

## The effects of energy consumption on economic growth in post-transition countries

### Efekti energetske potrošnje na privredni rast u post-tranzicionim zemljama

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**Abstract:** Energy is the relevant input of production activities and one of the fundamental determinants of the economic development. This paper examines the impact of energy consumption on the economic growth of EU and non-EU post-transition countries. The impact of the energy consumption on economic growth is estimated using panel data for ten post-transition countries in observed period from 2012-2020. The results show that energy consumption has positive and statistically significant impact on economic growth. A one percent increase in final energy consumption per capita will lead to rise, on average a 0.557 percent real GDP per capita. These results can be important for defining the policy measures and energy incentives toward the new technologies and energy-efficient industries providing the sustainable economic growth.

**Keywords:** energy consumption, economic growth, post-transition countries, panel data analysis.

**Sažetak:** Energija predstavlja značaj faktor proizvodnih aktivnosti i jednu od osnovnih determinanti privrednog razvoja. U ovom radu ispituje se uticaj energetske potrošnje na privredni rast u post-tranzicionim zemljama Evropske unije kao i u onim koje nisu članice Evropske unije. Uticaj energetske potrošnje na privredni rast je ocenjen korišćenjem panel podataka za uzorak od deset post-tranzicionih zemalja u posmatranom periodu od 2012-2020. godine. Rezultati pokazuju da energetska potrošnja ima pozitivan i statistički značajan uticaj na privredni rast. Jednoprocentno povećanje finalne energetske potrošnje per capita uzrokuje rast u proseku za 0.557 procenata realnog GDP per capita. Navedeni rezultati mogu biti značajni za definisanje mera politike i energetske podsticaja ka uvođenju novih tehnologija i razvoju energetske efikasne industrije koje obezbeđuju održiv privredni rast.

**Ključne reči:** energetska potrošnja, privredni rast, post-tranzicione zemlje, analiza panel podataka.

#### INTRODUCTION

Energy is considered to be the relevant input of many economic activities and limiting factor of the sustainable growth and production. Sustainable economic growth necessitates sufficient and continuous energy consumption. The energy is one of the fundamental determinants of the economic development and energy consumption per capita is used as an indicator to describe the development achiev-

ements of a country. The energy demand has been accelerating increased in the last period due the high growth rates of investments and new capacity in developing countries. Many countries are facing challenges such as increasing and unstable energy prices, rising climate change problems, security risk in producer countries. To decrease the costs and consumption of the fuel and energy from traditional sources, the European Union has promoted the

development of renewable energy sources as a priority. The EU aims to get at least 27 percent of its final energy consumption from renewable energy sources by 2030 (European Parliament, 2016). Although environmental protection has been a relevant objective of the economic and social policy, its achieving imposed a numerous change in economy with different effects on energy intensive economic sectors. For that reason, the impact of energy consumption on economic growth has been the subject of public discussions and academic researching.

The results of empirical studies show the four different hypotheses about causality energy consumption and economic growth that can be tested. The "neutrality hypothesis" indicates that there is no statistically significant dependency between energy consumption and the real GDP growth. This is the characteristic of countries whose economic growth relies on low energy consuming sectors such as service sector. The "conservation hypothesis" or "uni-directional causality from economic growth" implies that economic growth causes energy consumption. The increasing economic activity leads to raising energy consumption. The third hypothesis is "growth hypothesis" which indicates uni-directional causality economic growth from energy consumption. According to this hypothesis consumption of energy impacts the real GDP growth. This relationship can be positive, when economy is based in larger extent on high energy intensive sectors, or negative when low energy sectors activities are prevalence in economy. The "feedback hypothesis" or "bi-directional causality" indicates the interdependence between energy consumption and economic growth. This mean that any change in consumption of energy will impact the real GDP growth with a reverse effect (Marinas et al., 2018).

There are few empirical studies about energy consumption effects on economic growth in EU post-transition countries which have become EU member states after 2004. Most studies are focused on developed and developing countries. The aim of this paper is to test the hypothesis that energy consumption has positive statistically significant impact on economic growth of post-transition countries. In addition, this paper aims to contribute the present literature researching the energy consumption effects in EU and non-EU post-transition countries.

The rest of the paper is organized as follows: Section 1 presents the review of the recent empirical findings; Section 2 describes specification of the empirical model. Section 3 presents the results and the last Section concludes.

## 1. LITERATURE REVIEW

The existing literature shows different results about relation between energy consumption and economic growth. The numerous studies research the impact of energy consumption on economic growth finding positive statistically significant effects. As an example, we consider the study that imply the increasing of 1 percent of energy consumption affects the growth of GDP for 0.2349 percent (Zhixing, 2011). Similarly, the empirical results show that 1 percent increase in total renewable energy consumption increases real GDP of Brazil by 0.20 percent (Pao, Fu, 2013). Using panel data for 42 developing countries, Ito finds positive effects of renewable energy consumption on the economic growth in the long-run, but the non-renewable energy consumption has negative effects on the economic growth (Ito, 2017). Similar results were found by Alper and Oguz (Alper, Oguz, 2016), Anwar and others (Anwar et al., 2017). In addition, Ahmed and Azam examine the temporary and permanent causal nexus between energy consumption and economic growth finding that results differ among high, medium, and low-income countries. The conservation hypothesis about unidirectional causality that runs from economic growth to energy consumption has been confirmed in 12 high-income countries, 27 middle-income countries and 1 low-income countries suggesting that these countries are less energy dependent economies. Bidirectional causality between economic growth and energy consumption has been found in 7 high-income, 10 middle-income and 1 low-income countries suggesting that economic growth and energy consumption have mutually influence to each other (Ahmed, Azam, 2016). The conservation hypothesis was confirmed by Jebli and Youssef for a sample of 69 countries (Jebli, Youssef, 2015).

Mbarek and others have confirmed that unidirectional causality, runs from economic growth to renewable energy consumption, is statistically significant in the short and the long-run in the developed countries and in the short-run in the developing countries (Mbarek et al., 2018). This means that economic growth will lead to increasing of renewable energy consumption. These results are in line with the empirical study of Narayan and Doytch. In addition, it shows that economic growth has a positive and statistically significant impact on industrial energy consumption of the low- and middle-income countries, and not high-income countries (Narayan, Doytch, 2017).

The empirical evidence about energy consumption effects on economic growth in post-transition countries is scarce. It would be presented the results of few studies of this relationship in EU member states. Šikić has researched the differences between the energy consumption impact on economic growth in 16 developed EU member states and 11 post-transition EU member states. The results for post-transition EU countries show if long-term renewable energy consumption increases by 1 percent than GDP will rise by 0.68 percent. In addition, she has found that changes in energy consumption influences economic growth in developed EU countries only in long run. Besides that, renewable energy consumption has negative impact on economic growth in these countries (Šikić, 2020). On the other side, Soava and others have found the positive impact of renewable energy consumption on economic growth using the panel data for 28 EU countries. For 12 EU countries this relationship is bi-directional (Soava et al., 2018). Similar results were founded by Alper and Oguz emphasizing that no causality between the energy consumption and economic growth is found in Cyprus, Estonia, Hungary, Poland and Slovenia, while the conservation hypothesis is confirmed for Czech Republic (Alper, Oguz, 2016).

Kasperowicz and Štreimikiene studied the relationship between energy consumption and economic growth for V4 countries and 14 EU "old" member states. Similar to Šikić, they concluded that GDP growth in post-transition countries is more energy depended on than in developed EU countries. The results of researching show a one percent rise in energy consumption would increase the GDP growth for 0.19 percent in V4 countries while in EU "old" member states GDP growth would increase for 0.066 percent (Kasperowicz, Štreimikiene, 2016). Bercu and others have found that energy consumption has positive and statistically significant impact on GDP growth in 14 Central and Eastern European countries. The one percent increase of energy consumption increases the economic growth by 0.239 percent (Bercu et al., 2019). Analysing the relationship between renewable energy consumption and economic growth in 9 Black Sea and Balkan countries, Kocak and Sarkgünesi have confirmed the growth hypothesis in Bulgaria, Greece, Macedonia, Russia, and Ukraine (Kocak, Sarkgünesi, 2017). Testing the same hypothesis for ten EU member states from Central and Easter Europe, Marinas and others have concluded that correlation between renewable energy consumption and economic growth is statistically significant on short run for Czech Republic, Estonia, Hungary, Lithuania, Poland, Slovakia, and Slovenia, but on the long run, the growth

hypothesis is rejected in Czech Republic and Hungary (Marinas et al., 2018).

## 2. DATA AND METHODOLOGY

Depending on data availability, in the sample are selected ten post-transition countries: Albania, Bulgaria, Croatia, Czech Republic, Hungary, Montenegro, North Macedonia, Poland, Romania, and the Republic of Serbia. The observed period is from 2012 to 2020. The numerous previous empirical studies suggested the using the non-classical Cobb-Douglas production function to integrate energy consumption with real GDP growth. Having that in mind, the specification of panel data model can be written as:

$$\log GDP_{it} = \alpha_i + \beta_1 \log FEC_{it} + \beta_2 \log GFC_{it} + \beta_3 \log L_{it} + u_{it} \quad (1)$$

( $i = 1, 2, \dots, N$ ;  $t = 1, 2, \dots, T$ )

where  $GDP$  is real GDP per capita in constant 2015 US\$ in country  $i$  and time  $t$ ;  $FEC$  is final energy consumption per capita;  $GFC$  is real gross fixed capital formation per capita in constant 2015 US\$;  $L$  is labour force and  $u_{it}$  is disturbance term. All variables are expressed in natural logarithms and the coefficients can be interpreted as elasticities. For this research, final energy consumption data are collected from Eurostat database. The rest of the data series are from World Bank World Development Indicators Online. Gross Domestic Product (GDP) measures economic activity and the value of all the final goods and services produced in economy over one year. Final energy consumption covers the energy consumption of end-users, such as industries, transport, households, services, and agriculture. It excludes the consumption of energy sector itself and losses occurring during transformation and distribution of energy (Eurostat, 2023). Gross fixed capital formation and labour force present the traditional inputs of Cobb-Douglas production function capital and labour.

## 3. RESULTS AND DISCUSSION

In the process of selection an appropriate panel data model specification, first we tested the existence of unobservable individual specific effects by performing F test for fixed effects model and modified Breusch-Pagan (Breusch, Pagan, 1980) for random effects model. The results in Table 1 show that individual specific effects are statistically significant. The heteroskedasticity is confirmed by performing modified Wald test. The result of Pesaran CD test (Pesaran, 2004) indicates that there is no cross-sectional independence of panel data model. The result of the Hausman misspecification test

(Hausman, 1978) suggests that the individual effects should be treated as fixed parameters and the fixed effects model is more likely to be appropriate than random effects model.

Table 1 - Results of fixed and random effects model

	Fixed effects model	Random effects model
	<b>logGDP</b>	<b>logGDP</b>
logFEC	0.835*** (6.81)	0.850*** (9.58)
logGFC	0.225*** (5.12)	0.268*** (7.09)
logL	0.219 (1.22)	0.054** (2.21)
cons	-0.812 (-0.69)	0.067 (0.33)
R <sup>2</sup>	0.76	0.76
F test	25.73 (p=0.0000)	
BP test	106.37 (p=0.0000)	
Wald test	893.51 (p=0.0000)	
Pesaran CD test	6.331 (p=0.0000)	
Hausman test	27.07 (p=0.0000)	

Notes: t and z-values are in parentheses;  
\*\*\*represents statistical significance at 1 percent;  
\*\*represents statistical significance at 5 percent  
Source: Autor's calculations

Due the presence of heteroskedasticity and autocorrelation, LSDV model with panel-corrected standard errors and Prais-Winsten transformation is used (Greene, 2002). Results in Table 2 show that the explanatory variables are statistically significant. The results confirmed the hypothesis that the final energy consumption has positive and statistically significant impact on economic growth. According to the results of estimation, a one percent increase in final energy consumption per capita will lead to rise, on average a 0.557 percent real GDP per capita. It means that availability of energy is the prerequisite of achieving the economic growth in post-transition countries. The positive sign of real gross fixed capital formation per capita and labour force coefficient shows that the increasing of these factors leads real GDP growth. Comparison with other studies in which the energy consumption impact on economic growth in post-transition countries was researched indicates that the estimation results are in line with those found by Šikić (2020), Bercu and others (2019), Kasperowicz and Štreimikiene (2016).

Table 2 - Results of LSDV model

	<b>logGDP</b>
logFEC	0.557*** (5.27)
logGFC	0.275*** (7.65)
logL	0.434*** (3.21)
cons	-1.597** (-1.99)
R <sup>2</sup>	0.9

Notes: Dummy variables for individual effects are included; z-values are in parentheses.

\*\*\*represents statistical significance at 1 percent;

\*\*represents statistical significance at 5 percent

Source: Autor's calculations

## CONCLUSION

For sustainable economic growth it is necessary providing the sufficient and continuous energy consumption. There are four different hypotheses about causality energy consumption and economic growth that can be tested. The aim of this paper is to test the hypothesis that energy consumption has positive statistically significant impact on economic growth of post-transition countries. The review of empirical studies shows the differences between the results depending of main focus of the researching. Some research studies are based on long-run or short-run relationship, some are based on single country study or the group of countries with using different period, data, and econometric technique. Most studies about energy consumption effects on economic growth in post-transition countries are focused on EU member states. The contribution of this paper to the present literature is researching the energy consumption effects in post-transition countries including non-EU post-transition countries.

The impact of the energy consumption on economic growth is estimated using panel data for ten post-transition countries in observed period from 2012 to 2020. The results confirm the hypothesis about positive statistically significant relationship between energy consumption and economic growth. A one percent increase in final energy consumption per capita will lead to rise, on average a 0.557 percent real GDP per capita. The results are in line with those found in previous empirical studies focused on post-transition countries.

The "trade-off" between energy consumption and economic growth emphasis the necessity of implementing energy policies and incentives toward the new technologies and energy-efficient industries providing the sustainable economic growth. In addition, it is necessary to develop the incentives for

using renewable energy sources by policy makers in non-EU post-transition countries.

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