from the economic activity to the labour market has changed is to run a regression on this particular period. However, such an analysis is made impossible by the very short time span of only 16 quarters in total (2013 Q1-2016 Q4).

unemployment rate gap. Therefore, we follow the methodology in Anderton et al. (2014) and estimate separate *ßg* coefficients for each component of GDP. By introducing $\lambda_g \Delta GDP_g$ we are able to isolate the differential unemployment responsiveness ("unemployment intensity"), $ß_g$, of each expenditure component in aggregate demand, presented in Table 2.

Table 2: Estimation of disaggregate Okun's law (gap specification)

Dependent variable: Unemployment gap	
Explanatory variable	Coefficient
λ_{con}CON_GAP(-4)	-0.136***
	(0.047)
λ_{gov}GOV_GAP(-4)	-0.493***
	(0.117)
λ_{inv}INV_GAP(-4)	-0.050
	(0.039)
λ_{exp}EXP_GAP(-4)	-0.124**
	(0.053)
λ_{imp}IMP_GAP(-4)	0.080
	(0.050)
Sample: 2004Q1 2016Q4	
Adjusted R-squared	0.317
Jarque Bera test p-value	0.312

*, ** and *** refers to 10%, 5% and 1% significance, accordingly.
Coefficient standard errors are given in parentheses.
Source: Authors' calculations.

The estimated parameters for the individual expenditure components reveal the differential impact of the components of aggregate demand on unemployment. Absolute values range from around 0.5 for the government consumption gap to less than 0.1 for investments and import gaps (which are however not statistically significant[8]), with all of the components having the expected signs. Moreover, according to the adjusted R-squared, the explanatory power of the model increases significantly – from 0.22 in the aggregate formulation of this rule (Table 1) to 0.32 when the Okun's relationship is decomposed by expenditure components (Table 2).

The results are generally in line with the findings of ECB (2012a), Anderton et al. (2014) and Pesliakaitė (2015) on the relative magnitudes of the differential impacts of various GDP components on unemployment. The results show that

[8] However, all estimated parameters are jointly statistically significant (see Appendix, Table 3).

unemployment is most sensitive to the domestic demand components of output, while foreign trade components have a lower impact on the unemployment rate. Consequently, a decrease in labour-intensive domestic demand will have a considerably larger negative effect on employment than an equivalent decrease in capital-intensive exports.

Table 3 presents differential component elasticities, which are the unemployment intensities multiplied by the individual weights of the expenditure components[9]. The sum of the elasticities of all output components is -0.19, which is broadly in line with the estimated aggregate Okun's coefficient presented in Table 1, thus indicating the robustness of this extension. One key finding is that unemployment is most responsive to changes in the consumption component of output, to the extent that a 1 percentage point decrease in the private consumption gap increases next-year's unemployment rate gap by 0.1 percentage points. The absolute magnitude of the elasticity of the other components ranges from 0.01 to 0.07, confirming that changes in domestic demand have by far the greatest impact on unemployment developments. Namely, the relatively higher unemployment intensities for consumption capture the labour-intensive nature of the services that represent a large quantity of consumer expenditures. On the other hand, around 70% of exports consist of goods, of which more than half is industry-related exports. By their nature, manufactures tend to have higher productivity and be relatively less labour intensive than services. Furthermore, the Macedonian exports of goods have very high import contents, hence the value added output and labour intensity of a given increase in exports are expected to be relatively lower than for the domestic demand components, which corroborates with Anderton et al. (2014).

Table 3: Component elasticities, averages 2004 Q1-2016 Q4

gaps	Unemployment intensities (β_g)	Average weight (λ_g)	Component elasticity ($\beta_g \lambda_g$)
Consumption	-0.136	0.756	-0.10
Government expenditure	-0.469	0.158	-0.07
Investment	-0.050	0.260	-0.01
Export	-0.124	0.410	-0.05
Import	0.080	0.583	0.05
Total			-0.19
GDP			-0.18

Source: Authors' calculations.

[9] The weights of each component, λ_g, refer to the whole period averages (2004 Q1-2016 Q4).

5.2. Robustness checks

In this section we report several checks carried out in order to evaluate the robustness of the empirical findings, summarized in Table 4. The first two columns of Table 4 refer to the results from our benchmark specifications with gaps (aggregate and disaggregate approach). Columns 3 and 4 show the results of the introduction of dynamics into the gap version of Okun's law. The remaining columns show results associated with the difference version of Okun's law.

Table 4: Okun's Law estimates under aggregate and disaggregated approaches

dependent variable	Unemployment gap				Unemployment rate annual change			
explanatory variables/1	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP (-4)	-0.176***		-0.031		-0.094**		-0.034	
	(0.043)		(0.035)		(0.042)		(0.031)	
λ_{con}CON(-4)		-0.136***		-0.027		-0.064		0.007
		(0.047)		(0.040)		(0.047)		(0.034)
λ_{gov}GOV(-4)		-0.493***		-0.047		-0.235*		0.125
		(0.117)		(0.112)		(0.128)		(0.102)
λ_{inv}INV(-4)		-0.050		-0.026		-0.057		-0.027
		(0.039)		(0.030)		(0.041)		(0.029)
λ_{exp}EXP(-4)		-0.124**		-0.049		-0.105*		-0.029
		(0.053)		(0.042)		(0.061)		(0.044)
λ_{imp}IMP(-4)		0.080		0.029		0,092		0.032
		(0.050)		(0.038)		(0.059)		(0.042)
UNEMP(-1)			0.668***	0.655***			0.568***	0.652***
			(0.088)	(0.108)			(0.081)	(0.092)
Constant					-0.674***	-0.694***	-0.386**	-0.424**
					(0.210)	(0.236)	(0.155)	(0.168)
Sample: 2004Q1 2016Q4 (52 observations)								
Diagnostic tests:								
Adjusted R-squared	0.223	0.317	0.634	0.612	0.072	0.007	0.530	0.519
F-statistic					4.964	1.075	29.769	10.165
Prob(F-statistic)					0.030	0.387	0.000	0.000
Jarque Bera p-value	0.064	0.312	0.000	0.000	0.327	0.604	0.226	0.205

*, ** and *** refers to 10%, 5% and 1% significance, accordingly.
Coefficients standard errors are given in parentheses.
1/ UNEMP always reflects the quantitative expression of the unemployment rate as a dependent variable.
Source: Authors' calculations.

To this end, in order to evaluate the robustness of our benchmark specifications (column 1 and 2), we estimate their dynamic counterparts, by adding a lagged term of the dependent variable, i.e. a lag of the unemployment rate gap (columns 3 and 4), thus broadly following Anderton et al. (2014).

The coefficient on the output gap in benchmark equation is –0.176; when lag is included, the Okun's coefficient becomes -0.031[10], pointing to relatively high persistence of the unemployment rate gap, which ultimately signals a higher labour market rigidity[11] (which is broadly in line with expectations). Apart from the evidence given by Okun's coefficient, the low volatility of the unemployment rate cycle itself (Figure 2) appears to be another indication of the rigidity of the labour market.

Turning to the parameters of the different expenditure components (column 4), the introduction of a lagged dependent variable makes all of the individual parameters statistically insignificant[12].The dynamic specifications (column 3 and 4) basically correct for omitted effects of past unemployment rate gap on its contemporaneous value. However, a main drawback of the dynamic specifications compared to the benchmark models is that they are not as easy to interpret as their static counterparts (adding complexity is generally perceived as an undesirable feature for a rule of thumb).

However, the relative magnitudes of the long-run coefficients are similar to those reported in the respective benchmark estimations (column 2 in Table 4, in the Appendix)[13].

---

[10] The Wald test for the specification in column 3 implies that the coefficients are jointly statistically significant. In particular, we test the null hypothesis that all coefficients are jointly equal to zero (C(1)=C(2)=0), against the alternative that the estimated coefficients are jointly significantly different from zero. The probability value (p=0.0) of the F-statistics (F(2,50)=46.93) shows that the null hypothesis is rejected in favour of the alternative hypothesis.

[11] This implies to relatively high costs of employment adjustment, which in turn means that firms accommodate short-run output fluctuations in other ways: they adjust the number of hours per worker and the workloads (which produces procyclical movements in measured labour productivity).

[12] However, the F-test of overall significance implies that the coefficients are jointly not all equal to zero. In particular, we test the null hypothesis that all coefficients are jointly equal to zero (C(1)=C(2)=C(3)=C(4)=C(5)=C(6)=0) against the alternative that the estimated coefficients are jointly significantly different from zero. The probability value (p=0.0) of the F-statistics, (F(6,46)=14.96) shows that the null hypothesis is rejected in favour of the alternative hypothesis.

[13] The long-run response of unemployment gap to changes in output gap and its components are derived through normalization based on coefficient on lagged unemployment rate gap.

At this point we shift our focus toward the difference version of Okun's law. This specification avoids strong and sometimes controversial assumptions regarding the definition and computation of potential output and full employment. Instead of first differencing[14], we follow the approach of Anderton et al. (2014) and ECB (2012a, 2012b) and thus use annual growth rates of the variables. Further, the finally employed specification relies on the fourth lag of output growth instead of the contemporaneous one, meaning that we again do not digress from the previously identified country specific labour-market regularity. This is in line with IMF (2013), which concludes that unemployment and economic activity are rather de-linked when contemporaneous changes are analysed.

The estimation results show that Okun's law in difference form (column 5 and 6) may not be as reliable as the gap specification suggests. In particular, first point of concern is the low regressions fit (adjusted R-squared). In addition, the joint dynamics of the mean and the slope coefficients in the disaggregated form are not statistically significant (F-statistics is insignificant). Moreover, the ratio "–a/b" (*Annual growth in the unemployment rate = a + b*(Annual real output growth(-4)*) in column 5, which gives the annual rate of output growth registered a year before consistent with a stable annual change in unemployment rate, or how quickly the economy would typically need to grow a year before to maintain an unchanged level of unemployment rate in the current period, analysed on annual basis, is negative, making this particular specification of Okun's law counterintuitive.

For the sake of completeness, we have estimated a dynamic version of the difference specification of the Okun's law as well (columns 7 and 8). The main concern related to the specification in column 8, is linked to the inadequate sign of some of the domestic demand components. Having in mind that the disaggregated version is practically augmented standard Okun's relationship based upon an accounting approximation which decomposes changes in aggregate GDP into changes of its constituent expenditure components, we find it unjustifiable to use the aggregate counterpart of this specification as well (column 7), because ultimately the conclusions drawn from this pair of specifications should converge.

To sum up, after a bunch of rigorous model validations, we find it legitimate to limit ourselves to using benchmark model specifications (column 1 and 2) for further analysis.

[14] Equation in first difference with contemporaneous effect (Equation 2) was estimated as well. However the results show that the Okun's coefficient has an incorrect sign.

5.3. Evaluating the potential forecast accuracy gain from the disaggregated Okun's law in gaps

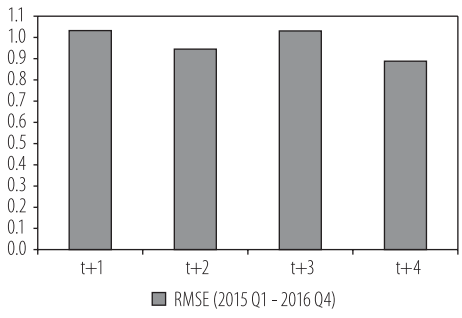
This section evaluates the extent to which the disaggregated approach enhances the forecasting performance over the aggregate Okun's "rule of thumb". Namely, very often policymakers use Okun's law as a real-time rule of thumb to assess conditions in the labour markets. Consequently, it would be useful to set up a framework for a comprehensive comparison of the aggregate and the disaggregate approach. Indeed, there is a possibility that the decomposition of Okun's relationship, which takes a fuller account of the differing reactions of unemployment rate gap to movements of the various expenditure components gaps, may significantly enhance the predictive accuracy.

To test our hypothesis directly we carry out an out-of-sample forecasting experiment for the last 16 quarters, spanning the period from 2013 Q2 to 2017 Q1, i.e. we run a horserace between these two models. To describe the losses associated with forecast errors, we have adopted a standard average loss function, i.e. the Root Mean Squared Error (RMSE), defined as:

$$RMSE = \sqrt{\frac{\sum_{t=1}^{n}(y-\hat{y})^2}{n}} \tag{6}$$

The model that has the smallest RMSE average losses in the out-of-sample forecasting simulation is then the superior forecasting approach.

Figure 4: Ratios of the RMSE of up to four quarters ahead out-of-sample forecasts of the unemployment rate gap (RMSE of disaggregated model versus the aggregated benchmark)



Source: Authors' calculations.

We are interested in examining how the numerical values of the RMSE ratios would evolve if we would consider only the latest period (2015 Q1-2016 Q4). Figure 4 below summarizes the forecasting competition outcome via a comparison of the ratios of the RMSE from the disaggregated Okun's law in a gap form relative to the aggregate benchmark, with a value less than one indicating that the forecast from the disaggregated model outperforms the benchmark at the specified horizon. More precisely, the bars in Figure 4 are

actually ratios of the average RMSE from the disaggregated model relative to the aggregated benchmark.

As expected, the results confirm that, on average, the disaggregated version of the gap form of Okun's relationship produces more accurate forecasts as compared with the aggregate benchmark specification. Forecasting improvements relative to the aggregate benchmark are particularly visible for the second and the fourth period ahead. On average, the RMSE ratios show almost 2.6% greater forecast accuracy of the disaggregated approach relative to the aggregated benchmark up to 4 quarters ahead. In addition, the RMSE ratios vary only marginally across the different forecast horizons.

6. Conclusion

This paper investigates Okun's law in Macedonia and should be useful for policymakers trying to support economic growth while at the same time trying to lower unemployment as one of the historically most important economic problems. It focuses on three key questions. First, is Okun's law a reliable and stable relationship in Macedonia? Second, what is the impact of the individual expenditure categories (consumption, investment, government expenditure, exports and imports) on changes in unemployment? And third, is the law a useful forecasting tool?

The evidence suggests that Okun's relationship regarding the responsiveness of the unemployment rate gap to changes in output gap (i.e. our benchmark model) has declined around mid-2013 and it has remained relatively stable ever since. This actually reflects the observed intensive job creation that the Macedonian economy experienced during this time span (i.e. decline in the unemployment rate that is quicker than its historical norm – a process which, due to its structural nature, reduced the equilibrium (potential) level of the unemployment rate). This probably reflects to a great extent the effects of structural reforms undertaken as a form of the government's response to the global financial crisis, and particularly to the subsequent European debt crisis. Namely, throughout the past several years, the Macedonian government's key policy statements dealing with a wide range of issues were related to the medium and long-term growth of the country, put forward to ensure employment-intensive growth prospects.

Moreover, our results indicate that the unemployment rate gap is mostly affected by changes in the domestic demand components, while movements in the foreign trade (export and import) expenditure gap have a significantly lower impact on

the unemployment gap. The estimates of the relative magnitudes of the differential effects also seem sensible. In other words, the change in labour-intensive domestic demand will have a considerably larger effect on unemployment than an equivalent change in capital-intensive exports. In addition, the results show that, on average, the disaggregated version of Okun's relationship produces more accurate forecasts compared to the aggregate benchmark.

The empirically-driven estimates in this study should be relevant to policy-makers, as they try to further support the economic growth and the growth of employment. In addition, they might also help calibration choices. In particular, the coefficients that characterize these fundamental behaviours might be employed as an important input in the version of the MAKPAM model, which is the key block in the forecasting and policy analysis system of the central bank. Moreover, the coefficients derived from our benchmark model might be considered as prior means in some estimated DSGE model for Macedonia, like for instance the one described in Bašić Vasiljev (2018) on the case of Serbia, but with a labour-market extension.

References:

1. Anderton, R., Aranki, T., Bonthuis, B. and Jarvis, V. (2014). Disaggregating Okun's Law: Decomposing the Impact of the Expenditure Components of GDP on Euro Area Unemployment. ECB Working Paper No. 1747.
2. Ball, L., Leigh, D. and Loungani, P. (2013). Okun's Law: Fit at Fifty. IMF Working Paper WP/13/10.
3. Bašić Vasiljev, T. (2018). Estimated DSGE Model for Monetary and Fiscal Policy Coordination Analysis – The Case of Serbia. *Journal of Central Banking Theory and Practice*, 2018, 1, pp. 145-173.
4. Daly, M. C., Fernald, J., Jordà O. and Nechio, F. (2014). Interpreting Deviations from Okun's Law. Federal Reserve Bank of San Francisco, FRBSF *Economic Letter* 2014-12, April 21, 2014.
5. Ebeke, C. and Everaert, G. (2014). Unemployment and Structural Unemployment in the Baltics. IMF Working Paper WP/14/153.
6. ECB. (2012a). Euro Area Labour Markets and the Crisis. ECB Structural Issues Report, October 2012.
7. ECB. (2012b). "Recent Developments in the Okun Relationship in the Euro Area". ECB Monthly Bulletin, July 2012, Box 3.
8. Hlédik, T., Bojceva Terzijan S., Jovanovic B. and Kabashi R. (2016). Overview of the Macedonian Policy Analysis Model (MAKPAM). National bank of the Republic of Macedonia Working Paper.
9. IMF. (2010). "Unemployment Dynamics in Recessions and Recoveries: Okun's law and Beyond". *World Economic Outlook*, April 2010, Chapter 3.
10. IMF. (2012). "Jobs and Growth: Can't Have One without the Other?". World Economic Outlook, October 2012, Chapter 4, Box 4.1.
11. IMF. (2013). Will Structural Transformation Allow Labor Market Convergence? *Republic of Macedonia: Selected Issues Paper, IMF Country Report* No. 13/179, pp. 3-15.
12. Knotek, E.S. (2007). How Useful Is Okun's Law? Federal Reserve Bank of Kansas City, *Economic Review,* Fourth Quarter 2007, pp. 73-103.
13. Kovtun, D., Cirkel, A. M., Murgasova Z., Smith, D. and Tambunlertchai, S. (2014). Boosting Job Growth in the Western Balkans. IMF Working Paper WP/14/16.
14. McKinsey Global Institute. (2011). An Economy That Works: Job Creation and America's Future. June 2011 Report.
15. Okun, A.M. (1962). Potential GNP: Its Measurement and Significance. *Proceedings of the Business and Economics Statistics Section of the American Statistical Association*, pp. 98–104.
16. Owyang, T.M. and Sekhposyan, T. (2012). Okun's Law over the Business Cycle: Was the Great Recession All That Different? Federal Reserve Bank

of St. Louis, *Federal Reserve Bank of St. Louis Review*, September/October 2012, 94(5), pp. 399-418.
17. Pesliakaitė, J. (2015). The Impact of GDP Structure on the Stability of Okun's Law in Lithuania. *Bank of Lithuania Academic Journal "Monetary Studies"* 2015/2, pp.88-94.
18. Petkov, B. (2008). The Labour Market and Output in the UK – Does Okun's Law Still Stand? Bulgarian National Bank Discussion Paper DP/69/2008.
19. Petrovska, M., Krstevska, A., and Naumovski, N. (2016). Forecasting Macedonian Business Cycle Turning Points Using Qual Var Model. *Journal of Central Banking Theory and Practice*, 2016, 3, pp. 61-78.
20. Poghosyan, K. (2016). A Comparison of Different Short-Term Macroeconomic Forecasting Models: Evidence from Armenia. *Journal of Central Banking Theory and Practice*, 2016, 2, pp. 81-99.

APPENDIX

Table 1: Correlation matrix

a) Gaps

correlation coeff. (2004 Q1-2016 Q4)		GDP_GAP				
		t	t-1	t-2	t-3	t-4
U_GAP	t	-0.17	-0.17	-0.34	-0.49	-0.50

b) Annual changes

correlation coeff. (2004 Q1-2016 Q4)		GDP_4GROWTH				
		t	t-1	t-2	t-3	t-4
U_4CHANGE	t	0.14	0.18	0.03	-0.19	-0.30

Source: Authors' calculations.

Table 2: ADF test for stationarity

	level		annual change	
series	t-stat	prob	t-stat	prob
Unemployment rate	-1.84	0.67	-2.69	0.01
GDP	-3.62	0.04	-3.45	0.00
Private consumption	-2.22	0.47	-3.38	0.00
Government consumption	-3.89	0.02	-3.69	0.00
Investment	-7.26	0.00	-6.35	0.00
Export	-1.72	0.73	-3.14	0.00
Import	-2.51	0.32	-2.76	0.01
Unemployment rate gap	-3.94	0.00		
GDP gap	-5.13	0.00		
Private cons gap	-4.05	0.00		
Government cons gap	-3.90	0.00		
Investment gap	-7.86	0.00		
Export gap	-3.38	0.00		
Import gap	-6.06	0.00		

Source: Authors' calculations.

Table 3: Coefficients' restriction test

Wald Test:			
Null Hypothesis: C(1)=C(2)=C(3)=C(4)=C(5)=0			
Test Statistic	Value	df	Probability
F-statistic	6.018	(5. 47)	0.000
Chi-square	30.091	5	0.000
Restrictions are linear in coefficients.			

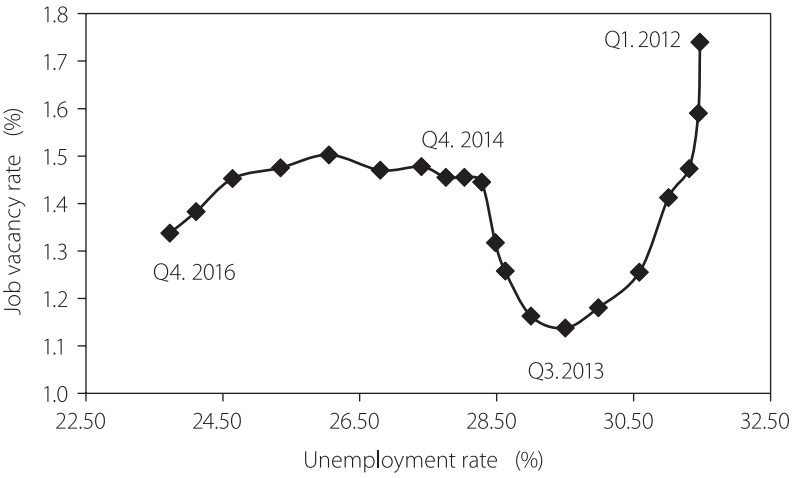
Source: Authors' calculations.

Table 4: Calculated long term coefficients

dependent variable	Unemployment gap	
explanatory variables	(1)	(2)
GDP (-4)	-0.094	
λ_{con}CON(-4)		-0.078
λ_{gov}GOV(-4)		-0.136
λ_{inv}INV(-4)		-0.075
λ_{exp}EXP(-4)		-0.141
λ_{imp}IMP(-4)		0.083

Source: Authors' calculations.

Figure 1: Beveridge curve for Macedonia*



* The basis for this analysis is quarterly data on unemployment rate, vacancies and occupied posts. The national statistical authority is responsible for compiling job vacancy statistics. The job vacancy rate is calculated as the ratio between the number of vacancies and the sum of the number of vacant and occupied posts. For the analysis to be clear, it is necessary to remove seasonality from the figures. Unfortunately, the job vacancy rate (JVR) figures are available only starting from 2012 Q1, so it was chosen, along with the unemployment rate data, to average them over four quarters (e.g., the figure for 2014q4 is calculated as an average of 2014q1, 2014q2, 2014q3 and 2014q4). In addition, due to the objective constrains related to the length of the JVR series, the JVR data for 2012 Q1 plotted in the Figure 1 is actually the official JVR rate itself for this period. JVR figure for 2012 Q2 is an average of the 2012 Q1 and the 2012 Q2 JVR official rates. Analogously, the JVR data presented in Figure 1 for 2012 Q3 is calculated as an average of the official JVR rates for the 2012 Q1-2012 Q3 period.

Source: Authors' calculations.