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EXAMINING OKUN'S LAW VALIDITY IN NORTH MACEDONIA

(2010Q1 – 2020Q4)

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Abstract

The following paper examines Okun's law application in North Macedonia in the period from the first quarter of 2010 to the last quarter of 2020. After examining the developments concerning GDP and unemployment the paper focuses on estimating Okun's coefficient through static and dynamic approaches. The inclusion of lagged regressors is also taken into consideration. The results, obtained through the static gap and difference versions signify a weak link, while the dynamic approaches utilized identify a strong negative relationship. Keywords (Okun's law, dynamic version, gap version, OLS, unemployment, North Macedonia, econometrics)

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Introduction

Over the years, policymakers have shown a significant interest in monitoring two macroeconomic factors: unemployment and economic output. More specifically, policymakers have aimed to uncover whether the relationship between the two macroeconomic phenomena is negative and whether the relationship has changed over time (Sadiku et al. 2015; Rahman and Mustafa 2017; Guay et al. 2019). By doing so, policymakers can evaluate the level of unemployment and identify reasons that may have caused a shift (Andonova and Petrovska 2019). Consequently, adequate policies could be devised that enhance economic output by reducing unemployment (Villaverde & Maza 2009).

As the relationship between the two macroeconomic phenomena was first analyzed in Okun's (1962) study, it is widely known as "Okun's Law" (Sadiku et al. 2015; Rahman and Mustafa 2017). Derived from Keynesianism, Okun's Law represents the connection between the Philips curve and the aggregate demand curve. From a theoretical perspective, Okun's coefficient has served as a "rule of thumb" for policymakers (Acaroglu 2018, 148). From an empirical standpoint, Okun (1962) identified a statistical relationship between economic growth and unemployment. More specifically, the findings signified a weak negative relationship where a 1 percent increase in economic output would lead to a 0,3 percent decrease in the unemployment rate (Bankole et al. 2013). Therefore, it could be said that this statistical relationship represents much more than a structural feature of any economy.

Furthermore, the growing importance of Okun's law in the field of short-run macroeconomics has resulted in numerous empirical studies reporting estimates of the correlation between fluctuations in real Gross Domestic Product and the rate of unemployment. However, a consensus is yet to be reached on the degree to which the examined relationship is negative (Perman et al. 2015). The derived differences in findings of studies conducted on the matter can be attributed to model selection, differences in model assumptions, economic and cultural differences in different geographical regions (Sadiku et al. 2015; Acaroglu 2018, 148). Firstly, some of the studies conducted have used static, while others have adopted the dynamic modeling approach. Secondly, some studies have utilized the first-difference approach to remove stationarity, while others have utilized the gap model. Finally, the last reason for the discrepancy in findings is whether unemployment or economic output was used as the dependent variable (Perman et al. 2015). Moreover, this paper aims to utilize both the dynamic and static approaches to modeling

Literature Review

Numerous studies have been conducted to estimate the relationship between growth in economic output and unemployment. Ball et al. (2019) identified differences in Okun's coefficient that depend on whether the country in question, is an advanced economy or not. In the case of advanced economies, the study indicated that almost 86 percent of the cases examined exhibited a strong and negative relationship. On the other hand, almost 61 percent of developing countries used in the study exhibited a positive and statistically significant coefficient.

In North Macedonia, Tumanoska (2019) estimated the relationship by utilizing an Auto-regressive distributed lag model. The study signified that, in the period between 1991 to 2017, a long-run relationship between the two macroeconomic phenomena exists. More specifically, a 1 percent increase in GDP would be accompanied by a 2.57% decrease in the unemployment rate. Furthermore, Bournakis and Christopoulos (2017) tested the existence of Okun's law, in the last 55 years, through three different modeling approaches. More precisely, both a static and dynamic approach of estimating the law was applied. Lastly, the third modeling approach attempted to capture asymmetries and dynamics in the GDP-unemployment relationship. Moreover, the findings signified an asymmetric relationship, where an annualized growth rate of GDP below 1 percent would be accompanied by a decrease in unemployment of 1.21 percent. On the other hand, an annualized GDP growth rate above 1 percent would be accompanied by a 1.47% reduction in the unemployment rate.

Similarly, Mihajlovic (2020) identified that, in the Republic of Serbia, a negative asymmetric relationship between the two macroeconomic phenomena exists. More specifically, through a linear and non-linear autoregressive distributed lag approach, the relationship was estimated for the period between 2000 and 2017. The asymmetric relation of the variables signifies that a 1 percent increase in real GDP growth would lead to a 4,74 percent decrease in unemployment. On the other hand, a decrease of real GDP growth by 1 percent would result in a reduction of 1,52 percent in the rate of unemployment. In addition, Karadzic et al. (2021) examined Okun's law applicability in Montenegro from 2007 until 2019. The analysis was carried out through both the static and dynamic approaches. The results obtained from the difference approach signify that a 0.27% decrease in unemployment would accompany a 1%

increase in GDP growth rate. Similar results were obtained through the error correction model.

Furthermore, a study conducted by Halebić (2021) examined Okun's relationship in Bosnia and Herzegovina in the period between 2009 to 2019. The study identified a relatively strong negative relationship between changes in real gross domestic product growth and the unemployment rate. More specifically, only the periods accompanied by high economic growth resulted in a reduction in unemployment. Moreover, Madzova et al. (2019) tested the hypothesis, through a pooled OLS and panel regression analysis approach, for the Western Balkan countries. The study indicated that, in the period between 2000 to 2017, a weak correlation coefficient between economic output and unemployment was detected. Consequently, Okun's law did not hold in North Macedonia, Serbia, Montenegro, Bosnia and Herzegovina, and Albania. In addition, Acaroglu (2018) examined whether a trade-off between economic output and unemployment exists for G-20 countries in the period between 1991 to 2014. In terms of the estimation techniques, the gap and difference methodologies were used to test the robustness of the relationship. The results indicate that, for most G-20 countries, the law holds except for China, Indonesia, Turkey, and Saudi Arabia. Therefore, it could be argued that the value of Okun's coefficient depends heavily on the heterogeneity of productivity and the development structure of the country in question.

Likewise, Pata et al. (2018) examined the impact that changes in real output growth have on youth unemployment, standard unemployment, and prime working years unemployment rates. The results obtained through the unrestricted VAR methodology and Hsiao's Granger causality test indicate that, in the period between 2006 and 2014, a negative statistically significant relationship exists in the short term. The discrepancy in findings between Pata et al. (2018) and Acaroglu (2018), for the case of Turkey, can be attributed to the fact that Okun's coefficient is sensitive to the estimation technique and the choice of a sample (Economou and Psarianos 2016). Lastly, Rahman and Mustafa (2017) examined Okun's law application in 13 developed countries. While Okun's coefficient was significant in the United States and South Korea, the law was invalid for Finland, France, Italy, The Netherlands, Sweden, and the United Kingdom. The underlying reason behind such a low validity rate for European countries can be attributed to low labor market flexibility. Thus, labor market flexibility could be achieved through an expansionary fiscal policy or, in some cases, monetary easing. Moreover, North Macedonia's developments concerning GDP would be

examined, emphasizing the factors that have caused an increase or decrease in the period from the first quarter of 2010 to the fourth quarter of 2020.

Real Gross Domestic Product in North Macedonia

In 2010, North Macedonia's real GDP experienced an increase of 1,8 % following a decline in 2009. The positive performance continued through all quarters of 2010. The main drivers of the positive macroeconomic developments can be attributed to the increase in exports, the recovery of domestic demand, and the entrance of new foreign direct investments. Therefore, it could be said that the positive trend of economic recovery was enhanced by increased production, new capacities for industrial production, favorable trends in metal prices, and an increase in the demand for exports (Ministry of Finance of the Republic of Macedonia 2012, 14-15).

Furthermore, the North Macedonian economy was relatively well protected, as the Eurozone was experiencing a debt crisis. The protective nature of the economy comes as a result of the classical model of functioning that relies mainly on domestic sources of financing. However, stagnation and a drop in foreign demand followed in the second part of the year, significantly deteriorating GDP growth. Moreover, the effects of the crisis could be felt in 2012 as real GDP experienced a drop of 16,39 % in the first quarter. The main driver behind the drop was lower foreign demand which limited exports and decreased industrial production. However, during the following three quarters of 2012, the North Macedonian economy started to recover (Ministry of Finance of the Republic of Macedonia 2013, 14-15; Ministry of Finance of the Republic of Macedonia 2014, 12-13).

Moreover, the economic recovery during 2013 can be attributed to an increase in exports and private consumption. In terms of the sectors, construction achieved the highest growth, which reflected the positive economic trend. Likewise, industry growth was achieved by increasing the production of consumer goods, energy, and capital goods. Similarly, the patterns of growth continue in 2014, where positive growth was evident across all sectors. Investments in industrial development zones and public sectors infrastructure led to the growth of gross investments, while exports of goods and services also played a significant role in contributing to output growth (Ministry of Finance of the Republic of Macedonia 2014, 13; Ministry of Finance of the Republic of Macedonia 2015, 5-6). Likewise, favorable growth rates continued from 2015 until 2016. The main drivers behind the growth in 2015 were the encouraging

developments in construction and the service sector. Thus, the shift towards activities in line with companies in the economic free zone also contributed to exports' growth. On the other hand, in 2016, the instability of the political scene resulted in an output growth slowdown resulting in a decrease of 8,38 % in the first quarter. The main contributors to growth in the period were the construction and manufacturing sector (Ministry of Finance of the Republic of Macedonia 2015, 5-6; Ministry of Finance of the Republic of Macedonia 2016, 11-12).

In 2017, a significant decline in investment activities was evident. Moreover, private consumption experience growth while public spending had decreased. The main drivers of higher private consumption were the increase in employment, wages, and disposable income. On the other hand, gross investments depreciated due to the depreciation of activities in the construction sector, while net export grew. The minor growth trend continued in 2018, which reflected the adverse developments in the construction sector. On the other hand, the positive developments in 2018 came from the positive growth achieved in the services and industrial sectors. In addition, an increase in construction activities, public and private consumption, gross investments, and exports contributed to real GDP growth in 2019 (Ministry of Finance of the Republic of Macedonia 2017, 10-11; Ministry of Finance of the Republic of Macedonia 2018, 12; Ministry of Finance of the Republic of Macedonia 2019, 12-13). Moreover, a sharp decline in RGDP was experienced during the first half of 2020. The underlying reason for this drop was the government measures undertaken to prevent the spread of Covid-19. In this period, public consumption was the only GDP component that registered growth, while private consumption, investments, and net exports experienced a decline (Ministry of Finance of the Republic of Macedonia 2020, 10-11). Moreover, the RGDP movements over time are presented in **Appendix 1**.

Labor Market in North Macedonia (2010 – 2020)

As a reflection of the economic recovery from the economic crisis period and additional developments in the real sector, positively impacted the labor market (Ministry of Finance of the Republic of Macedonia 2012, 19; Ministry of Finance of the Republic of Macedonia 2013, 19). Compared to 2010, an increase of active population by 2.01 % was evident. Likewise, both the activity rate and employment rate experience an increase. More specifically, the activity rate increased by 1.44 percent, while the employment rate experienced a significant increase of 4.77 percent. Consequently, the positive developments lead to a 6.87 percent decrease in the unemployment rate.

Furthermore, in 2012 positive developments in the labor market stagnated. A decline of 1.21 percent in the activity rate and a decrease of 1.78 percent in the employment rate were evident. In this context, the inactive population grew by 2.52 percent while the unemployment rate grew by 1.28 percent. However, it is essential to mention that the increase in unemployment was slowed down due to the implementation of reforms solely focused on improving labor market conditions. In 2013 the labor market in North Macedonia experienced positive developments (Ministry of Finance of the Republic of Macedonia 2014, 14). Diving into specifics, the inactive population experienced a year-on-year decrease of 1.05 percent while the employment rate grew by 3.61 percent. Likewise, the proportion of the active population to the total population increased by 1.36 percent, which led to a 5.38 percent decrease in unemployment.

Similarly, the positive developments in the labor market continued in 2014 (Ministry of Finance of the Republic of Macedonia 2015, 7). Moreover, in 2014 growth of 0.48 percent was observed in the active population. In the period in question, the activity rate increased by the same amount, while the employment rate experienced an increase of approximately 2.6 percent. On the other hand, the inactive population decreased by 0.64 percent. Consequently, unemployment was eradicated by 5.02 percent. In 2015, the positive developments can be attributed to the increase in employment because of the company activities in the free economic zones and the implementation and realization of policies aimed to eradicate unemployment. Thus, the government introduced a new project under the name "Macedonia employs" (Ministry of Finance of the Republic of Macedonia 2016, 12). Specifically, in 2015 unemployment experienced a further decrease of 3.87 percent. The decrease can be attributed to an increase of 0.10 percent in the active population and a 1.44 percent increase in the employment rate. On the other hand, the activity rate deteriorated by 1.58 percent.

Furthermore, the positive developments of the "Macedonia employs" project and investments in public infrastructure resulted in an additional decrease in unemployment (Ministry of finance of the Republic of Macedonia 2017, 11). In this context, in 2016, unemployment experienced a staggering decline. Specifically, unemployment experienced a decrease of 10.26 percent when compared to 2015. An interesting finding that could be derived from this period is that the active population decreased by 1.41 percent. On the other hand, the employment rate had increased by approximately 2.3 percent.

Moreover, due to the higher employment in the services, industrial, and agricultural sectors, the positive developments in the labor market continued in 2017. However, the positive developments were stagnated due to a reduction of employment in the construction sector (Ministry of Finance of the Republic of Macedonia 2018, 12-13). Consequently, unemployment decreased by 6.53 percent. Likewise, both the activity and employment rate grew by 0.66 and 2.68 percent, respectively. Positive developments were also evident in 2018 as the unemployment rate decreased by approximately 5.7 percent. The eradicating unemployment can be attributed to the further increase in the activity rate of 0.25 percent and the employment rate of 2 percent. The main driver behind the positive developments was the registered decrease in unemployment amongst the youth and females. (Ministry of Finance of the Republic of Macedonia 2019, 14)

Moreover, the positive labor market trend continued in both 2019 and 2020. More specifically, in 2019, a decline of 17.59 was recorded, which represents the most significant decline from the examined period. This decline was accompanied by an increase of 5.2 percent in the employment rate and an increase of 0.43 percent in the active population. In this context, employment growth was recorded in the service and construction sector (Ministry of Finance of the Republic of Macedonia 2019, 14). Similarly, in 2020 unemployment declined by approximately 9 percent while active population and employment grew by 0.73 and 2.57 percent, respectively. It is essential to mention that the slowdown in employment growth can be attributed to the Covid-19 pandemic (Ministry of Finance of the Republic of Macedonia 2020, 11-12). Lastly, the unemployment rate in the examined period is presented in **Appendix 2**.

Approaches to Okun's Law Modelling

Diving into specifics, it could be said that Okun's law aims to capture the effects that shifts in aggregate demand have on long-term unemployment levels. For instance, a positive shift in aggregate demand results in firms hiring workers, which causes a reduction in long-term unemployment levels, and vice versa (Tovar Jalles 2019). In essence, an economy can produce more goods and services by having more labor, which can be increased in ways such as firms employing more or employees working for longer hours. Therefore, Okun identified the unemployment rate as a helpful proxy that signifies unused labor in an economy. This approach is widely known as the difference version of Okun's law (Andonova and Petrovska 2019).

Regarding potential output, Okun aimed to identify how much an economy would produce under full-employment conditions. In other words, full employment is referred to as the unemployment level through which an economy would be able to produce as many goods and services as possible without generating any additional inflationary pressures. This version is widely known as the gap version (Tovar Jalles 2019; Andonova and Petrovska 2019). Furthermore, this paper aims to estimate Okun's coefficient using the gap, difference, and dynamic versions.

Gap Version

The first approach to estimating Okun's coefficient is the gap version. Referred to in Okun's (1962) study, the gap approach considers cyclical fluctuations of economic output and unemployment (Louail & Riache 2019). The gap form of the approach mentioned above may be expressed through the following equation:

$$\text{Equation 1: } U_t - U_t^* = \beta(Y_t - Y_t^*) + \varepsilon_t$$

In equation 1, β represents Okun's coefficient, U_t^* and Y_t^* represent the natural rate of unemployment and potential output, respectively. Likewise, U_t represents the rate of unemployment while Y_t represents the real output of the economy. Lastly, ε_t represents factors that shift the cyclical relationship between unemployment and output (Andonova and Petrovska 2019). However, it is important to mention that equation 1 has a major limitation: estimating potential output and the natural rate of unemployment. As U_t^* and Y_t^* are unmeasurable, a statistical filtering technique would be used to derive the variables (Micallef 2017). The Hodrick-prescott filter with a smoothening parameter of 16000 would be applied, to derive the NAIRU and potential output (Bhowmik & Poddar 2021). The potential level of real GDP, as well as the NAIRU, are illustrated in **Appendix 3.**

Difference Version

While the gap version of Okun's law focuses on examining the oscillations of economic output and unemployment around their natural levels, the difference version captures the variables period-on-period fluctuations. More specifically, the difference version utilizes the percentage change of the unemployment growth as the dependent variable, while the change in real GDP growth rate is used as a regressor. It could be argued that the difference version is more reliable when compared to the gap version as it eradicates the need to estimate the

natural rate of unemployment and potential GDP (Akram et al. 2014; Boďa and Považanová 2020). Okun's coefficient, through the difference version, can be estimated through the following equation:

$$\text{Equation 2: } \Delta U_t = \beta_0 - \beta_1 \Delta Y_t + \varepsilon_t$$

In the equation, ΔU_t represents the change of the log of the rate of unemployment from current to previous period. Likewise**,** ΔY_t represents the change in growth rate of output from current to previous period. Finally, ε_t represents the part of the variation in ΔU_t that cannot be explained by variation in ΔY_t. Lastly, the dynamic version of Okun's law would be examined. Additionally, through the AIC, BIC and HQC criteria the most appropriate lag order would be identified. Lastly, changes in RGDP and unemployment growth are illustrated in **Appendix 4.**

Dynamic Version

Lastly, the dynamic version aims to relate changes in the unemployment rate to changes in past and current output and past unemployment. The dynamic version attempts to encompass all the different aspects ignored by the difference version. Similarly, Okun (1962) firmly believed that the dynamic version draws its superiority from the fact that the variation in the unemployment level can be additionally explained by past and current variations in RGDP and past variations in unemployment. However, it is essential to mention that a significant drawback of this approach is the problematic interpretation of the model (Akram et al. 2014, 175; Arif 2020, 96; Adeyeye et al. 2014, 40). The dynamic model can be estimated through the following formula:

$$\text{Equation 3: } \Delta U_t = \beta_0 - \beta_1 \Delta Y_t + \beta_2 \Delta Y_{t-1} + \beta_2 \Delta U_{t-1} + \varepsilon_t$$

In equation 3, the two new regressors in the equation are ΔY_{t-1} and ΔU_{t-1} are a one period lagged version of the change in growth rate of real GDP and change in unemployment growth, respectively. It is important to note that the VAR lag selection method will be applied to examine the most appropriate lag.

Data Preparation

For the study, the data obtained is in quarterly frequency and governs the period from the first quarter of 2010 to the fourth quarter of 2020. It is essential to notify the reader that the 2020 values for base year GDP are estimates computed by the State Statistical Office of R.M.

(2021). Likewise, the value of GDP at base year prices (real GDP) and the unemployment rate were obtained from the State Statistical Office of R.M. (2020). In this context, the summary statistics for the variables in question are presented in **Table 1**.

Table 1: RGDP and Unemployment Summary Statistics

Details	Real Gross Domestic Product	Unemployment Rate
Mean	1.4054x10^5	0.2527
Median	1.3869x10^5	0.2615
Minimum	98696	0.1610
Maximum	1.8781x10^5	0.3350
Standard Dev.	23538	0.0543
Critical Value	0.1675	0.2149
Skewness	0.1799	-0.3118

Firstly, the obtained data were adjusted for seasonality using the X-12-ARIMA package, applied using the Gretl software created by Baiocchi and Distaso (2003) for statistical analysis. The X-12-ARIMA package focuses on decomposing a quarterly or monthly time series into a product of three components: trend, seasonal, and irregular. The seasonally adjusted series is then derived by dividing the original time series by the seasonal component, whose values are seasonal factors (Lytras et al., 2007).

To estimate the gap version, the natural rate of unemployment and the potential GDP need to be derived from the real GDP and unemployment rate, respectively. The procedure is conducted using the Hodrick-Prescott filter. Specifically, the HP filter removes the trend component by solving the following equation:

Equation 4: $MIN\ \sum_{t=1}^{T}((y_t - \tau_t)\text{^}2 + \lambda((\tau_{t+1} - \tau_{t-1}))\text{^}2)$

In the equation, y_t represents the time series data, τ_t represents the smooth trend, and λ represents the smoothening parameter (Ravn and Uhlig 2002). For the study, a λ parameter of 16000 was used to obtain the NAIRU and potential GDP. Moreover, the output gap variable is obtained by taking the log difference of the seasonally adjusted GDP and potential GDP, while the unemployment gap variable is calculated by taking the difference between the unemployment rate and NAIRU. For the difference version and dynamic versions of Okun's law, the first difference of the seasonally adjusted rate of GDP and the first difference of the log of unemployment is taken. Additionally, the unit root tests and the process of identifying the appropriate lag structure of each model are examined.

Unit Root Tests

The test conducted to determine whether a time series in question contains a unit root would be the Augmented Dickey-Fuller test (ADF). The test aims to compare the null hypothesis of an Autoregressive Integrated Moving Average (p, 1, 0) process against an alternative (p+1,0,0) process. The test utilizes the following equation:

Equation 5: $\Delta X_t = \mu + \gamma_t + \alpha\, x_{t-1} + \sum_{j=1}^{k-1} \beta_j\, \Delta x_{t-j} + u_t$

In the equation, u_t represents the white noise innovation while Δx_t represents the change of the time series. The test aims to examine the negativity of α based on the regressions t-ratio (Cheung and Lai 1995). In this context, the ADF asymptotic p-value would be obtained for the gap specification's endogenous and exogenous variable.

Augmented Dickey-Fuller test (Gap Specification)

Under the Gap model specifications, the following test has been conducted for the endogenous variable Unemployment Gap and the exogenous variable Output Gap. It is essential to notify the reader that the maximum lag order has been tested through the AIC criterion.

Table 2 :ADF (Gap Specification) Hypothesis

	Hypothesis
H0:	The time series Output Gap/Unemployment Gap contains a unit root
H1:	The time series Output Gap/Unemployment Gap does not contain a unit root

Table 3: ADF (Gap Specification) Results Summary

Details	**Output Gap**	**Unemployment Gap**
Model	(1-L) y = b0 + (a-1) *y (-1) + e	
(a – 1) value	-0.719553	-0.381827
Tau Statistic	-4.86746	-4.51749
P - value	3.782e-05***	0.0001781

Based on the results obtained from **Table 3** above, it could be seen that none of the time series in question contains a unit root. More specifically, the asymptotic p-value for Output Gap is 3.782e-05 which is lower than the significance level. Therefore, the null hypothesis,

which states that the Output Gap time series contains a unit root, can be rejected with 99 % confidence. Likewise, the asymptotic p-value of the ADF test for the Unemployment Gap is 0.0001781, which is again lower than the bound set by the level of significance. Therefore, the hypothesis that Unemployment Gap contains a unit root can be rejected with 99% confidence. Furthermore, the unit root test for the difference and dynamic version would be conducted.

Augmented Dickey-Fuller test (Difference and Dynamic Specification)

The following test has been conducted for the endogenous variable Change in Unemployment growth and changes in real GDP growth, under the difference and dynamic model specifications. It is important to notify the reader that test is conducted with the presence of a constant, and the maximum lag order has been tested through the AIC criterion.

Table 4: ADF (Difference and Dynamic) Hypothesis

	Hypothesis
H0:	The time series Δ RGDP/Unemployment growth does contain a unit root
H1:	The time series Δ RGDP/Unemployment growth does not contain a unit root

Table 5: ADF (Difference and Dynamic) Results Summary

Details	**Δ Real GDP Growth**	**Δ Unemployment Growth**
Model	b0 + (a-1) y (-1) + ... + e	
(a – 1) value	-6.28499	-0.781488
Tau Statistic	-6.27634	-3.21034
P - value	2.52e-08***	0.01942**

Based on the results obtained from the **Table 5** above, it could be seen that none of the time series in question contains a unit root. More specifically, the asymptotic p-value for the first difference of the real GDP growth is 2.52e-08 which is lower than a level of significance of 1 percent. Therefore, the null hypothesis, which states that the real GDP growth time-series change contains a unit root, can be rejected with 99 % confidence. Similarly, the asymptotic p-value, obtained from the ADF test for Changes in Unemployment growth, is 0.01942, which is again lower than the bound set by the significance level. Therefore, the hypothesis that the changes in unemployment growth contain a unit root can be rejected with 95%

confidence. Next, the paper examines the appropriate lag order of each of the models in question.

Appropriate Model Lag Structure

In addition, the optimal lag order of the models in question would be examined. It is important to note that the optimal lag selection has been conducted through the Gretl software, created by Baiocchi and Distaso (2003), by using the VAR lag selection technique. Specifically, the technique relies on the AIC, BIC, and HQC criteria. The criteria would also be used to identify the most appropriate dynamic models. Akaike's information criterion (AIC) focuses on determining the best-approximating model to the true data generating process in the context of the criteria. In other words, the criterion is used to select a model that minimizes the likelihood based on the number of parameters in question. The criterion is determined through the following equation:

Equation 6: $AIC = N * \left(Log\left(\frac{2\pi Res}{N}\right) + 1\right) + 2 * p$

In the equation, p represents the number of parameters included in the model. Moreover, the BIC criterion would be examined. In contrast to the AIC criterion, the Bayesian Information Criterion (BIC) depends on the sample size in the second term of the equation and is derived from the Bayesian framework as an estimate. The criterion is calculated through the following equation (Acquah 2010 003; Yoan and Lendasse 2009):

Equation 7: $BIC = N * Log\left(\frac{RES}{N}\right) + p * log(N)$

Lastly, the Hannan-Quinn information criterion is the third technique conducted to determine the optimal lag for the corresponding models. Most commonly, the criterion is used in cases where a finite set of models exists. While it is not solely based on the log-likelihood, it still incorporates a penalty based on the number of parameters. While close to AIC and BIC, this criterion aims to provide consistency in model and lag selection. The criterion is estimated through the following equation (Yoan and Lendasse 2009):

Equation 8: $HQC = N * \log\left(\frac{Res}{N}\right) + 2 * p * loglogN$

Gap Specification Lag Order

The results obtained from the VAR optimal lag selection tool have been summarized in the table below. The results signify that the most appropriate lag of the Output Gap variable would be 2. However, the question remains on whether a lagged relationship exists and whether the relationship is statistically significant. Most importantly, the recommended gap model should utilize a regressor that is lagged by two quarters. However, the most appropriate model that incorporates a lagged regressor would be chosen based on the adjusted R-squared, AIC, BIC, and HQC criteria. Meaning that the lag used in the model would not solely depend on the VAR optimal lag selection tool results.

Table 6: VAR Optimal Lag Selection (Gap Specification)

Lag	AIC	BIC	HQC
1	-8.523666	-8.435693	-8.492961
2	-8.608829*	-8.476870*	-8.562772*
3	-8.564473	-8.388527	-8.503063
4	-8.575998	-8.356064	-8.499235
5	-8.544055	-8.280135	-8.451940

Difference and Dynamic Specification Lag Orders

Furthermore, the optimal lag would be selected for the static difference model and the dynamic model. The results are summarized in the table below. In this context, differences between the results obtained from each of the criteria are evident. Specifically, the AIC and HQC criteria suggest that the use of a regressor lagged by three quarters would be most appropriate. On the other hand, the BIC criterion suggests a regressor lagged by a single quarter. Consequently, through a trial-and-error process, the most appropriate model would be selected.

Table 7: VAR Optimal Lag Selection (Difference and Dynamic Specifications)

Lag	AIC	BIC	HQC
1	-5.086565	-4.953249*	-5.040544
2	-5.091470	-4.913716	-5.030109
3	-5.132902*	-4.910710	-5.056201*
4	-5.111763	-4.845132	-5.019722
5	-5.085351	-4.774281	-4.977969

Modeling with HAC Errors

Before diving into model specifics and assumptions, it is essential to notify the reader that heteroskedasticity and autocorrelation appear as potential problems that may lead to a spurious regression. However, as a lagged dependent variable would be used as a regressor, the problem of serially correlated residuals is removed. On the other hand, the problem of heteroskedastic residuals remains. Therefore, the HAC methodology for eradicating autocorrelation and heteroskedasticity would be used. In other words, the Heteroskedasticity and Autocorrelation Correction (HAC) methodology relies on estimating covariance matrices that consider the conditional heteroskedasticity and serial correlation of the error term (West 2010). Next, the model specifications and assumptions would be presented. As previously mentioned, the HAC methodology would be applied to remove the heteroskedasticity issue.

Gap Version

Firstly, **Table 9** below represents the model summary of the Gap version, specified in Okun (1962) study. The model aims to uncover whether a negative relationship between the unemployment gap and output gap exists, and to which extent the relationship is significant. The model hypothesis, summary and assumptions are as follows:

Table 8: Gap Specification Hypothesis

Details	Hypothesis
H0:	A negative relationship between Output Gap and Unemployment Gap does exists
H1:	A negative relationship between Output Gap and Unemployment Gap does not exist

Table 9: Gap Specification Regression Results

Gap Version HAC	Coefficient	Standard error	z	p
Output Gap	−0.0768062	0.0467204	−1.688	0.1502
R-squared	0.109999	**Adjusted R-squared**	0.109999	
F (1, 41)	2.070569	**P-value (F)**	0.157405	
Log-Likelihood	154.7173	**Akaike criterion**	−307.4346	
Schwarz Criterion	−305.6504	**Hannan-Quinn**	−306.7729	
rho	0.776896	**Durbin- Watson**	0.446001	

Table 10: Gap Specification Assumptions

Assumptions	Null Hypothesis	Statistic	Value
Normality	Errors are normally distributed	p-value	0.0204
Heteroskedasticity	Error is homoscedastic	HAC	HAC
Autocorrelation	Error is not serially correlated	HAC	HAC
Error Mean	The mean of the error is zero	Mean	7.5393e-07

Based on the model specification recommended by Okun (1962), it is evident that the Output Gap does not represent a significant explanator of the unemployment gap. More specifically, at a significance level of 10 percent, the null hypothesis that a negative relationship exists is rejected. The p-value of the F statistic also suggests that the model, in general, is not statistically significant at a 10 percent level of significance. Therefore, for North Macedonia, the gap specification of Okun's law does not hold. Consequently, a statistically significant negative relationship between deviations of output around its potential level and deviations of unemployment around its natural level cannot be detected.

Gap Version with lagged regressor

Furthermore, the study aims to evaluate whether the inclusion of a lagged regressor would represent a better fit for the model. The model selection procedure examines the AIC, BIC, and HQC criteria and the adjusted R-squared. Based on the previously mentioned criteria, the most appropriate model is selected. The values for each of the criteria and the adjusted R squared are presented in **Table 11** below:

Table 11: Gap Specification with Lagged Regressor Model Selection

Regressor	Schwarz Criterion	Akaike Criterion	Hannan-Quinn	Adjusted R squared
Output Gap (-1)	−299.4590	−301.2202	−300.5707	0.140365
Output Gap (-2)	−293.2656	−295.0033	−294.3664	0.123199
Output Gap (-3)	−291.6113	−293.3249	−292.7009	0.208038

Table 12: Gap Specification with third order lagged regressor Model Summary

Gap Version HAC	Coefficient	Standard error	z	p
Output Gap (-3)	−0.151982	0.0540142	−2.814	0.0049

Table 13: Gap Specification with third order lagged regressor Hypothesis

Details	Hypothesis
H0:	A negative relationship between the third lagged order of Output Gap and Unemployment Gap exists.
H1:	A negative relationship between the third lagged order of Output Gap and Unemployment Gap does not exist.

Even though the optimal lag selection technique suggested that a second-order lag of output gap is the most appropriate regressor, the third lagged order of output gap provides the most significant model. Based on the model, it is evident that a statistically significant relationship between the third lagged order of Output Gap and Unemployment Gap exists. Therefore, the null hypothesis that states that a negative relationship between the third lagged order of Output Gap and Unemployment Gap exists, is not rejected.

Difference Version

Furthermore, the paper examines the difference approach to Okun's law modeling. Thus, this approach takes the first difference of the log of the unemployment rate and regresses it based on the change of real output growth. The log of unemployment is taken because the first difference of the rate did not yield a stationary series, i.e., by taking the logged difference, the time series is made stationary at a 5 percent level of significance as shown by the ADF test. Moreover, the hypothesis, assumptions, and model summary are as follows.

Table 14: Difference Specification Hypothesis

Details	Hypothesis
H0:	A negative relationship between Δ RGDP and Δ Unemployment growth does exist.
H1:	A negative relationship between Δ RGDP and Δ Unemployment growth does not exist.

Table 15: Difference Specification Assumptions

Assumptions	Null Hypothesis	Statistic	Value
Normality	Error is normally distributed	p-value	0.0021
Heteroskedasticity	Errors is homoscedastic	HAC	HAC
Autocorrelation	Error is not serially correlated	HAC	HAC
Error Mean	The mean of the error is zero	Mean	-3.8825e-18

Table 16: Difference Version Regression Summary

Difference V. HAC	Coefficient	Standard error	z	p
constant	−0.0164247	0.00366635	−4.480	7.47e-06
Ch. RGDP Growth	−0.0247573	0.0298506	−0.8294	0.4069
R-squared	0.008132	**Adjusted R-squared**	-0.016665	
F (1, 41)	0.687863	**P-value (F)**	0.411815	
Log-Likelihood	106.0386	**Akaike criterion**	−208.0772	
Schwarz Criterion	−204.6019	**Hannan-Quinn**	−206.8034	
rho	0.354062	**Durbin- Watson**	1.283717	

Based on the difference model specification recommended by Okun (1962), it is evident that the changes in RGDP growth do not represent a significant explanator of the log differences in unemployment. More specifically, at a significance level of 10 percent, the null hypothesis that a negative relationship exists is rejected. The p-value of the F statistic also suggests that the model, in general, is statistically insignificant at a 10 percent level of significance. Therefore, for the case of North Macedonia, the difference specification of Okun's law does not hold for the period from the first quarter of 2010 to 2020.

Difference Version with lagged regressor

Next, the paper examines the relationship between changes in unemployment growth and a lagged order of changes in RGDP growth. Likewise, the same approach used for the gap specification would be used for the difference version. In other words, the most appropriate model would be selected based on the AIC, BIC, HQC, and R-squared criteria.

Table 17: Difference Specification with lagged regressor Model Selection

Regressor	Schwarz Criterion	Akaike Criterion	Hannan-Quinn	Adjusted R squared
Δ RGDP Growth (-1)	−198.7225	−202.1497	−200.9017	-0.020005
Δ RGDP Growth (-2)	−194.1690	−197.5468	−196.3255	-0.013379
Δ RGDP Growth (-3)	−190.7956	−194.1227	−192.9289	0.006509

Table 18: Difference Specification with lagged regressor Hypothesis

Details	Hypothesis
H0:	A negative relationship between the third lagged order of Δ RGD growth and Δ Unemployment growth exists.
H1:	A negative relationship between the third lagged order of Δ RGD growth and Δ Unemployment growth does not exist.

Table 19: Difference Specification with third order lagged regressor

Gap Version HAC	Coefficient	Standard error	z	p
constant	−0.0168068	0.00381734	−4.403	1.07e-05
Δ RGDP Growth (-3)	−0.106015	0.0629391	−1.684	0.0921

In the case of the difference specification, the VAR optimal selection technique yielded inconclusive results regarding which lagged order needs to be used. Therefore, the most appropriate lag order and model would be selected through a trial-and-error procedure. The results signify that the third lagged order of changes in RGDP growth would yield the most appropriate model. Likewise, the results are partially in line with the results obtained from the VAR optimal selection technique where the AIC and HQC recommended using a third lagged order regressor. Moreover, the results obtained from the regression signify a statistically significant relationship. Therefore, the null hypothesis that states a negative relationship between the third lagged order of changes in RGDP growth and changes in unemployment growth cannot be rejected.

Dynamic Model Specification

Lastly, the paper examines Okun's coefficient through a dynamic modeling approach. Firstly, the model specification recommended by Okun (1962) would be used. Secondly, a dynamic regression would be created where the lag order obtained from the VAR optimal lag order tool would be used. The dynamic specification adds the first lagged order of changes in RGDP growth and changes of unemployment growth to the right side of the equation. Likewise, the second dynamic specification conducted in the paper adds additional lags of RGDP growth changes to explain changes in unemployment growth. However, it is essential to mention that the dynamic approaches to Okun's Law modeling are challenging to interpret as they include multiple lagged values of the same regressor. The respective hypothesis, model summary, and assumptions are as follows:

Table 20: Dynamic Specification Hypothesis

Details	Hypothesis
H0:	A negative relationship between Δ RGDP and Δ Unemployment growth does exist.
H1:	A negative relationship between Δ RGDP and Δ Unemployment growth does not exist.
H0:	A negative relationship between Δ RGDP (-1) and Δ Unemployment growth does exist.
H1:	A negative relationship between Δ RGDP (-1) and Δ Unemployment growth does not exist.
H0:	A negative relationship between Δ Unemployment (-1) and Unemployment growth does exist.
H1:	A negative relationship between Δ Unemployment growth (-1) and Δ Unemployment growth does not exist.

Table 21: Dynamic Specification Model Summary

Dynamic V. HAC	Coefficient	Standard error	z	P
constant	−0.00962820	0.00282419	−3.409	0.0007
Δ RGDP Growth	−0.107136	0.0384444	−2.787	0.0053
Δ RGDP Growth (-1)	−0.0809526	0.0317718	−2.548	0.0108
Δ Unemployment (-1)	0.409624	0.147101	2.785	0.0054
Log-Likelihood	103.0748	**Akaike criterion**	−206.9581	
Schwarz Criterion	−200.1038	**Hannan-Quinn**	−204.4622	
rho	0.058043	**Durbin's h**	1.106546	

Table 22: Dynamic Specification Assumptions

Assumptions	Null Hypothesis	Statistic	Value
Normality	Error is normally distributed	p-value	0.0021
Heteroskedasticity	Error is homoscedastic	HAC	HAC
Autocorrelation	Error is not serially correlated	HAC	HAC
Error Mean	The mean of the error is zero	Mean	-3.8825e-18

The results obtained from the first dynamic model signify that Okun's law does hold. However, the model interpretation is not straightforward. Moreover, for the hypothesis for each of the regressors in question, it could be said that the null hypothesis is not rejected in all

cases. Consequently, a significant relationship between the two macroeconomic indicators is evident only if past values of changes in RGDP and Unemployment growth are considered.

Recommended Dynamic Specification

Lastly, the paper examines the dynamic specification recommended by the author. When compared to the previous dynamic model, the difference is the inclusion of the third lagged order of changes in RGDP growth as a regressor. It is essential to mention that the model has been chosen on a trial-and-error basis, emphasizing the adjusted R-squared, AIC, BIC, and HQC criteria. Moreover, the model hypothesis, summary and assumptions are as follows:

Table 23: Recommended Dynamic Specification Hypothesis

	Hypothesis
H0:	A negative relationship between Δ RGDP and Δ Unemployment growth does exist.
H1:	A negative relationship between Δ RGDP and Δ Unemployment growth does not exist.
H0:	A negative relationship between Δ RGDP (-1) and Δ Unemployment growth does exist.
H1:	A negative relationship between Δ RGDP (-1) and Δ Unemployment growth does not exist.
H0:	A negative relationship between Δ Unemployment (-1) and Δ Unemployment growth exists.
H1:	A negative relationship between Δ Unemployment growth (-1) and Δ Unemployment growth doesn't exist.
H0:	A negative relationship between Δ RGDP (-3) and Δ Unemployment growth does exist.
H1:	A negative relationship between Δ RGDP (-3) and Δ Unemployment growth does not exist.

Table 24: Recommended Dynamic Specification Model Summary

Recommended	**Coefficient**	**Standard error**	**z**	**P**
constant	−0.00852552	0.00282490	−3.018	0.0025
Ch. RGDP Growth	−0.108316	0.0453131	−2.390	0.0168
Ch. RGDP Growth (-1)	−0.0686904	0.0335423	−2.048	0.0406
Ch. Unemployment (-1)	0.499106	0.155492	3.210	0.0013
Ch. RGDP Growth (-3)	−0.121729	0.0648569	−1.877	0.0605
Log-Likelihood	105.5144	**Akaike criterion**	−201.0288	
Schwarz Criterion	−192.7109	**Hannan-Quinn**	−198.0444	
rho	0.031771	**Durbin's h**	0.830570	

Table 25: Recommended Dynamic Model Assumptions

Assumptions	Null Hypothesis	Statistic	Value
Normality	Error is normally distributed	p-value	0.0021
Heteroskedasticity	Error is homoscedastic	HAC	HAC
Autocorrelation	Error is not serially correlated	HAC	HAC
Error Mean	The mean of the error is zero	Mean	-3.8825e-18

Similar to the dynamic version, the recommended dynamic version also signifies a link between RGDP and unemployment. The discrepancy from the dynamic version recommended by Okun (1962) to the version recommended in this paper includes the third lagged order of changes in RGDP growth. It is evident that the null hypothesis cannot be rejected for all cases of regressors, meaning that a statistically significant relationship exists. The regression results are illustrated in **Table 24**. Nonetheless, it could be stated that Okun's law does hold for North Macedonia from 2010 to 2020.

Discussion of Results

Based on the results, it is evident that a profound lagged relationship between the two macroeconomic indicators exists. Firstly, it is crucial to identify whether the decrease in unemployment came because of increased employment or an increase in the total active population (Tainer 2006). Furthermore, Janevska and Lozanovska's (2018) findings are in line with the study findings where both authors argued that the North Macedonian labor market has been trailing behind other countries in the world in terms of efficiency and flexibility. Specifically, during the political crisis, the increase in the inactivity rate can be attributed to the inefficient use of talent. Similarly, Serafimovic (2021) argued that Macedonians have not been satisfied with the country's job availability and living standards. While the country has experienced an increase in GDP growth in the past decade, employment levels have not reflected such an increase. Consequently, the incentive for individuals to take their talents elsewhere is higher. Additionally, the unemployment rate represents a leading indicator of economic expansion. In other words, when the economy grows, more workforce is needed. Consequently, a reduction in unemployment indicates that the country is entering a period of economic expansion. However, the results of unemployment eradication may be translated into GDP growth in 1-2 quarters (Palaşcă and Jaba, 2014). In terms of North Macedonia, a lagged relationship of three quarters is evident, which can be attributed to the high levels of

youth unemployment and the weak labor market dynamics. Consequently, the lack of talent in the labor market makes it difficult for firms to find adequate individuals to employ, prolonging the reflection of unemployment eradication to GDP growth by an additional quarter. Thus, lagging the relationship between the two macroeconomic indicators by three quarters.

Concluding Remarks

The paper aims to examine whether Okun's law holds for North Macedonia from 2010 to 2020. By doing so, policymakers can create measures that would boost the economic output through unemployment eradication. Furthermore, the law's applicability is tested through the Gap version, which is one of the approaches recommended in Okun's (1962) study. The regression results imply that a significant relationship between variations of RGDP around its potential and full employment does not exist.

Similarly, Andonova and Petrovska (2019) found that the Gap model's responsiveness has significantly declined around mid-2012 and has remained stable since then. Similar findings were obtained from the static difference version, which signified no significant statistical relationship between changes in RGDP growth and changes in unemployment growth. Moreover, in a dynamic setting where past values of both the endogenous and exogenous variables are considered. The dynamic specification signifies that Okun's law does indeed hold for North Macedonia. Lastly, a lagged relationship of three quarters is identified for the two macroeconomic phenomena. The reasoning for such a relationship is derived from the fact that the Macedonian labor market is not efficient; there is a lack of talent and high levels of informal employment. The high levels of youth unemployment in the examined period can be observed in **Appendix 5**. Consequently, employers take more time to find adequate employees.

Therefore, policymakers should devise policies that would incentivize talented youth to remain within the country's borders. Policies that introduce mandatory internships programs and dual education would be an appropriate measure. Likewise, programs where employers would be included in the curriculum design process, would lead to positive developments in the labor market (Tumanoska, 2019). By doing so, policymakers would eradicate the timespan needed by employers to identify suitable job candidates. Thus, by taking part in the design process of the curriculum, employers can emphasize skills that the market needs. Consequently, decreasing the time that it takes employers to identify qualified talent on the labor market.

Bibliography

Acaroğlu, Hakan. 2018. "Is there a Trade-off between Output and Unemployment? An Evidence from Okun's Law for G-20 Countries." Eskişehir Osmangazi Üniversitesi İktisadi ve İdari Bilimler Dergisi, 13(2): 147-162.

Acquah, Henry de-Graft. 2010. "Comparison of Akaike information criterion (AIC) and Bayesian information criterion (BIC) in selection of an asymmetric price relationship." Journal of Development and Agricultural Economics, 2(1): 001-006.

Adeyeye, Patrick Olufemi, Anthonia T. Odeleye, and Olufemi Adewale Aluko. 2017. "Investigating Okun's Law in Nigeria through the Dynamic Model." Journal of Economics and Behavioral Studies, 9(6): 39-46.

Akram, Misbah, Shahzad Hussain, Syed Hasan Raza, and Saqib Masood. 2014. "An empirical estimation of Okun's Law in context of Pakistan." Journal of Finance and Economics, 2(5): 173-177.

Andonova, Danica Unevska, and Magdalena Petrovska. 2019. "Disaggregating Okun's Law: A Case-Study for Macedonia." Journal of Central Banking Theory and Practice, 8(1): 183-207.

Arif, Farah. 2020. "The Validity of Okun's Coefficient in Pakistan: A Time Series Analysis." Asian Journal of Economics, Finance and Management. 94-112.

Baiocchi, Giovanni & Distaso, Walter. 2003. GRETL: Econometric software for the GNU generation. Mac. JSTOR.

Ball, Laurence, Davide Furceri, Daniel Leigh, and Prakash Loungani. 2019. "Does one law fit all? Cross-country evidence on Okun's law." Open Economies Review, 30(5): 841-874.

Bankole, Abiodun S., and Basiru Oyeniran Fatai. 2013. "Empirical test of Okun's Law in Nigeria." International Journal of Economic Practices and Theories, 3(3): 227-231.

Bhowmik, Debesh, and Sandeep Poddar. 2017. "Cyclical and seasonal patterns of India's GDP growth rate through the eyes of Hamilton and Hodrick Prescott Filter models." Asia-Pacific Journal of Management and Technology, 1(3): 7-17.

Blázquez-Fernández, Carla, David Cantarero-Prieto, and Marta Pascual-Sáez. 2018. "Okun's Law in Selected European Countries (2005-2017): An Age and Gender Analysis." Economics: 263-274.

Boďa, Martin, and Mariana Považanová. 2020. "Formal and statistical aspects of estimating Okun's law at a regional level." Papers in Regional Science, 99(4): 1113-1136.

Bournakis, Ioannis, and Dimitris K. Christopoulos. 2017. "Output and Unemployment: Estimating Okun's Law for Greece." Political Economy Perspectives on the Greek Crisis: Debt, Austerity and Unemployment, 274.

Cheung, Yin-Wong, and Kon S. Lai. 1995. "Lag order and critical values of the augmented Dickey–Fuller test." Journal of Business & Economic Statistics, 13(3): 277-280.

Economou, Athina, and Iacovos N. Psarianos. 2016. "Revisiting Okun's Law in European Union countries." Journal of Economic Studies, 43(2): 275-287.

Halebić, Jasmin. 2021. "Okun's law and assessment of stimulus to the economy of Bosnia and Herzegovina." In BH Ekonomski forum, 13(2): 29-41.

Jalles, João Tovar. 2019. "On the Time-Varying Relationship between Unemployment and Output: What shapes it?." Scottish Journal of Political Economy, 66(5): 605-630.

JANESKA, VERICA, and ALEKSANDRA LOZANOSKA. 2018. "THE IMPACT OF THE POLITICAL CRISIS IN THE REPUBLIC OF MACEDONIA ON THE LABOR MARKET." Economic Development/Ekonomiski Razvoj, 1(2): 27-45.

Karadzic, V., Backovic, T., & Streimikis, J. (2021). Relevance of Okun's Law in Montenegro. Montenegrin Journal of Economics, 17(1), 59-69.

Lim, Guay C., Robert Dixon, and Jan C. van Ours. 2019. "Beyond Okun's law: output growth and labor market flows." Empirical Economics, 1-23.

Louail, Bilal, and Siham Riache. 2019. "Asymmetry relationship between economic growth and unemployment rates in the Saudi economy: Application of Okun's law during the period." International Journal of Advanced and Applied Sciences, 83-88.

Lytras, Demetra P., Roxanne M. Feldpausch, and William R. Bell. 2017. "Determining Seasonality: A Comparison of Diagnostics From X-12-ARIMA."

Madzova, Violeta, Luljeta Sadiku, and Nehat Ramadani. 2019. "EMPIRICAL ANALYSIS OF ECONOMIC GROWTH AND UNEMPLOYMENT RATE FOR WESTERN BALKAN COUNTRIES." Knowledge International Journal, 35(1): 261-265.

Micallef, Brian. 2017. "Empirical Estimates of Okun¡¯ s Law in Malta." Applied Economics and Finance, 4(1): 138-148.

Miche, Yoan, and Amaury Lendasse. 2009 "A Faster Model Selection Criterion for OP-ELM and OP-KNN: Hannan-Quinn Criterion." In ESANN'09: European Symposium on Artificial Neural Networks, d-side Publications, 177-182.

Mihajlović, Vladimir. 2020. "The nexus between unemployment and economic growth in Serbia: Does Okun's law hold?." Ekonomika preduzeća, 68(7-8): 484-499.

Ministry of Finance of the Republic of Macedonia. 2012. Pre-accession Economic Programme 2012 -2014. Macroeconomic policy, Public finances and Structural reforms..https://finance.gov.mk/wp-content/uploads/2021/02/pre_accession_economic_programme_2012_2014.pdf

Ministry of Finance of the Republic of Macedonia. 2013. Pre - accession Economic Programme 2013 -2015. Macroeconomic Trends, Public Finances and Structural Reforms. https://finance.gov.mk/wp-content/uploads/2021/02/sion_Economic_Programme_2013_2015_en_version.pdf

Ministry of Finance of the Republic of Macedonia. 2014. Pre - accession Economic Programme 2013 -2015. Macroeconomic Trends, Public Finances and Structural Reforms. https://finance.gov.mk/wp-content/uploads/2021/02/Pre-acession_Economic_Programme_2014_-_2016_0.pdf

Ministry of Finance of the Republic of Macedonia. 2015. NATIONAL ECONOMIC REFORM PROGRAMME 2015. NATIONAL ECONOMIC REFORM PROGRAMME. https://finance.gov.mk/wp-content/uploads/2015/01/29.01.2015-NERP-EN-final_0.pdf

Ministry of Finance of the Republic of Macedonia. 2016. NATIONAL ECONOMIC REFORM PROGRAMME. NATIONAL ECONOMIC REFORM PROGRAMME. https://finance.gov.mk/wp-content/uploads/2015/01/ERP_2016_en.pdf

Ministry of Finance of the Republic of Macedonia. 2017. NATIONAL ECONOMIC REFORM PROGRAMME 2017. NATIONAL ECONOMIC REFORM PROGRAMME. https://finance.gov.mk/wp-content/uploads/2015/01/ERP_2017_2019_MK.pdf

Ministry of Finance of the Republic of Macedonia. 2018. NATIONAL ECONOMIC REFORM PROGRAMME 2018. NATIONAL ECONOMIC REFORM PROGRAMME. https://finance.gov.mk/wp-content/uploads/2015/01/Macedonia_ERP_2018.pdf

Ministry of Finance of the Republic of Macedonia. 2019. NATIONAL ECONOMIC REFORM PROGRAMME 2019 - 2021. NATIONAL ECONOMIC REFORM PROGRAMME. https://finance.gov.mk/wp-content/uploads/2021/02/ERP_2019_EN.pdf

Ministry of finance of the Republic of Macedonia. 2020. NATIONAL ECONOMIC REFORM PROGRAMME 2021 - 2023. NATIONAL ECONOMIC REFORM PROGRAMME. https://finance.gov.mk/wp-content/uploads/2021/01/Economic-Reform-Programme-2021-2023.pdf

Okun, Arthur M. 1962. "Potential GNP': Its Measurement and Significance. Reprinted in Joseph Pechman." Economics for Policy-Making.

PALAŞCĂ, Silvia, and Elisabeta Jaba. 2014. "Leading and lagging indicators of the economic crisis." Revista Română de Statistică, 62: 31.

Palombi, Silvia, Roger Perman, and Christophe Tavéra. 2017. "Commuting effects in O kun's L aw among B ritish areas: Evidence from spatial panel econometrics." Papers in Regional Science, 96(1):191-209.

Pata, Ugur Korkut, Suleyman Yurtkuran, and Adem Kalca. "A revisited causality analysis of Okun's Law: The case of Turkey." Theoretical & Applied Economics, 25(4): 118-129.

Perman, Roger, Gaetan Stephan, and Christophe Tavéra. 2015. "Okun's Law—a Meta-analysis." The Manchester School, 83(1): 101-126.

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

Ravn, Morten O., and Harald Uhlig. 2002. "On adjusting the Hodrick-Prescott filter for the frequency of observations." Review of economics and statistics, 84(2): 371-376.

Sadiku, Murat, Alit Ibraimi, and Luljeta Sadiku. 2015. "Econometric estimation of the relationship between unemployment rate and economic growth of FYR of Macedonia." Procedia Economics and Finance, 19: 69-81.

Serafimovic, Gordana. 2021. "THE RELATIONSHIP BETWEEN THE GDP AND UNEMPLOYMENT RATE IN NORTH MACEDONIA." Knowledge International Journal. 45(1): 221-225.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,IV.2020". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=13567.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,III.2020". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=13495.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,II.2020". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=13409.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,I.2020". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=3332.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,IV.2019".Stat.gov.mk.https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=3239.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,III.2019".Stat.gov.mk.https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=3165.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,II.2019". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=3080.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,I.2019". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=2998.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,IV.2018".Stat.gov.mk.https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=2900.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,III.2018".Stat.gov.mk.https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=2824.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,II 2018". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=2743.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,I.2018". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=2666.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,IV 2017". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=2570.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,III 2017". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=2498.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,II 2017". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=2423.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,I 2017". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=2352.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,IV 2016". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=2253.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,III 2016". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=2180.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,II 2016". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=2105.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,I 2016". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=2031.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,IV 2015". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=1935.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,III 2015". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=1866.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,II 2015". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=1790.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,I 2015". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=1710.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,IV 2014". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=1627.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,III 2014". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=1559.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,II 2014". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=1480.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,I 2014". *Stat.gov.mk*. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=1398.

State Statistical Office. 2021. "State Statistical Office - News release: Active Population in the Republic of Macedonia Results from the Labour Force Survey, IV quarter 2013". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=1315.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,III 2013". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=1242.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,II 2013". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=1159.

State Statistical Office. 2021. "State Statistical Office - News release: Active Population in the Republic of Macedonia Results from the Labour Force Survey, I quarter 2013". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=1079.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,IV 2012". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=987.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,III 2012". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=913.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,II 2012". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=835.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,I 2012". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=752.
State Statistical Office. 2021. "State Statistical Office - News release: Active population ,IV 2011". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=673.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,III 2011". *Stat.gov.mk*. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=606.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,II 2011". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=532.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,I 2011". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=448.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,IV 2010". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=361.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,III 2010". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=331.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,II 2010". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=330.

State Statistical Office. 2021. "State Statistical Office - News release: Active population ,I 2010". Stat.gov.mk. https://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?id=98&rbr=329.

State Statistical Office. 2021. "Formal and informal employment, by gender and age, by years". Makstat.stat.gov.mk. http://makstat.stat.gov.mk/PXWeb/pxweb/en/MakStat/?rxid=46ee0f64-2992-4b45-a2d9-cb4e5f7ec5ef.

State Statistical Office. 2021. "Бруто-домашен производ според производниот метод, по НКД Рев.2, по тримесечја-PX-Web". PX-Web. http://makstat.stat.gov.mk/PXWeb/pxweb/mk/MakStat/MakStat__BDP__BDPTrimesecni__BDPsporedESS2010/125_NacSmA_Mk_01ProKv_01_ml.px/table/tableViewLayout2/?rxid=46ee0f64-2992-4b45-a2d9-cb4e5f7ec5ef.

Tainer, Evelina M. 2006. “Using economic indicators to improve investment analysis”. Vol. 315. John Wiley & Sons, 184.

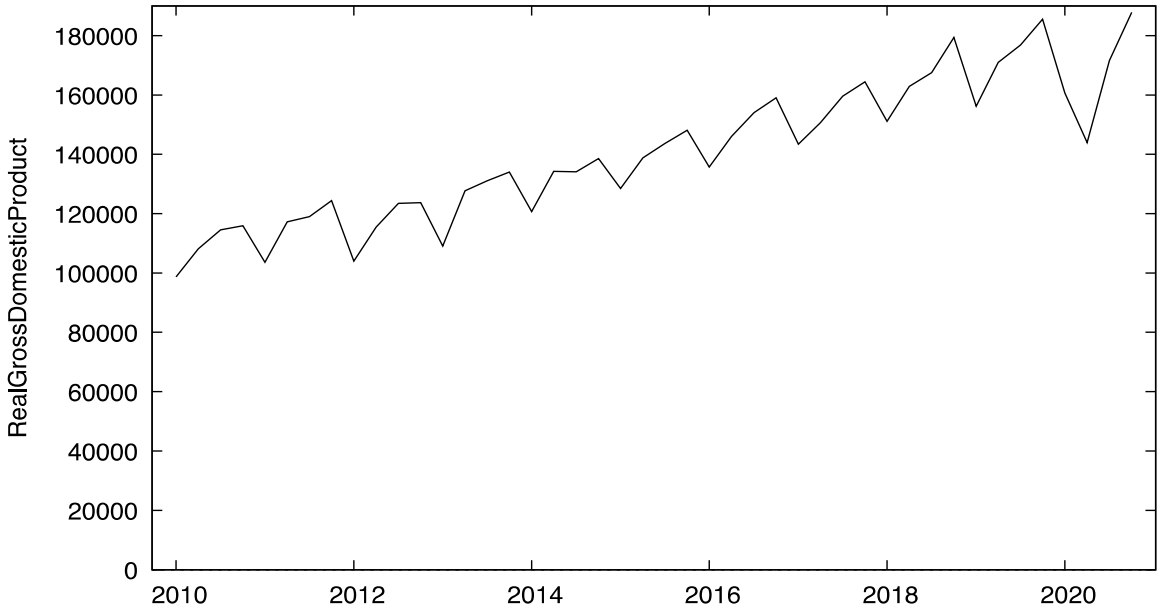
Tumanoska, Despina. 2019. "The Validity of Okun's Law in North Macedonia." Business and Economic Research, 9(2): 160-168.

Villaverde, José, and Adolfo Maza. 2009. "The robustness of Okun's law in Spain, 1980–2004: Regional evidence." Journal of Policy Modeling, 31(2): 289-297.

West, Kenneth D. 2010. "Heteroskedasticity and autocorrelation corrections." In Macroeconometrics and Time Series Analysis. Palgrave Macmillan, London, 135-144.

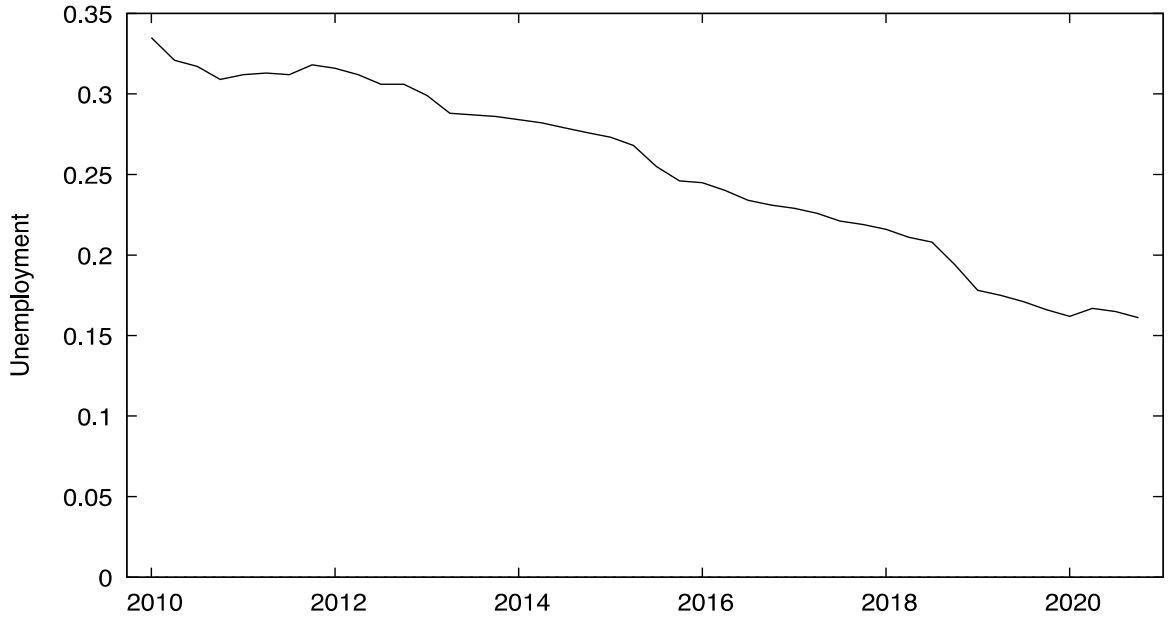
Appendixes

Appendix 1: Real Gross Domestic Product in North Macedonia (2010Q1 – 2020Q4)



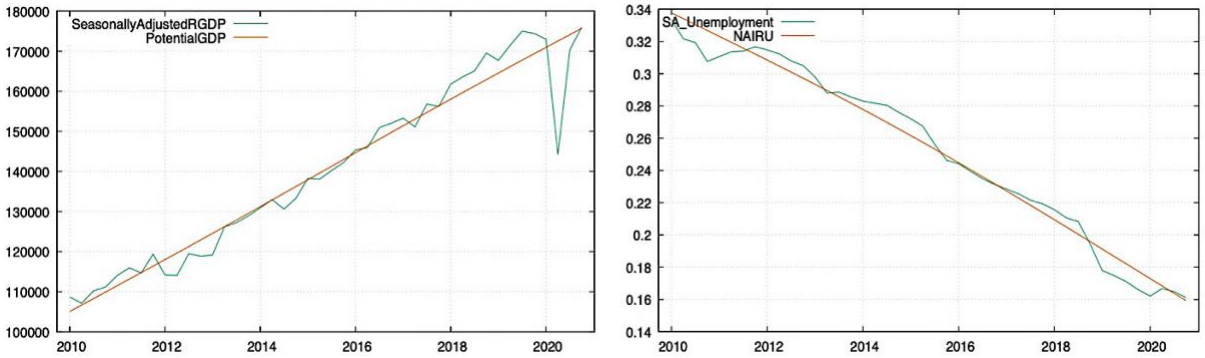
Source: Calculations of the Author

Appendix 2: Unemployment Rate in North Macedonia (2010Q1 – 2020Q4)



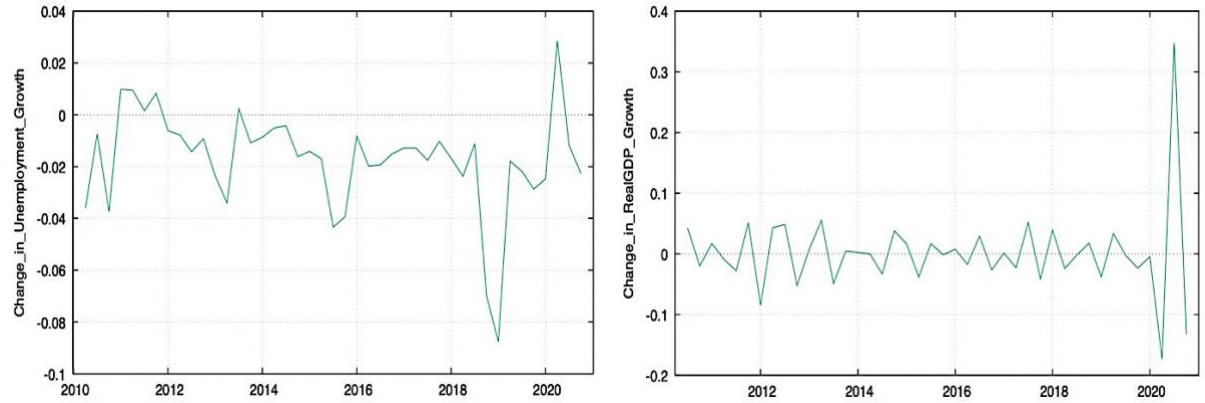
Source: Calculations of the Author

Appendix 3: RGDP and Unemployment around their Potential Levels (2010Q1 – 2020Q4)



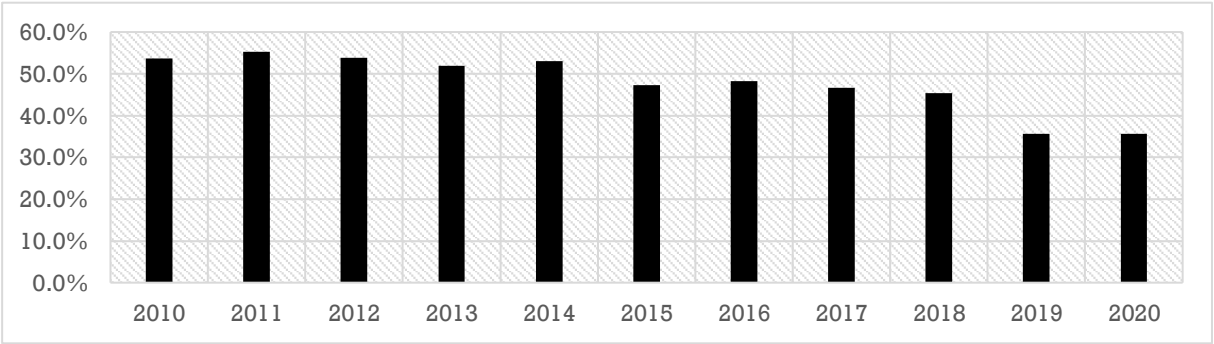
Source: Calculations of Author

Appendix 4: RGDP and Unemployment around their Potential Levels (2010Q1 – 2020Q4)



Source: Calculations of Author

Appendix 5: Youth Unemployment Rate in North Macedonia (2010-2020)



Source: (State Statistical Office 2021)