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THE RELATIONSHIP BETWEEN ENERGY CONSUMPTION AND GROSS DOMESTIC PRODUCT: POTENTIAL IMPACT OF ENERGY CRISIS ON ECONOMIC GROWTH OF REPUBLIC OF NORTH MACEDONIA

Abstract: Energy is a key source of economic growth for any economy because of the fact that many consumption and production activities involve energy as a basic input. Energy is one of the most important inputs for economic development. The aim of this paper is to examine the relationship between gross domestic product and energy consumption on the sample data taken for the period from 2008 to 2020 for Republic of North Macedonia. Energy consumption measured in kilo tons of oil equivalent is taken as an independent variable, whereas gross domestic product measured in millions of denars is taken as dependent variable. In the performed statistical tests descriptive statistics, correlation and regression analysis were primarily involved. The conclusion of this paper is that there is a positive relationship between energy consumption and gross domestic product in the Republic of North Macedonia. The existence of a positive relationship between growth level and energy consumption in Republic of North Macedonia suggests that any disruption in production or in consumption of the energy caused by price fluctuations or possible shortages of energy will have a negative impact over the country's GDP.

Keywords: energy consumption, GDP, energy crisis, economic growth

JEL Classification: E2

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Introduction

The energy is considered as a backbone of any economy. The use of energy drives economic productivity and is essential to the operation of any modern economy. If there are not sufficient energy resources, industrialization will not take place; it is crucial for running output units, for residual and commercial use and for transportation. Production and consumption of energy and GDP interact with each other, because energy determines economic and social development, and GDP growth leads to an increase in energy demand. Due to the nature of the relationship between the energy consumption and the GDP, a general consensus over the relationship between these two variables has still not been reached.

In the literature which examines the relationship between gross domestic product and energy consumption we can find four different aspect of viewing the same relationship, although many latest studies conducted in the recent decades confirm positive correlation between GDP and energy consumption. These discrepancies were one of the reasons why we decided to address the aforementioned issue as part of this paper. Additionally, we were not able to find any paper which relates to the discussed topic for the Republic of North Macedonia. This deficiency leaves space for conducting a research regarding the relationship between energy consumption and gross domestic product in Republic of North Macedonia. The third reason, supporting the importance of this paper, is the fact that the world has entirely been changed by globalization, financial and economic crisis, Covid-19 pandemic and the most recent energy crisis. Many issues have emerged among which the energy got sufficient attention of researchers.

The aim of this paper is to examine the relationship between gross domestic product (GDP) and energy consumption (EC) on the sample data taken for the period from 2008 to 2020 for Republic of North Macedonia and based on existence or non-existence of the examined relationship to comment on the potential impact of energy crisis on the economic growth of Republic of North Macedonia.

To study the relationship between the two variables in the present paper implies descriptive statistics, correlation and regression analysis followed by some additional analysis of the energy sector in Republic of North Macedonia.

The rest of this paper includes a literature review regarding the relationship between gross domestic product and energy consumption, the research methodology, the results and the concluding remarks.

1. LITERATURE REVIEW

The impact of energy usage on the economic growth of a country is discussed in various studies, but a general consensus over the relationship between gross domestic product and energy consumption has still not been reached.

In the literature which examines the relationship between gross domestic product and energy consumption we can find four different aspect of viewing the same relationship. The first group of authors states that there is a relationship directed from energy consumption towards economic growth of a country (growth hypothesis). The second group, has an opinion which implies a relationship directed from economic growth towards energy consumption of a country. The third group of authors supports the existence of a so-called feedback loop, where economic growth affects energy consumption, but at the same time the energy consumption affects the economic growth. The last group of authors concludes that there is no relationship between economic growth and energy consumption.

Narayan and Popp (2012), examined the relationship between gross domestic product and energy consumption on a sample of 20 European economies and 73 economies from all around the world in the period 1980–2006. Narayan and Popp used the Granger causality approach. In their study, the relationship between gross domestic product and energy consumption was confirmed only in five countries out of the total sample.

Destek and Aslan (2017) analyzed whether there is a relationship between economic growth and consumption of renewable energy versus the relationship between economic growth and the use of non-renewable energy. They analyzed a sample consisting of 17 emerging economies in the period from 1980 to 2012. In their study Bootstrap panel causality test was used. When they analyzed the relationship between the use of renewable energy and GDP they confirmed a positive relationship only in Peru, while in Greece and South Korea the feedback loop between the variables was confirmed. When they analyzed the relationship between the use of non-renewable energy and GDP, they confirmed a positive relationship in almost all of the countries in the sample, whereas the two-way relationship was confirmed in Turkey.

Smolowic et al. (2020), investigated the link between the use of renewable energy consumption and gross domestic product for a different sample composed of the Member States of the European Union for the period from 2004 to 2018. In order to check whether a relationship exists between the two

variables they used dynamic panel models and regression analysis. The authors concluded that, in the long run the consumption of renewable energy has a statistically significant impact on the economic growth of the Member States of the European Union for the given period.

Coers and Sanders (2013) analyzed the relationship between energy consumption and gross domestic product on a sample of 40 OECD countries. In their study they analyzed the period between 1960 and 2000. For the purpose of the study an error correction model was used. The conclusion was that in the short run the relationship between energy consumption and gross domestic product was directed from production to consumption of energy, but in the long run the relationship was opposite, they found a positive relationship directed from energy consumption towards gross domestic product.

Although a lot of research has been done on the topic regarding the relationship between energy consumption and economic growth, the results are still inconclusive. Frequently the reason is that the researchers analyze this relationship between energy consumption and gross domestic product using different research methods, testing very different samples, and in different time periods. These discrepancies were one of the reasons why we decided to address aforementioned issue as part of this paper. As it can be seen from the studies cited above, the relation is analyzed for countries which are different in many aspects compared to Republic of North Macedonia. We were not able to find a paper which relates to the discussed topic for the Republic of North Macedonia. This deficiency leaves space for further analysis of the relationship between energy consumption and gross domestic product in Republic of North Macedonia.

2. METHODOLOGY

In order to study the relationship between gross domestic product (GDP) and energy consumption (EC) in Republic of North Macedonia, we use two variables: GDP measured in millions of denars and EC measured in thousands of tons of oil equivalent. For the purpose of this research we gathered secondary data from the official website of the State Statistical Office in Republic of North Macedonia. A sample of time series data is taken from 2008 to 2020 since these are the last available data. After the collecting stage, we conducted a statistical analysis by using SPSS statistical software package. The purpose of statistical analysis is to test whether the final energy consumption in Republic of North Macedonia measured by EC (energy consumption) relates to the

level of economic growth in Republic of North Macedonia measured by GDP (gross domestic product). The statistical tools that were used in this research are Descriptive Statistics, Pearson correlation and regression analysis. For this research, we define a linear regression model in order to test the effect of independent variable, the energy consumption on dependent variable measuring the growth level in Republic of North Macedonia:

$$GDP_t = \alpha + \beta(ECT) + \epsilon_t$$

where GDP represents the dependent variable, determinant of the country's growth level, α represents unobserved, invariant, productivity factor; β represents a coefficient of energy consumption, as independent variable in period t ; ϵ is the error term; and t is the year.

3. RESULTS AND DISCUSSION

This part summarizes all the results regarding GDP level and energy consumption of Republic of North Macedonia. At first the descriptive analysis is conducted. Then we proceed with the correlation and linear regression analyses to examine the relationship between GDP and energy consumption and at the end of this section some additional analysis of the energy sector in Republic of North Macedonia will be performed which may be beneficial for us to draw conclusions.

Table 1. Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Energy	13	288,326,00	1,677,099,00	1,965,425,00	1,839,477,6923	67,109,87070
GDP	13	278,061,00	414,622,00	692,683,00	539,120,4615	98,090,77017
Valid N (listwise)	13					

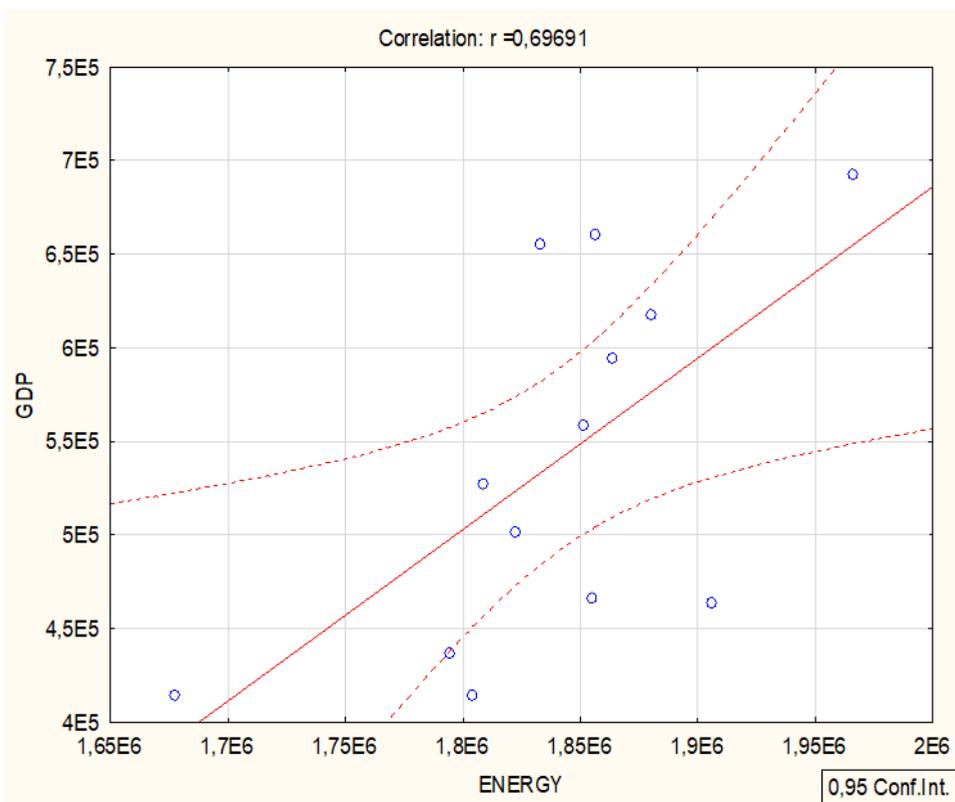
Source: Author's calculations

From the results obtained in Table 1 it can be noted that the arithmetic mean (M), or the average GDP in the Republic of North Macedonia for the period under study is 539,120 million of denars with a minimum value of 414,622 million of denars in 2009 and the maximum value of 692,683 million of denars in 2019. Additionally, from the results obtained in Table 1 it can be

noted that the arithmetic mean (M), or the average EC in the Republic of North Macedonia for the period under study is 1,839,478 thousand of tons of oil equivalent with a minimum value of 1,677,099 thousand of tons of oil equivalent in 2009 and the maximum value of 1,965,425 in 2019.

At the very first stage of the analysis and the results presented in Table 1, we can conclude that the minimum and the maximum values for both variables occurred at the same period. In 2009, Republic of North Macedonia had the lowest level of GDP and the lowest amount of energy consumed, while in 2019 Republic of North Macedonia had its highest GDP level so far, which was supported by the highest amount of energy consumed during the same year.

Figure 1. Scatter Plot Graph



Source: Author's calculations

The scatter plot graph presented in Figure 1, shows the correlation between energy consumption and economic growth in the Republic of North

Macedonia for the period between 2009 and 2020. On the graph presented in Figure 1 we can see a pattern of the dots. They are positioned in a way that it is possible to draw a line by connecting them and going upwards. To conclude, the graph shows a positive correlation between GDP and energy consumption in the Republic of North Macedonia in the given period.

Table 2. Pearson Correlation

		Energy	GDP
Energy	Pearson Correlation	1	,6969*
	Sig. (2-tailed)		,022
	N	13	13
GDP	Pearson Correlation	,6969*	1
	Sig. (2-tailed)	,022	
	N	13	13

*. Correlation is significant at the 0.05 level (2-tailed).

Source: Author's calculations

The results which were obtained from analyzing the Scatter Plot Graph presented in Figure 1 are confirmed with Pearson Correlation test. As we can see from Table 2, the Pearson's r correlation coefficient for the relationship between energy consumption and GDP is 0.6969, and is statistically significant at a 0.05 level of significance ($p=0.022$). This means that there is positive relationship between energy consumption and GDP, and changes in one variable are related to changes in the other variable. Because the Pearson's correlation coefficient is positive ($r=0,6969$), there is positive correlation between energy consumption and GDP and it means that increase in one variable will increase the other variable's value. From the results presented in Table 2, we can conclude that there is statistically significant correlation between energy consumption and GDP in Republic of North Macedonia. In the following table, Table number 3, you can see the coefficients of determination and the results from the regression analysis where GDP appears as a dependent variable and energy consumption as an independent variable. According to the results obtained using correlation analysis and linear regression, the relationship between GDP and energy consumption is positive and statically significant. It means that if the energy consumption increases by 1 unit or 1 thousand of ton of oil equivalent, GDP will increase by 1.9 million of denars.

Table 3. Coefficients

Model	Unstandardized Coefficients			Standardized Coefficients	t	Sig.
	B	Std. Error	Beta			
1	(Constant)	-1146418,780)	631970,499		-1,814)	,097
	Energy	1,916	,343	,6969	2,669	,022

a. Dependent Variable: GDP

Source: Author's calculations

From the results presented in Table 4, we can see that 59% of the changes in GDP level are explained with the changes in energy consumption.

Table 4. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,6969 ^a	,593	,338	79820,17494

a. Predictors: (Constant), Energy

Source: Author's calculations

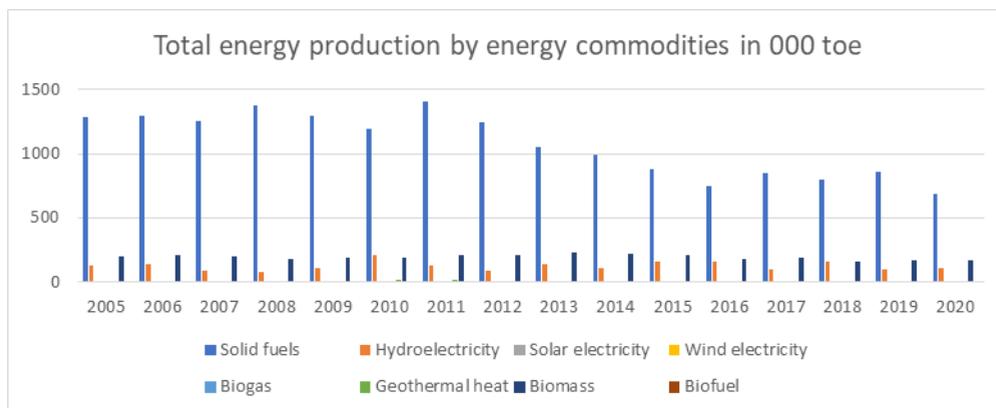
From all the analysis performed so far, we can conclude that there is a positive relationship between GDP and energy consumption in Republic of North Macedonia. The positive relationship between GDP and energy consumption means that as energy consumption increases GDP level increases as well, but if for some reason the energy consumption decreases or there are not sufficient energy resources, this will result in lower GDP or at least reduced GDP growth in our country.

Since the analysis showed that energy consumption is useful as a predictor of the growth level in Republic of North Macedonia, we will next briefly analyze the energy sector in our country to see what may impede the growth level in a period of an energy crisis or period where the overall energy resources price rises or there is a great shortfall in the energy resources supply.

From Figure 2, we can see the total energy production in Republic of North Macedonia by different energy commodities and we can see that solid fuels are dominant source of energy in our country, especially coal as the most used one. Starting from 2016 these numbers begin decreasing, mainly because of the lack of coal in our country and the need for an increased amount of imported energy which can be seen on the next graph presented in Figure 3.

In both cases, the exploitation of coal as a non-renewable source of energy and the imported energy resources can have a significant negative impact over GDP growth in our country in an energy crisis period.

Figure 2. Total energy production in RNM

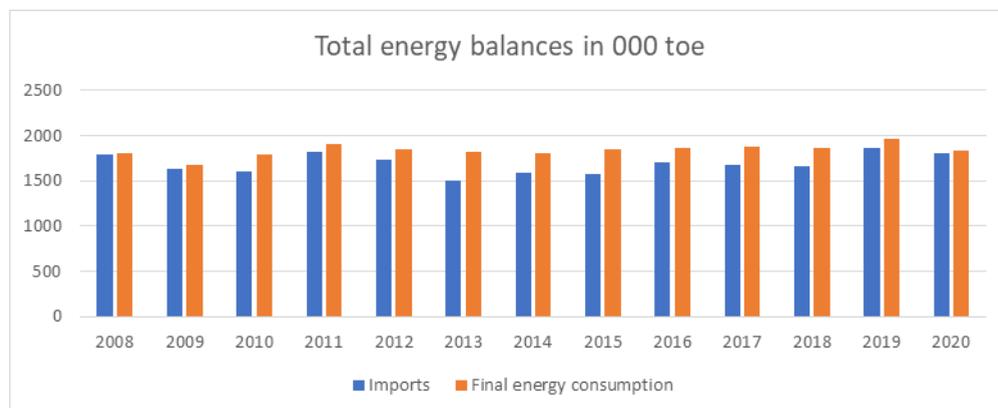


Source: State Statistical Office

On the next graph, presented in Figure 3, you can see the share of imported energy in the total energy consumption over the years in Republic of North Macedonia. If we take into account final energy consumption, we can see that imports almost equal energy consumption needs in our country. This means that our country is very dependent on regular imports of energy components. In a country where there is a positive relationship between GDP and energy consumption, such dependence on imports may lead to a decreasing country's growth in a period of energy shortfall or price rise of the imported energy resources. Additionally, in our country natural gas is imported mainly from Russia through an entry point at the Bulgarian border which may be disrupted given the circumstances¹.

¹ (Bankwatch, 2022)

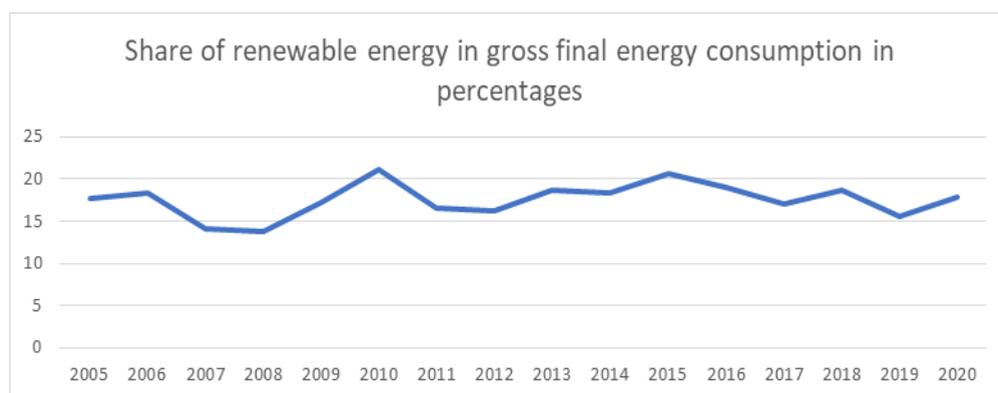
Figure 3. Total Energy balance in RNM



Source: State Statistical Office

On the following graph, presented in Figure 4, we can see the share of renewable energy in the final energy consumption. As it can be seen from Figure 4, the use of renewable energy in Republic of North Macedonia is low with an average value over the years of 17.5%. In January 2020 the government adopted new Energy Development Strategy 2020-2040 which elaborates different scenarios which are all mainly related to the moderate transition and green scenarios and they all foresee coal phase-out in 2030; and Under Energy Community commitments to increase the share of renewable energy in its mix, Republic of North Macedonia has a target of 28% in gross final energy consumption in 2022.

Figure 4. Renewable energy in RNM



Average value: 17,5%

Source: State Statistical Office

Conclusion

This paper intended to determine the relationship between energy consumption and gross domestic product in Republic of North Macedonia for the period 2008-2020. In order to do this, the research was designed as a correlation study where the relationship between gross domestic product as a dependent variable and energy consumption as an independent variable was tested. The conclusion of this paper is that there is a positive relationship between energy consumption and gross domestic product and the relationship is directed from energy consumption towards gross domestic product which is in line with the conclusion of the first group of authors who confirmed the so-called growth hypothesis.

We can conclude that because of the existence of a positive relationship between growth level and energy consumption in Republic of North Macedonia any disruption in the production or in the consumption of energy may lead to changes in the level of GDP in the country.

Having seen that our country is very dependent on regular imports of energy components, it is at the same time exposed to price fluctuations and possible shortages of energy, we expect that the energy crisis will have a negative impact over the country's GDP. The analysis in this paper will continue once the energy crisis is over in an attempt to estimate the consequences.

Our country must try to find a way to reduce the import of energy and increase the percentage of renewable energy in the total production as anticipated in the Energy Development Strategy of Republic of North Macedonia for the period 2020-2040.

Additionally, this paper suggests that the Government of Republic of North Macedonia should focus on utilization of energy resources which in turn will smooth the way for economic development. Additionally, the Government should support projects which will enable a shift from oil usage to other renewable energy resources such as hydro energy, wind and solar energy, and to furthermore encourage domestic energy production rather than import.

We should encourage campaigns for the citizens to become more aware of the energy crisis gravity for our country and to try to alter their attitude in a way to increase energy efficiency, which manifests itself in stagnation or even reduction of at least electricity consumption. The results of this study should constitute energy and environmental policy basis by being authorized and implemented.

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