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THE RELATIONSHIP BETWEEN ENERGY CONSUMPTION, CURRENT ACCOUNT DEFICIT AND ECONOMIC GROWTH: THE CASE OF BRICS-T COUNTRIES

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ABSTRACT

With industrialization, energy consumption is considered as an important input for development. It is also known that the increase in energy consumption of countries has an impact on growth. However, one of the most important problems for countries that are dependent on foreign energy is the current account deficit problem. The purpose of this study is to test this effect by using panel fixed effects and panel random effects models for BRICS-T countries. The data used in the analysis covers the period 1994 to 2021. According to the econometric findings obtained with the help of Driscoll-Kraay Standard Error Model Estimation, current account deficit has a negative and significant effect on economic growth, while energy consumption has a positive and significant effect on economic growth. This result supports the growth hypothesis that an increase in energy consumption increases economic growth. According to the causality test results, there is a bidirectional causality relationship between energy consumption and economic growth. There is a unidirectional causal relationship from current account deficit to economic growth. However, there is no significant causality relationship between energy consumption and current account deficit.

Keywords: *Energy Consumption, Economic Growth, Current Account Deficit, Panel Data Analysis.*

JEL Codes: *F32, Q43, O47, C23.*

1. INTRODUCTION

Energy, which has been one of the most fundamental elements of production and consumption activities throughout human history, has an crucial role in the growth and development process. As a matter of fact, in the globalizing world, countries-need energy more and more every day as they grow. Especially in the industrialization process, energy has become the basic need of industry. The energy sector continues to grow rapidly due to its use as an industrial raw material and as a heating and converting power. On the other hand, energy resources are scarce and unevenly distributed across the

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world. The unbalanced distribution of energy resources can also cause countries to use economic, political and military power against each other from time to time.

The ever-increasing need for energy is important not only for the development of industry but also for increasing social welfare and improving living standards. However, problems such as the World Wars and the oil crises of the 1970s threatened the security of energy supply and negatively affected the economies of both developed and underdeveloped countries. Especially after the oil crises of the 1970s, the relationship between economic growth (EG), energy consumption (EC) and current account deficit (CAD) became quite evident. Therefore, this article mainly aims to test whether this relationship is valid or not with the help of econometric methods.

Today, many factors such as quantitative and qualitative changes in industrialization, population growth, and technological advances are the main reasons for the increase in energy demand and thus energy imports. This situation may threaten the macroeconomic balances of many energy importing countries such as Türkiye. Since the rate of EC is higher than the rate of energy production, CAD becomes a chronic problem in these countries. The CAD also poses a risk to EG by causing domestic savings to flow to other countries. Therefore, CAD and low growth rates are among the most serious problems caused by dependence on foreign energy. The relationship between EC, EG and CAD is important for shaping the energy policies of countries.

There are many articles in the literature investigating the relationship between EC and EG. In some of these articles, analyses have been conducted for a single country and in others for samples covering more than one country. However, there is no consensus in the literature on the direction of the relationship between EC and EG. In fact, the empirical findings suggest that different causality relationships may emerge between these variables. The first one is the Growth Hypothesis, which is based on a unilateral causality from EC to EG. The second is the Conservation Hypothesis, which reveals a unilateral causal relationship from EG to EC. The third is the Feedback Hypothesis, which argues that there is a bidirectional causal relationship between EC and EG, and the fourth is the Neutrality Hypothesis, which argues that there is no causal relationship between EC and EG. Although there are many academic art examining the relationship between EC and EG, the number of articles that include the CAD variable in the model is quite limited. The purpose of this article is to examine the impact of EC and CAD on EG using panel fixed effects and panel random effects models for BRICS-T countries based on annual data for the period 1994-2021. It is also aimed to test the validity of the Growth Hypothesis. In this framework, first, the empirical literature testing the relationship between EC, CAD and EG is discussed. After introducing the data, econometric model and methodology, econometric findings are reported. In the conclusion, the theoretical framework and findings are summarized.

2. LITERATURE REVIEW

Despite the fact that the literature has many articles on the relationship between EC, CAD and EG, it is observed that a significant portion of these articles deal with the relationship between EG and EC. Various articles testing the relationship between these variables are summarized below.

Table 1. Literature Review

Author(s)	Country(s)	Period	Method	Obtained results
Stern (1993)	US	1947-1990	Granger test	EC → EG
Hondroyiannis, Lolos and Papapetrou (2002)	Greece	1960-1996	Johansen cointegration test, Granger test	EC↑ → EG↑
Paul and Bhattacharya (2004)	India	1950-1996	Johansen cointegration test, Granger test	EC ↔ EG
Huang, Hwang and Yang (2008)	82 selected countries	1972-2002	Panel system GMM	No relationship EC → EG Low- and middle-income countries: EG↑ → EC↑ High-income countries: EG↑ → EC↓
Mucuk and Uysal (2009)	Türkiye	1960-2006	Granger test, Impulse-Response Functions and Variance Decomposition	EC↑ → EG↑
Belke, Dobnik and Dreger (2011)	25 OECD	1981-2007	Panel cointegration test, dynamic panel causality test	EC ↔ EG
Kesikoğlu and Yıldırım (2014)	11 OECD countries	1980-2012	Panel causality test	natural gas/oil consumption; in Switzerland: EC → CAD and EG → CAD in Netherlands: EC → EG in South Korea: EC → EG
Kaya and Kaya (2016)	Türkiye	1980-2013	Johansen cointegration test, Granger test	EG → CAD
Hepaktan (2018)	Türkiye	1990-2017	Gregory-Hansen Cointegration Test, Toda-Yamamoto Causality Test	EC and CAD → EG EC ↔ CAD
Efeoğlu and Pehlivan (2018)	Türkiye	1987-2016	Johansen Cointegration Test	EC → EG CAD↑ → EG
Gozgor, Lau and Lu (2018)	29 OECD countries	1990-2013	ARDL	non-renewable EC↑ → EG↑ renewable EC↑ → EG↑
Baz et al. (2019)	Pakistan	1971-2014	NARDL	EC → EG
Bostan and Ravanoğlu (2019)	Türkiye	1984-2015	Granger test	EC↑ → EG↑

Şahin and Uçan (2020)	Türkiye	1975-2015	ARDL, Granger test	EC↑ → EG EG↑ → CAD
Kızıldere (2020)	Türkiye	1974-2015	Granger test	EC↑ → CAD↑ EG↑→ CAD↑
Arslan, Gençer Çelik and Kuzu (2021)	Türkiye	1980-2015	Granger test	No causality EC → EG
Ayhan and İnançlı (2022)	Türkiye	1980-2017	Johansen cointegration test	EC → EG EC → CAD CAD → EC CAD → EG EG → EC
Fendoğlu and Konat (2022)	G7 countries	1996-2020	Panel cointegration test	EG, CAD and EC are cointegrated.
László (2023)	27 EU member states	2010-2019	Purchasing power standard units, correlation analysis, and hierarchical cluster analysis	No strong relationship EG, EC
Gershon, Asafo, Nyarko-Asomani and Koranteng (2024)	17 selected African countries	2000-2017	Static panel technique	EC↑ → EG↑

Notes: ARDL: Autoregressive Distributed Lag, CAD: Current Account Deficit, EC: Energy Consumption, EG: Economic Growth, EU: European Union, GMM:Generalized Method of Moments, G7: Group of Seven, OECD: Organisation for Economic Co-operation and Development, NARDL: Non-linear Autoregressive Distributed Lag, US: United States.

As can be seen, the relationship between EG and EC has been analyzed by different authors for different countries using different techniques and different findings have been obtained. While some of the findings indicate a unidirectional causality relationship between these variables, others point to a bidirectional causality relationship. However, in general, it can be stated that there are more empirical results supporting the Growth Hypothesis, which argues that EC increases EG. In addition to EC, another variable of our article is the CAD. There is no consensus among the findings of the articles testing the relationship between CAD and EG. On the other hand, there are very few articles that include all three variables in the model. This article contributes to the literature both in terms of the model and the sample analyzed.

3. DATA, MODEL, AND METHODOLOGY

Table 2 presents summary information on the data and data sources used in this article to determine the impact of EC and CAD on EG in BRICS-T countries (Brazil, Russia, India, China, South Africa, Türkiye) through annual data for the period 1994-2021.

Table 2. Data Information

Symbol	Description	Measurement Unit	Data Source
GDP	Economic growth	GDP per capita (constant 2015 US$)	World Bank Indicators
CAD	Current account deficit	Current account balance (% of GDP)	World Bank Indicators
PEC	Energy consumption	Primary energy consumption	BP Statistical Review

The general model used in this article to test the impact of EC and CAD on EG is as follows:

$$GDP_{it} = a_{it} + \beta_1 PEC_{it} + \beta_2 CAD_{it} + \varepsilon_{it} \quad (1)$$

i= the cross-sectional dimension,

t= the time dimension,

β= the slope coefficients

ε_{it}=the error term.

Table 3. Descriptive Statistics

Variable	Observation	Mean	Standard Deviation	Min	Max
GDP	168	5979.721	3110.72	586.1755	13449.93
CAD	168	0.0296973	4.018019	-8.870208	17.47424
PEC	168	26.181	33.94349	2.285811	157.6472

Before estimating the model, we first present the descriptive statistics of the variables (Table 3). According to the data in Table 3, standard error values indicate that GDP has higher volatility than other variables. On the other hand, the CAD exhibits the lowest volatility.

Table 4. Correlation Matrix

	GDP	CAD	PEC
GDP	1.0000		
CAD	-0.0556	1.0000	
PEC	0.0543	0.4066	1.0000

Table 4 shows the results of the correlation analysis. These results, while the CAD has a negative correlation with EG, there is a positive correlation between EC and EG. The methods used in this article to econometrically analyze the impact of CAD and EC on EG are as follows; fixed effects model, random effects model, Driscoll-Kraay standard errors estimator, Dumitrescu-Hurlin panel causality test.

4. FINDINGS

Initially, regression analysis is performed with the fixed effects model to estimate the impact of CAD and EC on EG and the findings are presented in Table 5.

Table 5. Estimation Results of Fixed Effects Model

Independent Variable	Coefficient	Std. Error	t-Statistic	Prob.
CAD	-133.2831***	39.2903	-3.39	0.001
PEC	77.71851***	5.953287	13.05	0.000

Note: ***, p<0,01

The estimation results of the fixed effects model, the coefficient of the CAD is negative and statistically significant. Therefore, this finding can be interpreted that an increase in the CAD harms EG performance. At the same time, the coefficient of EC is statistically significant and positive. This result means that an increase in EC results in EG.

Secondly, the effect of CAD and EC on EG is also estimated with a random effects model and the obtained results are indicated (Table 6).

Table 6. Estimation Results of Random Effects Model

Independent Variable	Coefficient	Std. Error	t-Statistic	Prob.
CAD	-136.0421	39.36254	-3.46	0.001***
PEC	76.25572	5.938844	12.84	0.000***

Note: *** p<0.01.

In terms of the sign and significance of the coefficients, the findings of the random effects model coincide with the findings of the fixed effects model. In this context, the effect of CAD on EG is negative, while the effect of EC on EG is positive. Hausman test is employed to make a choice between the fixed effects model and the random effects model. The results of the Hausman test for this purpose are presented in Table 7.

Table 7. Results of Hausman Test

	(b) Fixed Effects	**(B)** Random Effects	**(b-B)** Difference	**sqrt(diag(V_bV_B))** S.E
CAD	-133.2831	-136.0421	2.758964	.
PEC	77.71851	76.25572	1.462788	0.4144392
Prob>chi2 = 0.0517				

According to Table 7, since the probability value of the model is greater than 0.05, it is decided that the random effects model is more appropriate. In order for the estimations to give accurate and reliable results, the model should not contain problems such as autocorrelation and heteroskedasticity. For this reason, autocorrelation and heteroskedasticity tests are performed and the results are indicated (Table 8).

Table 8. Results of Autocorrelation and Heteroskedasticity Test

Autocorrelation		
Born and Breitung (2016)	Q(p)-stat	p-value
	5.09*	0.078
Heteroskedasticity		
Likelihood-ratio test	LR chi2(5)	Prob>chi2
	82.64***	0.000

Note: *** p<0.01, * p<0.1.

According to Table 8, since the probability value of the autocorrelation test is greater than 0.05, there is no autocorrelation problem in the model, but since the probability value of the heteroskedasticity test is less than 0.05, there is a heteroskedasticity problem. The random effects model is re-estimated using Driscoll-Kraay Standard Errors to correct this problem and the results are presented in Table 9.

Table 9. Results of Driscoll-Kraay Standard Errors Estimator

Variables	Coefficient	Driscoll-Kraay Standard Errors	t	P>|t|
CAD	-136.0421**	50.52314	-2.69	0.012
PEC	76.25572***	4.6811	16.29	0.000
Constant	3987.31	3971.105	1.00	0.324
Prob > chi2	0.000***			

Note: *** p<0.01, ** p<0.5.

According to the estimation results in Table 9, CAD has a statistically significant and negative effect on EG at the 5% significance level. On the other hand, the increase in EC has a positive effect on EG at the 1% significance level. This result on the positive effect of EC on EG is somewhat similar to the findings of Hondroyiannis et al. (2002), Mucuk and Uysal (2009), Efeoğlu and Pehlivan (2018), Gozgor et al. (2018), Şahin and Uçan (2020) and Gershon et al. (2024). Finally, Dumitrescu-Hurlin causality test is performed to determine the causality relations between the variables and the findings are indicated in Table 10.

Table 10. Results of Dumitrescu-Hurlin Causality Test

Null Hypothesis	W-bar	Z-bar	Prob.	Decision	Conclusion
GDP ≠ > PEC	5.9856	8.6354	0.0000	GDP → PEC	GDP PEC
PEC ≠ > GDP	3.2161	3.8384	0.0001	PEC → GDP	
GDP ≠ > CAD	0.5433	-0.7910	0.4289	no relationship	CAD → GDP
CAD ≠ > GDP	3.6601	4.6074	0.0000	CAD → GDP	
PEC ≠ > CAD	1.2893	0.5012	0.6163	no relationship	no relationship
CAD ≠ > PEC	1.0105	0.0181	0.9855	no relationship	

Note: ≠ >: does not Granger cause

The Dumitresscu-Hurlin causality test results, there is a bidirectional causality relationship between EC and EG. This result is similar to the findings of Paul and Bhattacharya (2004) and Belke et al. (2011). There is a unidirectional causal relationship from CAD to EG. This finding is in line with the estimation results of Hepaktan (2018) and Ayhan and İnançlı (2022). However, there is no significant causality relationship between EC and CAD.

5. CONCLUSION

Since 1980, the globalization process, which has accelerated in the world and has made its effects felt today, has increased the relations of the world economies with each other. The increase in the economic activities of countries has on the one hand increased EC and on the other hand led to an increase in the external dependence of countries with insufficient energy resources. Energy production, which started with coal, continued with oil production, and the diversity in energy sources progressed as electricity and nuclear energy production. With the oil crisis in the 1970s, there was a shift towards renewable energy sources. However, external dependence on energy has deepened the CAD problem of countries. In developing countries such as Türkiye, which is dependent on foreign energy, the picture has become more and more severe over time. Therefore, it is crucial to research the issue and make evaluations on the solution.

There are many academic articles on EG and EC in the literature. However, there are very few articles on the CAD. This article attempts, to analyze EC and EG by adding the CAD variable as a third variable. The purpose of this article is to test these variables for BRICS-T countries using panel fixed effects and panel random effects models based on annual data for the period 1994-2021. According to the econometric findings obtained with the help of Driscoll-Kraay Standard Error Model Estimation, CAD has a negative and significant effect on EG, while EC has a positive and significant effect on EG. This result supports the growth hypothesis that an increase in EC increases EG. The Dumitresscu-Hurlin causality test results, there is a bidirectional causality relationship between EC and EG. On the other hand, there is a unidirectional causal relationship between CAD and EG. However, there is no significant causality relationship between EC and CAD. In line with the growth hypothesis, the fact that EC positively affects EG indicates that energy input demand and primary EC, and hence energy external dependence and CAD increase in BRICS-T countries due to economic activities. The CAD creates external dependence in energy and intermediate goods and resource transfer problems for the country's economy. In order to reduce the CAD in terms of energy, a sustainable energy policy is required. This sustainability can be achieved both through domestic energy production and the development of sustainable energy management processes. Increasing R&D activities to increase domestic and renewable energy investments and production in order to reduce dependency and resource transfer over time will enable the effective implementation of sustainable sectoral energy plans. In this way, the CAD will be reduced while contributing to EG.

Structural reforms and transformations in agriculture, industry and all other areas are at the heart of what needs to be done for countries with current account deficits to contribute positively to economic growth. In order to increase economic growth performance, it is necessary to reduce the current account deficit to reasonable levels. Otherwise, increasing interest rates to finance the deficit will have a negative impact on private investment. For a strong and rapid growth performance, it is also beneficial to reduce external dependence on energy. In this context, it is recommended to invest more in renewable energy sources such as wind, solar, hydro and geothermal.

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