THE ROLE OF ENERGY IN ECONOMIC GROWTH OF THE BALKAN COUNTRIES

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ABSTRACT

In this study, the aggregate production function that incorporates energy is estimated for some Balkan countries, namely Albania, Bulgaria, Greece, Romania and Turkey. The output (real GDP) is constructed as a function of three factors of production: capital stock, labor and total energy. The sample data, covering the period of 1960-2014 for Greece and Turkey, and 1971-2014 for Albania, Bulgaria and Romania. To find out whether a long run relationship among the variables exists, the bounds testing methodology developed by Pesaranet al. (2001) is employed. By using the autoregressive distributed lag (ARDL) approach, the long run elasticities are estimated. The short run elasticities are estimated by error correction mechanisms. The empirical results reveal that a long run level relationship among the variables is found for all countries, except for Turkey. The long run elasticities estimated by the ARDL models indicate that capital stock is significant for all of the economies. On the other hand, energy is a significant variable for Albanian, Bulgarian and Romanian economies, whereas labor seems to yield mixed results. The differences and the similarities among the countries are also explained by the composition and the historical backgrounds of the economies examined.

Keywords: *Production function, energy, GDP, bounds testing, Balkan countries*
JEL Classification: *C22, C51, E23, O57, Q43*

1. Introduction

Until 1970s, the role of energy in economic growth had been generally neglected in economics literature. After the energy crises that occurred during the 1970s, energy started to be included in economic analyses. Stern (2011) reviews extensively how the mainstream growth models have evolved and how energy use has been incorporated in production functions as one of the factors of production. Although energy may not appear in standard macroeconomics textbooks, there exist a vast literature on the relationship between energy use and economic growth, especially, on the empirical investigation of the causal relationship between energy and GDP, which constitutes an significant part of the energy economics literature.

There are many studies that attempt to explain economic growth within a production function that includes energy as one of the factors of production. Some examples of the early studies, among others, are Tintner et al. (1977) employ a Cobb-Douglas type and a constant elasticity substitution (CES) functions that include energy to estimate the output of the Austrian economy; Jorgenson (1984) uses energy as factor of production to investigate the productivity growth of

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the individual industries in the U.S.; Apostolakis (1987) investigates the role of energy in the production functions of five southern European economies by using annual time series data and concludes that by incorporating energy in the production function as a factor-input, specification errors are avoided.

More recent studies that treat energy as a factor of production are Kemfert (1998), Stern (2000), Dahl and Erdogan (2000), Thompson (2006), Wei (2007), Stresing et al. (2008), Lee and Chien (2010),Lecca et al. (2011), Stern and Kander (2012), Su et al. (2012), Ayres and Voudouris (2014), Salim et al. (2014),Esseghir and Khouni (2014), Dissou et al (2015), Voudouris et al. (2015),Lazkano and Pham (2016), and Thompson (2016), inter alia. The aforementioned studies either focus on estimating the (short-run and the long-run) coefficients of the production function or focus on the issues of substitution among production factors, or showing empirically the importance of energy use in economic growth as in Stern and Kander (2012). The studies use different types of specifications of production function. Although Cobb-Douglas type production functions may appear more frequently in the studies, constant elasticity substitution (CES) functions and nested functions may also be used.

Most of the studies mentioned above analyzed generally developed or industrialized countries. Recently, some studies analyzed some Balkan countries or economies in transition. For example, Acaravci and Ozturk (2010),Wolde-Rufael (2014),Kumar et al. (2014), Kumar et al. (2017) and Koçak and Şarkgüneşi(2017) investigates the relationship between energy consumption and economic growth either within or without the framework of production function for the Balkan countries. This study aims at investigating the role of energy in economic growth of some Balkan countries, namely, Albania, Bulgaria, Greece, Romania and Turkey by analyzing the aggregate production functions that incorporates energy for each country separately. The sample time series data, covering the period of 1960-2014 for Greece and Turkey, and 1971-2014 for Albania, Bulgaria and Romania, employed in this study are the largest data set on the basis of availability in comparison to the aforementioned studies.

2. Background of the Economies

The countries under examination have different historical backgrounds and different compositions of GDPs. The sample period of 1971-2014 for Albania, Bulgaria and Romania cover also the socialist era up to 1990. The economic structures of these countries have changed drastically towards a capitalist system afterwards. In addition, Bulgaria and Romania have been members of European Union (EU) since 2007.On the other hand, although the economies of Greece (which has been a member of EU since 1981) and Turkey have had a capitalist system throughout the sample period of 1960-2014, they have faced different financial and economic crises at different degrees. In order to have an idea about the structures of the economies we can look at the shares of GDPs by sectors. Table 1 presents the average percentage shares of GDP by sectors for each country.

Table 3. The Shares of GDP by Sectors (%)

Countries	Sectors	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	2010-14
Albania	Services	23	22	21	47	55	53	51
	Industry	44	45	32	16	20	27	27
	Agriculture	33	33	47	37	24	20	22
Bulgaria	Services	27	28	44	59	62	64	67
	Industry	57	61	42	25	27	30	28
	Agriculture	16	12	14	16	11	7	5
Greece	Services	-	-	-	72	72	77	80
	Industry	-	-	-	21	22	20	16
	Agriculture	-	-	-	7	6	4	4
Romania	Services	-	-	33	45	52	56	55
	Industry	-	-	45	37	35	37	38
	Agriculture	-	-	21	17	13	7	6
Turkey	Services	50	49	51	52	60	63	64
	Industry	27	32	32	33	29	27	27
	Agriculture	23	19	16	15	11	9	9

Source: World Development Indicators Database. (Note: Percentages *may not* total 100 due to rounding).

As can be seen from Table 1, the share of services has increased to become the dominant sector in all the economies. Especially, after the regime change, industrial output have fallen in Albania, Bulgaria and Romania. Nevertheless, Romania has the highest share of industry among the five countries. The data for Greece starts from 1995, and Greece has the highest share of services but the least share of industry among the economies. On the other hand, Albania has the highest share of agriculture, whereas the share of agriculture seems to have shifted to services in Turkey.

As for energy consumption, industry is thought of the most consuming sector, but services and agriculture are also energy dependent. Another important indicator of the economies with respect to energy use is energy intensity, which shows how efficiently energy is used in producing the output. Table 2 shows average energy intensities of the countries over the sample period. The figures in Table 2 are in fact index numbers indicating whether energy efficiency improves or deteriorates with respect to the base period.

Table 4. Average Energy Intensities of the Countries over Time (1971 = 100)

Period	Albania	Bulgaria	Greece	Romania	Turkey
1971 - 1975	99	93	110	90	107
1976 - 1980	110	86	119	76	111
1981 - 1985	105	77	128	65	112
1986 - 1990	100	65	147	64	115
1991 - 1995	70	57	158	57	111
1996 - 2000	53	57	157	48	115
2001 - 2005	53	46	149	38	110
2006 - 2010	42	35	135	29	109
2011 - 2014	39	32	143	24	107

Source: Author's own calculations based on WDI and Penn World Table data.

The base period here is chosen as the first year, so first years index value (1971 = 100) indicates that 100 unit of energy is required to produce, say, 100 unit of output in 1971. The index numbers, calculated for each country, in Table 2 indicate that energy efficiency have improved enormously in Albania, Bulgaria and Romania, but remained almost same in Turkey, while it has deteriorated in Greece.

3. Methodology and Data

3.1. Methodology

By taking energy as a factor of production, the output (real GDP) is constructed as a function of three factors of production: capital stock, labor and total energy:

$$Y = f(K, L, E) \tag{1}$$

where, Y is output (real GDP), K is capital stock, L is labor (number of employed people) and E is total energy use. Assuming a Cobb-Douglas function, the aggregate production function can be written as

$$Y_t = A K_t^{\alpha_1} L_t^{\alpha_2} E_t^{\alpha_3} \tag{2}$$

By taking the logarithms of both right-hand-side and left-hand-side of equation (2), the model becomes:

$$\ln Y_t = \ln A + \alpha_1 \ln K_t + \alpha_2 \ln L_t + \alpha_3 \ln E_t + \varepsilon_t \tag{3}$$

where, ε_t is a white noise error term. Although Autoregressive distributed lag (ARDL) modelling has been known for a long time, it has become increasingly popular in estimating the models related to energy economics in recent years due to the new approach developed by Pesaran et al (2001). An ARDL model is a general dynamic specification, which uses the lags of the dependent variable and the lagged and contemporaneous values of the independent variables, through which the short run effects can be directly estimated, and the long run equilibrium relationship can be indirectly estimated. Although ARDL modelling has been in use for a long time, Pesaran et al. (2001) introduced the bounds test for cointegration that can be employed within an ARDL specification. This method has definite advantages in comparison to other cointegration procedures. First, all other techniques require that the variables in the model are integrated of the same order, whereas the approach developed by Pesaran et al. could be employed regardless of whether the underlying variables are I(0), I(1), or fractionally integrated. Thus, the bounds test eliminates the uncertainty associated with pre-testing the order of integration. Secondly, it can be used in small sample sizes, whereas the Engle-Granger and the Johansen procedures are not reliable for relatively small samples (Altinay, 2007).

The ARDL approach involves two steps for estimating the long-run relationship. The first step is to examine the existence of a long–run relationship among all variables under examination. Conditional upon cointegration is confirmed; in the second stage the long-run coefficients and the short-run coefficients are estimated using the associated ARDL and error correction models. To test for cointegration in model (2) by the bounds test proposed by Pesaran et al. the following conditional ECM model which is a variant of parameterization of the ARDL model is constructed,

$$\begin{aligned}\Delta \ln Y_t = a_0 + a_1 \ln Y_{t-1} + a_2 \ln K_{t-1} + a_3 \ln L_{t-1} + a_4 \ln E_{t-1} + b_i \sum_{i=1}^{p} \Delta \ln Y_{t-i} + \\ c_i \sum_{i=0}^{p} \Delta \ln K_{t-i} + d_i \sum_{i=0}^{p} \Delta \ln L_{t-i} + e_i \sum_{i=0}^{p} \Delta \ln E_{t-i} + \varepsilon_t\end{aligned} \tag{4}$$

The variables are defined previously. For the bounds test two separate statistics are employed to test for the existence of a long-run relationship: an *F*-test for the joint significance of the coefficients of the lagged levels in equation (4), i.e., $H_0 : a_1 = a_2 = a_3 = a_4 = 0$ and a *t*-test for the null hypothesis of $H_0 : a_1 = 0$. Pesaran et al (2001) provides two asymptotic critical value bounds for the *F*-test when the independent variables are *I*(*d*) (where $0 \leq d \leq 1$): a lower value assuming the regressors are *I*(0), and an upper value assuming purely *I*(1) regressors. If the test statistics surpass their relevant upper critical values one can reject the null hypothesis of no cointegration and conclude that a long-run relationship exists. If the test statistics fall below the lower critical values one cannot reject the null hypothesis of no cointegration. If cointegration is confirmed, we move to the second phase and estimate the long-run coefficients of the production function obtained from the long-run static solution of the optimum ARDL model determined by the information criteria. The short-run dynamics are estimated by the associated error correction models (Altinay, 2007).

3.2. Data

The data for real GDP, capital stock and labor are obtained from Penn World Table (Version 9.0). Both real GDP and capital stock are measured in national currencies at constant 2011 prices and denoted "*rgdpna*" and "*rkna*", respectively, on Penn World Table. The methodology used for calculating real GDP and capital stock is explained in Feenstra et al. (2015).The data used for the variable labor (L) are the number of persons engaged and it is denoted "*emp*" on Penn World Table. The data used for the variable energy are "energy use per capita" and "population" obtained from the World Bank's World Development Indicators (WDI) database. The energy use per capita series are converted to "total energy use" by multiplying them with the population series. All the data are in the form of annual time series covering the period of 1960-2014 for Greece and Turkey, and 1971-2014 for Albania, Bulgaria and Romania. Thus, the data set used in this study is the largest sample available in comparison to the aforementioned studies conducted on the Balkan countries.

4. Empirical Results

As stated earlier, the bounds testing methodology does not require pre-testing the order of integration since it can be employed regardless of whether the underlying variables are I(0), I(1), or fractionally integrated. To avoid small sample bias of the conventional unit root tests when applied to small samples usually encountered in empirical studies related to energy economics, the bounds test is directly applied to the logarithms of the variables appear in equation 4. The order of ARDL for each country is determined on the basis of the minimum Akaike (AIC) and Schwarz-Bayesian (SBIC) information criteria values. The results of the bounds tests are presented in Table 3. As can be seen, the F-values of all countries, except for Turkey, surpass the upper bound (critical value) at five percent level of significance.

Table 3. The results of the bounds tests

Countries	ARDL Model	AIC	SBIC	F-Value	LM Test (χ^2)
Albania	ARDL(3,1,1,1)	-2.630746*	-2.166305*	5.0275**	1.2430 [0.265]
Bulgaria	ARDL(1,3,2,1)	-3.749140*	-3.242476*	7.1495**	3.8287 [0.050]

Greece	ARDL(1,1,1,2)	-3.863871*	-3.488631*	5.2966**	2.0136 [0.156]
Romania	ARDL(2,3,1,1)	-3.704731	-3.198067*	4.5993**	1.4099 [0.235]
Turkey	ARDL(1,1,1,1)	-3.612987*	-3.278409*	2.3184	1.0738 [0.300]

* Indicates the lowest value; ** indicates significance at 5 percent level.

Therefore, a long run relationship among the variables of production function is found for Albania, Bulgaria, Greece and Romania. Since the bound's testing is sensitive to correlated errors, a Lagrange multiplier (LM) test for serial correlation is applied to the residuals. The results of the LM test indicate that the residuals are not correlated at first order, at five percent level of significance. After confirming cointegration relationship, the long-run and short-run elasticities of production function can be estimated. The estimates of long-run coefficients of the ARDL models determined by the information criteria above are estimated by using Microfit for windows and presented in Table 4 for all the four countries.

Table 4. Estimates of the Long Run Coefficients of the ARDL Models

Countries	lnE	lnK	lnL	Constant	Period
Albania	0.26330 [0.001]	0.64141 [0.000]	-0.38448 [0.004]	-3.10610 [0.057]	1971-2014
Bulgaria	0.66572 [0.000]	0.48883 [0.000]	0.27480 [0.328]	-1.37730 [0.374]	1971-2014
Greece	0.11233 [0.457]	0.71395 [0.001]	0.34996 [0.044]	0.62445 [0.617]	1960-2014
Romania	0.80918 [0.000]	0.39717 [0.000]	-1.30900 [0.000]	-4.20090 [0.026]	1971-2014

[Numbers in brackets are p-values]

The short-run coefficients are estimated by using the corresponding error correction models of each country and presented in Table 5.

Table 5. Estimates of the Short Run Coefficients of the ARDL Models

Panel 1. Albania

Error Correction Representation for the ARDL(3,1,1,1) Model. Dependent variable is dLY

Regressor	dlnY(-1)	dlnY(-2)	dlnE	dlnK	dlnL	dC	ecm(-1)
Coefficient	0.1055	0.1023	0.2774	3.4174	-0.2752	-2.7055	-0.8710
[Probability]	[0.414]	[0.403]	[0.001]	[0.000]	[0.209]	[0.122]	[0.000]

Panel 2. Bulgaria

Error Correction Representation for the ARDL(1,3,2,1) Model. Dependent variable is dLY

Regressor	dlnE	dlnE(-1)	dlnE(-2)	dlnK	dlnK(-1)	dlnL	dC	ecm(-1)
Coefficient	0.3073	0.0598	0.0222	1.0266	-0.6110	0.2828	-0.4944	-0.3589
[Probability]	[0.017]	[0.572]	[0.807]	[0.005]	[0.069]	[0.329]	[0.449]	[0.029]

Panel 3. Greece

Error Correction Representation for the ARDL(1,1,1,2) Model. Dependent variable is dLY

Regressor	dlnE	dlnK	dlnL	dlnL(-1)	dC	ecm(-1)
Coefficient	0.1061	2.2746	0.5531	-0.0335	0.2121	-0.3396
[Probability]	[0.222]	[0.000]	[0.004]	[0.874]	[0.617]	[0.000]

Panel 4. Romania

Error Correction Representation for the ARDL(2,3,1,1) Model. Dependent variable is dLY

Regressor	dlnY(-1)	dlnE	dlnE(-1)	dlnE(-2)	dlnK	dlnL	dC	ecm(-1)
Coefficient	0.3488	0.4551	-0.1603	-0.2585	0.7736	-0.2949	-2.0563	-0.4895
[Probability]	[0.028]	[0.000]	[0.232]	[0.017]	[0.026]	[0.173]	[0.106]	[0.000]

The results of the short-run coefficient estimates will be summarized below.

5. Conclusion

The estimates of the long-run coefficients indicate that capital stock has the correct sign and is significant for all of the economies even at 1 percent level of significance. Energy use is a highly significant variable for Albanian, Bulgarian and Romanian economies, but insignificant for Greek economy even at 10 percent level of significance. On the other hand, labor (employment) seems to yield mixed results. For instance, the long-run labor coefficient for Albania and Romania seems significant but has negative sign, whereas, it has positive sign for Bulgaria but it is insignificant. Only for Greece it has a positive sign and is significant at 5 percent level.

As for the results of the short-run coefficient estimates, first, the error correction term (denoted ecm) has the correct sign and is significant at 5 percent level for all of the countries. This result can be thought of a verification of the results of the bounds test for cointegration. Secondly, Albania has the highest speed of adjustment (87%) towards equilibrium, whereas the speed of adjustment for Bulgaria, Greece and Romania are 36%, 34% and 49%, respectively. Thirdly, the short-run effect of capital stock on output is significant at 5 percent level and much larger than the long-run effect for all of the countries. Fourthly, as is the case in the long-run, the short term effect of energy use is significant for Albanian, Bulgarian and Romanian economies, but insignificant for Greek economy. Lastly, the short-term effect of labor is significant only for Greece.

In overall assessment, capital stock is the most important factor in economic growth of the four Balkan countries, namely Albania, Bulgaria, Greece and Romania, both in the long run and especially in the short run. Energy use is an important factor both in the long run and in the short run, for Albania, Bulgaria and Romania, in other words, for the economies in transition. On the other hand, energy does not seem to be important factor for Greek economy which is dependent heavily on services sector. On the contrary, the effect of labor is significant only for Greek economy.

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