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# National Bank of the Republic of Macedonia



**Working paper No. 8**

## **Disaggregating Okun's law: a case-study for Macedonia**

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May 2018

### **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 2014. Aggregate indicators show a link between output and unemployment that is in line with this empirical regularity and the findings for the other emerging markets and regional peers. We also find that the relationship has been somewhat weaker in the recent years, which might be related to the recent job-intensive growth in the wake of structural reforms before and during 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 of unemployment.

**JEL classifications:** E2, E24, C22.

**Keywords:** Okun's law, GDP, unemployment, Macedonia

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## 1. Introduction

In 1962, Arthur Okun reported an empirical regularity: a negative short-run relationship between unemployment and output (Okun, 1962)<sup>1</sup>. 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 cause firms to hire or 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 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. IMF (2012) and Ball, Leigh and Loungani (2013)). The idea is that when output grows 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 our work, which analyses Okun's law in Macedonia using quarterly data between 2004 and 2014. 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. 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 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, notwithstanding time-variation, 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 of unemployment.

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<sup>1</sup> Originally, it suggested that "the change in 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).

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. Data and methodology 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 US data, most of the studies examine the validity and stability of Okun's law for the US 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 into the Okun's coefficients is related to the business cycle, reflecting the fact that unemployment responds 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 ordinary least squares (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, 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 Autoregressive Distributed Lag model (ARDL) on UK quarterly data between 1973 and 2003, Petkov (2008) finds that factors possibly playing a major role in labor market's response 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 additional 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 to a strong and stable relationship in most of the analyzed countries, which did not

change substantially during the Great Recession. Additionally, findings by Daly et al. (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, which may partly explain some of the empirical findings of instability in the aggregate Okun's relationship. 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 ECB (2012a), Anderton et al. (2014) and Pesliakaitė (2015). ECB (2012a) and Anderton et al. (2014) with a panel fixed effects estimation on euro area countries and Pesliakaitė (2015) with an OLS analysis on Lithuania find that unemployment is particularly sensitive to movements in the private 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 labor-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 labor 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 analyzed countries, showing that Okun's relationship in these countries is not a clean 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 labor 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 et al. (2014) underline the structural nature of the long-lasting labor market weaknesses in the Western Balkans such as the institutional setup of labor markets, labor cost factors, and especially the unfinished transition process.

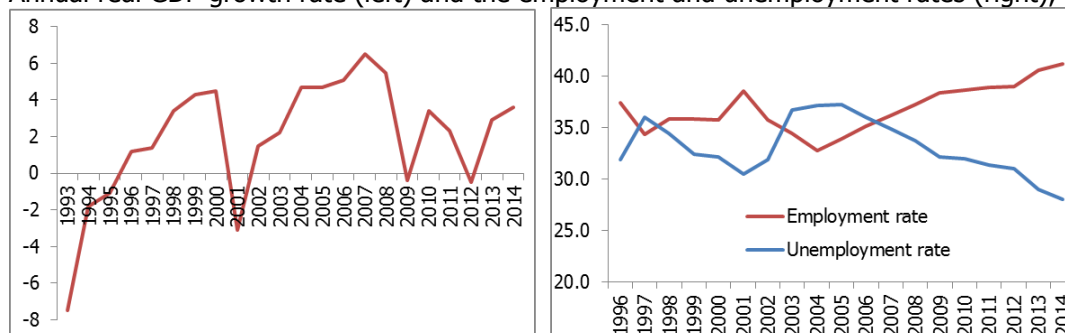
### 3. Stylized facts

Since its independence in early 1990s, there have been several distinct stages in the 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 stabilization in early 2000s, and amid favorable global economic environment, positive growth rates were generated, reaching an average of about 5% growth 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, but at a slower pace (averaging 3% between 2010 and 2014, with the exclusion of 2012), which was however higher than in most European countries.

In the pre-crisis period, the positive developments in economic activity were not fully reflected in the labor market. The high unemployment rate inherited 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, which continued during and after the global crisis and the European debt crisis. This positive trend largely reflects the intensive job creation, as well as the transitions from informal jobs to formal employment in the Macedonian economy, which was largely a result of the structural reforms undertaken by the Government. The main pillars of this employment-friendly policy include extensive agricultural subsidy schemes, comprehensive institutional support of micro and small businesses, various infrastructural projects, several types of active labor market measures, productivity enhancement packages, as well as FDI attraction policy and building of Technological-Industrial Development Zones (TIDZ). Consequently, the number of employees has increased. The biggest increase has been registered in transport and storage and construction, as well as in manufacturing and agriculture. Significant increases have also been noticed in administrative and support service activities, public administration and defense and information and communication. The increased labor demand has mostly been met by unemployed persons, which ultimately lead to the reduction of unemployment rate. Indeed, since 2013 the unemployment rate has been constantly below 30%, and at the end of 2014 it was 27.6%. However, the developments in GDP and the unemployment rate do not follow each other very closely, suggesting that the labor market does not respond immediately to the changes in the overall economic activity, which is taken into consideration in our estimations.

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 labor is typically required to produce more goods and services within an economy. More labor can come through a variety of forms, such as having employees work longer or hiring more workers. To simplify the analysis, Okun assumed that the unemployment rate can serve as a useful summary of the amount of labor not 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 perspective, 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 formula:

$$u_t - u_t^* = \beta(y_t - y_t^*) + \varepsilon_t \quad (1)$$

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 unemployment and potential GDP, respectively. The parameter  $\beta$  is often called "Okun's coefficient." The main assumption behind equation 1 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 labor productivity or in labor force participation. It should be also 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 above, in 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 formula:

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

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  $\alpha = -\beta \Delta y^*$ , where  $\Delta y^*$  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 modeling the data that avoids some of the problems inherent for the 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, in the right-hand side of the equation, both the 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.

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

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 ( $imp$ ):

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

where  $\lambda_g$  gives the weight of each component as a share in total GDP.

Substituting (4) into (2) yields:

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

Thus, by introducing the term  $\lambda_g \Delta GDP_g$ , separate  $\beta_g$  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  $\beta_g \lambda_g$  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 ( $\Sigma_g \beta_g \lambda_g$ ) 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 2014 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  $\lambda=1600$ , in line with the

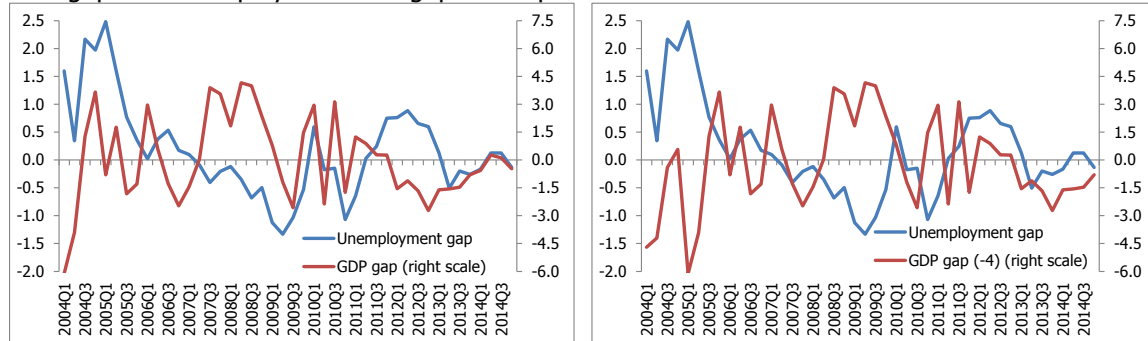
standard practice for quarterly data. In order to avoid the end-point bias of the HP filter, the gaps of both series are calculated on figures covering the period 1998 Q1-2016 Q4<sup>2</sup>.

## 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 small-scale calibrated New Keynesian Monetary Policy Analysis Model (MAKPAM) (latest version of this model is described in detail in Hlédik et al. (2016)). Previous versions of this model included a modification of Okun's law in gap form to provide a forecast of unemployment<sup>3</sup>. The unemployment response to changes in economic activity in these versions was 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.

Our methodology broadly follows Ball et al. (2013). We start with the gap form of Okun's relationship (Equation 1 above), 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 0.16 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).

<sup>2</sup> For the period after 2015 Q2 (last available data at the time of work on this paper) we use the NBRM forecast from October 2015. 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).

<sup>3</sup> The current MAKPM version only includes relations between employment and 4<sup>th</sup> lag of GDP.

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

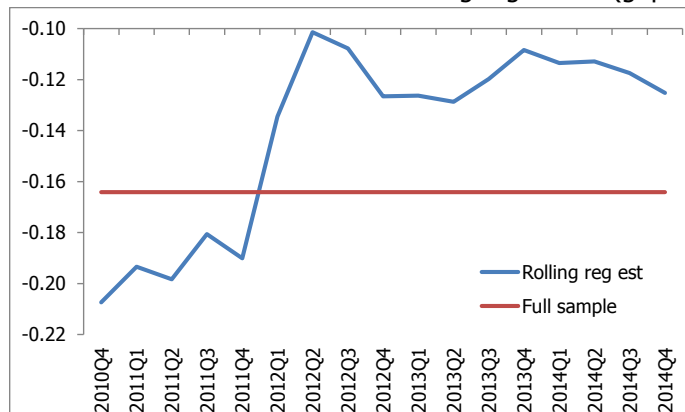
Dependent variable: Unemployment gap	
Explanatory variable	Coefficient
GDP gap (-4)	-0.164*** (0.046)
Sample: 2004Q1 2014Q4	
Adjusted R-squared	0.192
Jarque Bera test p-value	0.070

\*, \*\* and \*\*\* refers to 10%, 5% and 1% significance, accordingly.  
Coefficient standard errors are given in parentheses.

One of our key interests is to analyze 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 analyze 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 7-year sub-samples starting at the beginning of our full data sample and moving sequentially by one quarter. Results are shown in Figure 3, where the reported date corresponds to the end of the respective 7-year sub-sample.

Figure 3 shows that Okun's law in gap form yields greater stability starting from mid-2012. 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 this sub-period, since mid-2012, a 1-percentage-point increase in the output gap reduces the unemployment rate gap by roughly 0.12 percentage points after a year.

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



In addition, one can notice a decline in responsiveness of the unemployment rate gap to changes in output gap in the period following mid-2012. This largely reflects the observed intensive job creation along with the policies to support transition out of informality that Macedonian economy experiences during this time span i.e. the 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. Moreover, the structural changes can be highlighted as one of the factors that have improved the efficiency of the labor market, as indicated by Beveridge curve developments<sup>4</sup> (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 labor market, i.e. closer matching of labor supply and demand. On the other hand, the simultaneously declining unemployment rate and the increasing vacancy rate registered in the following period implies movements along the curve, which tend to reflect cyclical variations in unemployment (i.e. the ongoing positive aggregate activity shock). Therefore, the job-intensive growth, supported by structural reforms and fiscal policy stimulus, might cause the labor market to react more rapidly to the changes in the economic activity. Indeed, such a policy-induced change in the transmission time might be a possible reason behind the reduced sensitivity of unemployment to output from 2012 onwards<sup>5</sup>.

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

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<sup>4</sup> For more details, see NBRM (2015).

<sup>5</sup> Of course, the most correct way to check whether the transmission time of the effect from the economic activity to the labor 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 12 quarters in total (2012 Q1-2014 Q4).

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

Dependent variable: Unemployment gap	
Explanatory variable	Coefficient
$\lambda_{con}$ CON_GAP(-4)	-0.124** (0.050)
$\lambda_{gov}$ GOV_GAP(-4)	-0.493*** (0.123)
$\lambda_{inv}$ INV_GAP(-4)	-0.051 (0.040)
$\lambda_{exp}$ EXP_GAP(-4)	-0.117** (0.055)
$\lambda_{imp}$ IMP_GAP(-4)	0.075 (0.051)
Sample: 2004Q1 2014Q4	
Adjusted R-squared	0.317
Jarque Bera test p-value	0.381

\*, \*\* and \*\*\* refers to 10%, 5% and 1% significance, accordingly.  
Coefficient standard errors are given in parentheses.

The estimated parameters for the individual expenditure components reveal the differential impact of the components of aggregate demand on unemployment. Absolute values range from 0.5 for the government consumption gap to less than 0.1 for investments and import gaps (which are however not statistically significant<sup>6</sup>), 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 0.19 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 generally are 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, in general, 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 labor-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<sup>7</sup>. 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 private consumption component of output, to the extent that a 1 p.p. decrease in the private consumption gap increases next-year's unemployment rate gap by 0.09 percentage points. The absolute magnitude of the elasticity of the other components ranges from 0.01 to 0.08, confirming that changes in domestic demand

<sup>6</sup> However, they are jointly statistically significant (see Appendix, Table 3).

<sup>7</sup> The weights of each component,  $\lambda_g$ , refer to the whole period averages (2004 Q1-2014 Q4).

have by far the greatest impact on unemployment developments. Namely, the relatively higher unemployment intensities for consumption capture the labor-intensive nature of the services that represent the bulk of consumer expenditure<sup>8</sup>. On the other hand, around 70% of exports consist of goods, out of which more than half is industry-related exports. By their nature, manufactures tend to increase productivity and be relatively less labor intensive than services. Furthermore, Macedonian exports of goods have significant import contents, hence the value added output and labor intensity of a given increase in exports are expected to be relatively lower than for the domestic demand components (Anderton et al., 2014). Moreover, there is an additional analytical evidence to support this particular aspect related to services. Namely, according to the NBRM (2013), all coefficients of employment elasticity to different sectors of economic activity are positive and in general, services are associated with a higher coefficient. In addition, it shows that the employment in financial intermediation, real estate and other services actually displays the highest elasticity to the respective sector's economic activity, while industry has the lowest employment elasticity.

Table 3  
Component elasticities, averages 2004 Q1-2014 Q4

gaps	Unemployment intensities ( $\beta_g$ )	Average weight ( $\lambda_g$ )	Component elasticity ( $\beta_g \lambda_g$ )
Private consumption	-0.124	0.764	-0.09
Government expenditure	-0.493	0.160	-0.08
Investment	-0.051	0.243	-0.01
Export	-0.117	0.381	-0.04
Import	0.075	0.548	0.04
Total			-0.19
GDP			-0.16

## 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.

<sup>8</sup> According to the Use and Supply Tables provided by the State Statistical Office, in 2014, around 60% of the final consumption expenditures by households at current prices is associated with services.

Table 4

Okun's Law estimates under aggregate and disaggregated approaches

dependent variable	Unemployment gap				Unemployment rate annual change			
explanatory variables <sup>1/</sup>	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP (-4)	-0.164*** (0.046)		-0.031 (0.037)		-0.096** (0.040)		-0.047 (0.032)	
$\lambda_{con}$ CON(-4)		-0.124** (0.050)		-0.023 (0.044)		-0.075* (0.044)		-0.009 (0.036)
$\lambda_{gov}$ GOV(-4)		-0.493*** (0.123)		-0.067 (0.126)		-0.255** (0.120)		0.080 (0.113)
$\lambda_{inv}$ INV(-4)		-0.051 (0.040)		-0.027 (0.032)		-0.082** (0.039)		-0.045 (0.031)
$\lambda_{exp}$ EXP(-4)		-0.117** (0.055)		-0.043 (0.045)		-0.092 (0.057)		-0.029 (0.046)
$\lambda_{imp}$ IMP(-4)		0.075 (0.051)		0.028 (0.041)		0.109** (0.054)		0.048 (0.043)
UNEMP(-1)			0.654*** (0.094)	0.634*** (0.124)			0.489*** (0.090)	0.570*** (0.110)
Constant					-0.465** (0.204)	-0.495** (0.222)	-0.313* (0.160)	-0.380** (0.173)
Sample: 2004Q1 2014Q4 (44 observations)								
Diagnostic tests:								
Adjusted R-squared	0.192	0.317	0.617	0.586	0.099	0.051	0.462	0.434
F-statistic					5.750	1.466	19.475	6.494
Prob(F-statistic)					0.021	0.224	0.000	0.000
Jarque Bera p-value	0.070	0.381	0.000	0.000	0.178	0.454	0.356	0.370

\*, \*\* 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.

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  $-0.164$ ; when lag is included, the Okun's coefficient becomes  $-0.031^9$ , pointing to relatively high persistence of unemployment rate gap, which ultimately signals a higher labour market rigidity<sup>10</sup> (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, the introduction of a lagged dependent variable makes almost all of the individual parameters statistically insignificant<sup>11</sup>. 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

<sup>9</sup> The F-test for the specification in column 3 implies that the coefficients are jointly significant.

<sup>10</sup> This implies 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).

<sup>11</sup> However, the F-test of overall significance implies that the coefficients are jointly not all equal to zero.

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 5, in the Appendix)<sup>12</sup>.

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<sup>13</sup>, 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<sup>14</sup>, meaning that we again do not digress from the previously identified country specific labor-market regularity. This is in line with IMF (2013), which concludes that unemployment and economic activity are rather de-linked when contemporaneous changes are analyzed.

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 =  $a + b \cdot (\text{Annual real output growth}(-4))$* ), 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 an annual basis. In the case of specification 5, the ratio " $-a/b$ " is negative, making this particular specification of Okun's law counterintuitive.

For the sake of completeness, we have estimated the 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 the government consumption. 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

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<sup>12</sup> 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. This step is undertaken in order to achieve comparability between specifications 1 and 2, in the one hand, and 3 and 4 (in Table 4), on the other hand.

<sup>13</sup> 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.

<sup>14</sup> In addition, for the sake of robustness, Okun's specification in differences (i.e. annual growth rates) involving the contemporaneous effect of real activity has also been estimated, in line with Anderton et al. (2014). However, the results in Table 4 in the Appendix show that, under this particular specification, the Okun's coefficient is not statistically significant and has an incorrect sign. The same conclusion holds when GMM and dynamic GMM are employed as estimators, in order to address the problem of possible endogeneity.



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.

### **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 labor 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 2011 Q3 to 2015 Q2, 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:

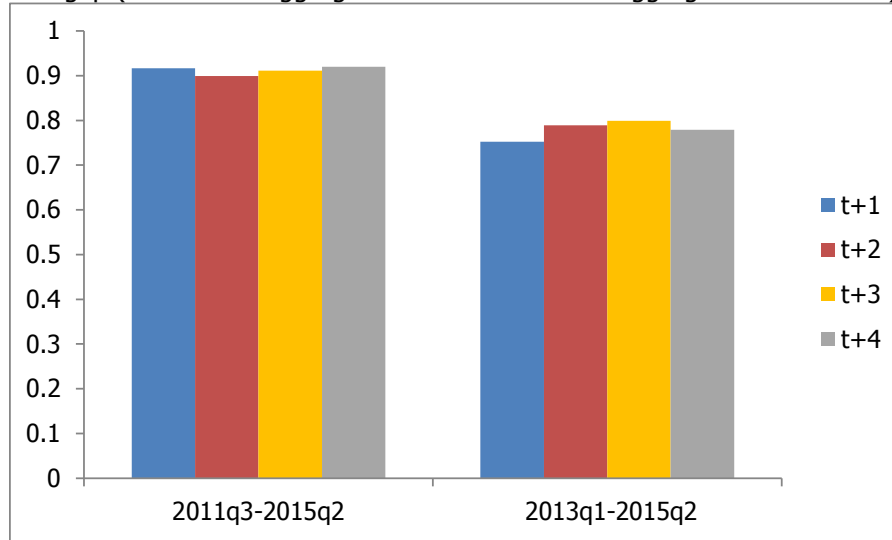
$$RMSE = \sqrt{\frac{\sum_{t=1}^n (y - \hat{y})^2}{n}} \quad (6)$$

The model that has the smallest RMSE average losses in the out-of-sample forecasting simulation is then the superior forecasting approach. Figure 4 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.

We were also interested in examining how the numerical values of the RMSE ratios would evolve if we would consider two sub-samples. So, the first sub-sample covers the period from 2011 Q3 to 2015 Q2, and the second one spans only over the 2013 Q1-2015 Q2 horizon, as a period when the estimated Okun's coefficient displays an evident stability.

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)



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. In addition, the difference in the performance of the disaggregated relative to the aggregated model is quite stark when confronting the results from the two sub-samples. Namely, in the first sub-sample, the RMSE ratios show almost 9% on average greater forecast accuracy of the disaggregated approach relative to the aggregated benchmark up to 4 quarters ahead. In addition, the improvements relative to the benchmark vary only marginally across the different forecast horizons.

On the other hand, for the second sub-sample, forecasting improvements relative to the aggregated benchmark are much greater (22% on average for all forecast horizons). Furthermore, the greatest accuracy gain relative to the benchmark is obtained for the forecast one quarter ahead (about 25% on average).

## 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, 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-2012 and has remained stable ever since. This actually reflects the observed intensive job creation and measures for dealing with unemployment that the Macedonian economy experienced during this time span (i.e. the 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 to a great extent reflects the effects of structural reforms undertaken by the Government. Namely, throughout the past several years, the Macedonian government's key policy statements dealing with a wide range of issues have been 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 private consumption gap, 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 labor-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. Moreover, the greatest accuracy gains relative to the benchmark are observed for the period from 2013 onwards, when Okun's coefficient displays an apparent stability.

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 behaviors might be employed as an important input in the latest version of the MAKPAM model, which is the key block in the forecasting and policy analysis system of the central bank.

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## APPENDIX

Table 1  
Correlation matrix

a) Gaps

correlation coeff. (2004Q1-2014Q4)		GDP_GAP				
		t	t-1	t-2	t-3	t-4
U_GAP	t	-0.11	-0.10	-0.29	-0.45	-0.47

b) Annual changes

correlation coeff. (2004Q1-2014Q4)		GDP_4GROWTH				
		t	t-1	t-2	t-3	t-4
U_4CHANGE	t	0.18	0.22	0.06	-0.20	-0.35

Table 2  
ADF test for stationarity

series	level		annual change	
	t-stat	prob	t-stat	prob
Unemployment rate	-3.24	0.00	-3.40	0.00
GDP	2.57	1.00	-3.15	0.00
Private consumption	1.13	0.93	-3.25	0.00
Government consumption	0.91	0.90	-3.56	0.00
Investment	0.35	0.78	-5.77	0.00
Export	1.88	0.98	-2.33	0.02
Import	1.34	0.95	-3.98	0.00
Unemployment rate gap	-3.81	0.00		
GDP gap	-4.66	0.00		
Private cons gap	-3.51	0.00		
Government cons gap	-3.35	0.00		
Investment gap	-7.02	0.00		
Export gap	-2.94	0.00		
Import gap	-5.34	0.00		

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	5.354	(5, 39)	0.001
Chi-square	26.768	5	0.000
Restrictions are linear in coefficients.			

Table 4

Difference specification of Okun's Law with contemporaneous effect

dependent variable	Unemployment rate annual change			
estimation method	OLS		GMM	
explanatory variables/1	(1)	(2)	(3)	(4)
GDP	0.051 (0.044)	0.061* (0.032)	0.185 (0.170)	0.056 (0.076)
UNEMP(-1)		0.534*** (0.085)		0.502*** (0.070)
Constant	-0.965*** (0.224)	-0.653*** (0.170)	-1.482** (0.591)	-0.669** (0.299)
Sample: 2004Q1 2014Q4 (44 observations)				
Diagnostic tests:				
Adjusted R-squared	0.008	0.480	-0.210	0.478
F-statistic	1.340	20.881		
Prob(F-statistic)	0.254	0.000		
Jarque Bera p-value	0.041	0.861	0.188	0.370
Instrument rank			3	5
J-statistic			0.263	2.937
Prob(J-statistic)			0.608	0.230

\*, \*\* and \*\*\* refers to 10%, 5% and 1% significance, accordingly.

Coefficients standard errors are given in parentheses.

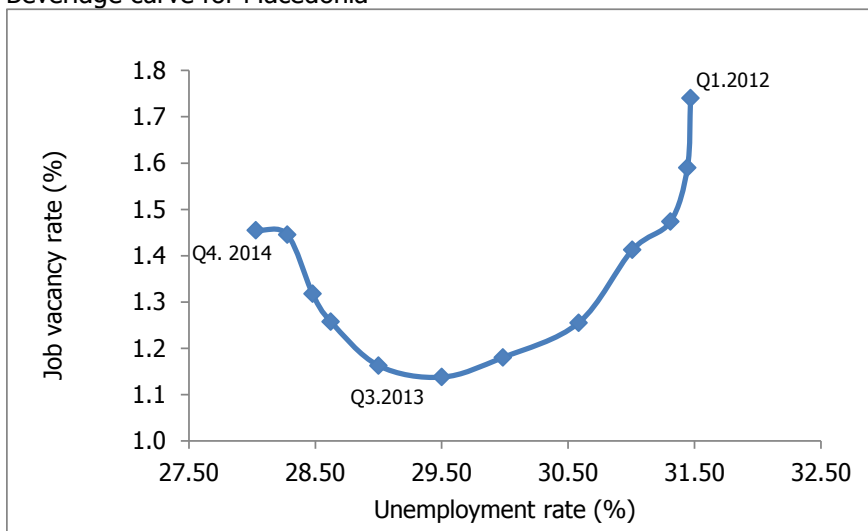
1/ UNEMP always reflects the quantitative expression of the unemployment rate as a dependent variable.

Table 5

Calculated long-term coefficients

dependent variable	Unemployment gap
explanatory variables	(1) (2)
GDP (-4)	-0.090
$\lambda_{con}$ CON(-4)	-0.062
$\lambda_{gov}$ GOV(-4)	-0.182
$\lambda_{inv}$ INV(-4)	-0.075
$\lambda_{exp}$ EXP(-4)	-0.117
$\lambda_{imp}$ IMP(-4)	0.075
Constant	

Figure 1  
Beveridge curve for Macedonia\*



\*The basis for this analysis is the 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 constraints 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. (See also NBRM (2015)).