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THE RELATIONSHIP BETWEEN ENERGY CONSUMPTION AND GROWTH IN EMERGING MARKETS BY PANEL QUANTILE REGRESSION: EVIDENCE FROM VISTA COUNTRIES

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Abstract

Energy consumption and economic growth relationship is an important topic for global economy. Most of researchers investigated this relationship with different methods on different macro-economic data. These methods are including not only time-series econometrics but also panel data analysis. Moreover, they analyzed different countries or country groups classified by OECD, World Bank or any other economic organizations. The aim of study is the relationship between energy consumption and economic growth with panel quantile regression method on VISTA countries (Vietnam, Indonesia, South Africa, Turkey and Argentina). Estimations are made annually for 1985 – 2013 period. Dependent variable is GDP per capita growth and independent variables are logarithmic energy consumption indicators which are Oil Consumption, Coal Consumption, Hydroelectricity Consumption and Primary Energy Consumption. Results show that the effects of logarithmic energy consumption variables are changing on economic growth for different quantiles (τ = 0.25; 0.50; 0.75; 0.90). In conclusion, effect of oil consumption on economic growth is falling at high quantiles of GDP growth. In contrast, effect of hydroelectricity consumption and primary energy consumption on economic growth is rising at high quantiles. But, there is not a statistical significant effect of coal consumption on economic growth at any quantile.

Keywords: *Emerging Markets, Energy Consumption, Economic Growth, Panel Quantile Regression*

JEL Codes: O13, Q43, C22

GELİŞMEKTE OLAN PİYASALARDA ENERJİ TÜKETİMİ VE BÜYÜME İLİŞKİSİNİN PANEL KANTİL REGRESYON İLE İNCELENMESİ: VISTA ÜLKELERİ ÖRNEĞİ

Özet

Enerji tüketimi ve ekonomik büyüme ilişkisi küresel ekonomi için önemli bir konudur. Çoğu araştırmacı, farklı makro ekonomik veriler kullanarak bu ilişki üzerine çalışmış ve zaman serisi analizleri, panel veri analizleri gibi yöntemler kullanmıştır. Çalışmalarda, OECD, Dünya Bankası veya diğer ekonomik kuruluşlar tarafından gruplandırılmış farklı ülke grupları üzerinde araştırmalar gerçekleştirilmiştir. Bu çalışmanın amacı Vietnam, Endonezya, Güney Afrika, Türkiye ve Arjantin ülkelerinden oluşan VISTA grubunda, enerji

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tüketimi ve ekonomik gelişme arasındaki ilişkiyi panel kantil regresyon tekniği ile incelemektir. Tahminler 1985 – 2013 yılları arasındaki yıllık veriler kullanılarak yapılmıştır. Oluşturulan modelde bağımlı değişken, Kişi Başına GSYİH Büyümesi olarak seçilirken; bağımsız değişkenler, Petrol Tüketimi, Kömür Tüketimi, Hidroelektrik Tüketimi ve Birincil Enerji Tüketimi verilerinin logaritmaları olarak belirlenmiştir. Analiz sonuçlarında, ilk olarak enerji tüketiminin büyüme üzerindeki etkisinin farklı kantillerde (τ = 0.25; 0.50; 0.75; 0.90), başka bir deyişle ekonomik büyüme dağılımının farklı dilimlerinde değiştiği gözlenmektedir. Sonuçlara göre, petrol tüketiminin ekonomik büyüme üzerindeki etkisi yüksek kantillerde azalmaktayken; aksine, hidroelektrik ve birincil enerji tüketiminin etkisi yüksek kantillerde artmaktadır. Ancak, kömür tüketimi ile ekonomik gelişme arasında istatistiksel olarak anlamlı bir ilişki tespit edilememiştir.

Anahtar Kelimeler: *Gelişmekte olan Piyasalar, Enerji Tüketimi, Ekonomik Gelişme, Panel Kantil Regresyon Tekniği*

1.INTRODUCTION

The relationship between energy consumption and the country's economic growth is a contemporary debate in the literature of energy economics, because energy is required to produce a unit of national product in nearly all economic activities. Studies of energy consumption and GDP relationship are depending on many economic activities. These studies are generally concerned time series variables and analyzed by causality tests. Unfortunately, the large number of studies in this area found different results for different countries also for different time periods within the same country. In many studies, researchers have focused on not only time-series econometrics but also panel data analysis for finding a relation between energy consumption and economic growth. According to many economists, energy is a key factor for growth and energy shortage is causality of economic shrinkage but this assumption is not true for every country. Energy dependency is very important subject for all countries, but there is not a certain research about the impact factor of energy consumption for different growth levels.

In this paper, our aim is examining the relationship between energy consumption (Oil Consumption, Coal Consumption, Hydroelectricity Consumption and Primary Energy Consumption) and annual percentage growth rate of GDP per capita based on constant local currency in VISTA countries (Vietnam, Indonesia, South Africa, Turkey, Argentina). VISTA countries are considered as emerging countries and the relationship will be investigated via panel quantile regression method between 1985 and 2013. According to the method, we can easily analyze the impact factor of energy consumption for different growth levels. Also, energy consumption policies may be determined based on the study results. Firstly, we will mention the literature of energy consumption and economic growth relation, secondly, data and methodology will be explained. After the results are represented, we will discuss about finding in conclusion part.

The VISTA countries are a group of emerging markets that, while are obviously not on the same size level as gigantic nations such as China and India, are large markets that are poised to grow quickly in the coming years. These nations generally have a young growing labor force, political stability, and surging levels of energy and other consumption. Unfortunately, the nations are usually less developed from both a financial and domestic perspective than developed countries.

2.LITERATURE

Yang (2000) re-examined the causality between energy consumption and GDP by using Taiwan data for the period 1954-1997. He investigated the causal relationship between GDP and energy consumption, including coal, oil, natural gas and electricity. According to Granger's technique, he found bidirectional causality between total energy consumption and GDP.

Soytas and Sarı (2003) in their study examined the relationship between energy consumption and GDP of ten emerging markets (G 7 countries, excluding China) countries. They discovered directional causality in Argentina, causality running from GDP to energy consumption in Italy and Korea, and from energy consumption to GDP in Turkey, France, Germany and Japan.

Oh and Lee (2004) investigated the causal relationship between energy consumption and economic growth including two multivariate time series models. The data of this study included period of 1981:1-2000:4. In the short run there was no causality between energy and GDP, in the long run there was a unidirectional causal relationship running from GDP to energy. The study implied an energy conservation policy may be feasible without compromising economic growth in the long run. Altinay and Karagol (2004) tried to investigate a series of unit root and causality tests to detect causality between the GDP and energy consumption in Turkey employing Hsiao's version of Granger causality method for the 1950–2000 period. In their study, the conventional unit root tests indicated the series were I(1), whereas the endogenous break unit root tests had proposed by Zivot and Andrews[1] and Perron[2] revealed that the series are trend stationary with a structural break. Therefore, it was inappropriate to take the first difference of the data to achieve stationarity. The main conclusion of that study was that there was no evidence of causality between energy consumption and GDP in Turkey based on the data.

Lee (2005) in his paper re-investigated the co-movement and the causality relationship between energy consumption and GDP in eighteen developing countries, using data for the period 1975 to 2001. The evidence showed that long-run and short-run causalities run from energy consumption to GDP. Iriani (2005) in his work investigated the causality relationship between GDP and energy consumption in the six countries of Gulf Cooperation Council (GCC). Empirical results indicated a unidirectional causality running from GDP to energy consumption and evidences showed no support for the hypothesis that energy consumption is the source of GDP growth in the GCC countries.

Lise and Montfort (2007) in their study, they expected to grow energy consumption and GDP by % 5,9 and % 7 annually until 2025 in Turkey. Their paper tried to unfold the linkage between energy consumption and GDP by undertaking a cointegration analysis for Turkey with annual data over the period 1970-2003. The analysis showed that energy consumption and GDP are co-integrated. That means there is a (possibly bi-directional) causality relationship between the two. There is a unidirectional causality running from GDP to energy consumption indicating that

[1] Zivot, E. and Andrews, D.W.K., 1992. Further evidence on the great crash, the oil price shock, and the unit root hypothesis, Journal of Business and Economics Statistics 10, 251–270.
[2] Perron, P., 1997, Further evidence on breaking trend functions in macroeconomic variables, Journal of Econometrics 80, 355–385.

energy saving would not harm economic growth in Turkey. Besides they found that energy consumption keeps on growing as long as economy grows in Turkey. Marathe and Mozumder (2007) in their study investigated the causal relationship between the per capita electricity consumption and the per capita GDP for Bangladesh using cointegration and vector error correction model. Their results showed that there was unidirectional causality from per capita GDP to per capita electricity consumption. However, electricity consumption (per capita) did not cause GDP (per capita) in case of Bangladesh. This article is very important from the point of energy conservation, emission reduction and economic development.

Narayan and Smyth (2008) in their paper examined the relationship between capital formation and energy consumption with real GDP in a G7 countries using panel unit root, panel cointegration, Granger causality and long run structural estimation. According to their findings capital formation and energy consumption Granger caused real GDP positively in the long run and a %1 increase in energy consumption increased real GDP by 0.12-0.39 %, while a %1 increase in capital formation increased real GDP by 0.10-0.28%. Huang, Hwang and Yang (2008) tested causal relationship between energy consumption and economic growth for 82 countries from 1972 to 2002. For this study income levels were taken by World Bank and the data divided into four categories. According to study level there was no causal relationship between energy consumption and economic growth in the low-income; economic growth leaded energy consumption positively in the middle-income group (lower and upper middle income groups), economic growth leaded energy consumption negatively in the high-income group countries. In addition to these results there was no evidence that energy consumption leaded economic growth in any of the four income groups.

Odhiambo (2009), in his study, investigated causal relationship between energy consumption and economic growth in Tanzania during the period of 1971-2006. Unlike the previous studies, he applied the newly developed autoregressive distributed lag (ARDL)-bounds testing approach to examine this linkage. He also used two proxies of energy consumption. They were total energy consumption per capita and electricity consumption per capita. The results of the bounds test showed that there was a stable long-run relationship between each of the proxies of energy consumption and economic growth. However, the conclusion of causality test indicated that there was a unidirectional causal flow from total energy consumption to economic growth and a causal flow from electricity consumption to economic growth. The summary of this study was energy consumption spurred economic growth in Tanzania. Zhang and Cheng (2009) investigated the existence and direction of Granger causality between economic growth, energy consumption, and carbon emissions in China, applying a multivariate model of economic growth, energy use, carbon emissions, capital and urban population in their paper. Empirical results for China over the period 1960–2007 suggested a unidirectional Granger causality running from GDP to energy consumption, and a unidirectional Granger causality running from energy consumption to carbon emissions in the long run. Evidence showed that neither carbon emissions nor energy consumption leads economic growth. Therefore, the government of China can purse conservative energy policy and carbon emissions reduction policy in the long run without impeding economic growth.

Apergis and Payne (2011) examined the relationship between renewable energy consumption and economic growth for a panel of six Central American countries over the period 1980-2006. The heterogeneous panel test revealed a long-run equilibrium relationship between real GDP, renewable energy consumption, real gross fixed capital formation and the labor force with the respective coefficients positive and statistically significant. The results from the panel error correction model indicated bidirectional causality between renewable energy consumption and economic growth in both the short and long run.

Campo and Sarmiento (2013) estimated the elasticity of the long-run relationship between energy consumption and GDP for ten countries in Latin America from 1971 to 2007. They applied Pedroni's panel cointegration test to determine if such a long-run relationship exists. They found cointegration between the two variables in both directions and this paper discussed energy dependency of some countries and their energy conservation policies.

Nindi and Odhiambo (2014) in their study, they investigated the causal relationship between energy consumption and economic growth in Mozambique using modern time series techniques. Unlike some of the previous studies, the current study has used the recently developed ARDL-bounds testing approach to co-integration and the ECM-based Granger causality method to examine this linkage. The results showed that there is a distinct unidirectional causality from energy consumption to economic growth. That implies that, for Mozambique, it is the consumption of energy that drives economic growth in the both long and short run.

3.DATA AND METHODOLOGY

The aim of the study is investigating the relationship between energy consumption and economic growth with panel quantile regression method on VISTA countries. VISTA is an abbreviation of country names which are Vietnam, Indonesia, South Africa, Turkey and Argentina. VISTA is used in economics for describing five emerging markets. In this study, VISTA countries' energy consumption and economic growth data were used. Data were collected from World Bank Databank and BP Statistical Review (2014).

Oil Consumption, Coal Consumption, Hydroelectricity Consumption and Primary Energy Consumption variables were used as energy consumption data. Oil consumption is measured in million tons and others in million tons of oil equivalent. Primary energy comprises commercially traded fuels including modern renewables used to generate electricity. GDP per capita growth data were used as economic growth variable. Annual percentage growth rate of GDP per capita is based on constant local currency. GDP per capita is gross domestic product divided by midyear population. All variables are employed with their natural logarithms. 1985-2013 period is selected according to data availability for all countries and data is prepared for panel data analysis. Descriptive statistics are shown in Table 1.

Table 1. Descriptive Statistics of Variables

	Growth	Oil Cons	Coal Cons	Hydro Cons	Primary Energy Cons
Mean	2.709142	25.61064	24.95839	4.183726	70.62548
Median	3.776392	22.46646	13.73962	3.016000	68.44216
Maximum	11.09415	73.82524	96.85500	13.41182	168.6794
Minimum	-14.35101	1.943070	0.255000	0.033036	10.07097
Std. Dev.	4.294628	15.38978	28.56184	3.545435	37.25920
Sum	392.8256	3713.543	3618.966	606.6402	10240.70

To investigate the relationship between energy consumption and economic growth, panel quantile regression estimates are employed in the study. Panel data models and quantile regression models are both widely used in applied econometrics. Quantile regression models allow the researcher to account for unobserved heterogeneity and heterogeneous covariates effects, while the availability of panel data potentially allows the researcher to include fixed effects to control for some unobserved covariates (Canay, 2011). Recently, some researchers associated these two methodologies and named it Panel Quantile Regression (Koenker, 2004; Geraci and Bottai, 2007; Abrevaya and Dahl, 2008; Galvao, 2008; Rosen, 2009; Lamarche, 2010; Guloglu, et al. 2016). Koenker (2011) explains the panel quantile regression with fixed effect like these: suppose that the conditional quantile functions of the response of the j^{th} observation on the i^{th} individual y_{ij} takes the form:

$$Qy_{ij}(\tau \mid x_{ij}) = \alpha_i + x_{ij}'\beta(\tau) \qquad j = 1,...,m_i, i = 1,...,n \tag{1}$$

In this formula, the α's have a pure location shift effect on the conditional quantiles of the response. The effects of the covariates, x_{ij} are permitted to depend upon the quantile, τ, of interest, but the α's do not. To estimate the model for several quantiles simultaneously, we propose solving,

$$\min_{(\alpha,\beta)} \sum_{k=1}^{q} \sum_{j=1}^{n} \sum_{i=1}^{m_i} \omega_k \rho_{\tau_k}(y_{ij} - \alpha_i - x_{ij}'\beta(\tau_k)) \tag{2}$$

Where, ρ_{τ_k} is describing as $\rho_{\tau_k}(u) = u(\tau - I(u < 0))$. Also, $\rho_{\tau_k}(u) = u(\tau - 1)$ is defined for $u < 0$ and $\rho_{\tau_k}(u) = u(\tau)$ is defined for $u > 0$.

4.RESULTS

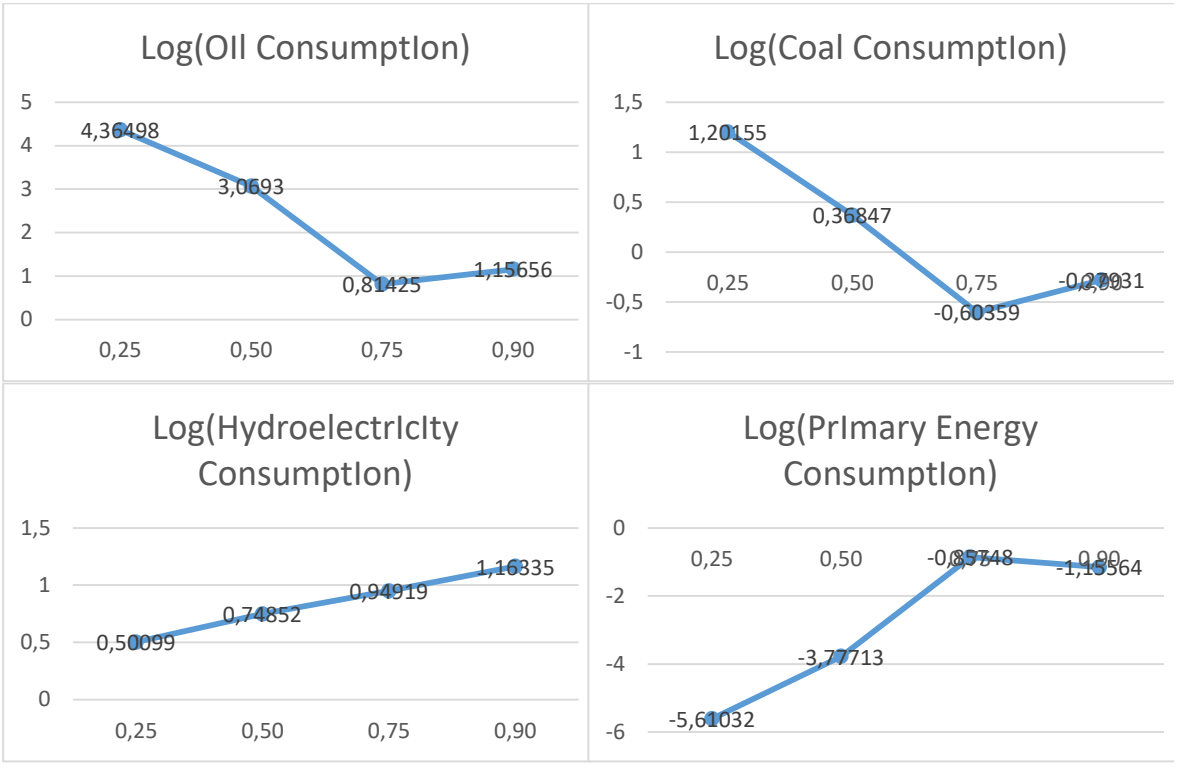
The panel quantile regression estimates are employed with economic growth which is dependent variable and logarithmic energy consumption indicators which are independent variables. First of all, Hausman test was applied to determine true estimator. When the null hypothesis of Hausman test is rejected, fixed effect estimator is consistent. According to the test result, the appropriate estimator for our model is fixed effect estimator (chi-square = 11.3349; p-value = 0.02305). The estimation results are exhibited in Table 2 and Figure 1 presents graphics of estimated coefficients.

Table 2. The Results of Panel Quantile Regression Estimations

Independent Variable: Log(Oil Consumption)				
Coefficients	**Standard Error**	**t-statistics**	**Prob.**	**Quantile**
4.36498	2.25572	1.93507	0.0553***	**0.25**
3.0693	1.40053	2.19153	0.0303**	**0.50**
0.81425	1.41574	0.57514	0.5663	**0.75**
1.15656	1.30706	0.88486	0.3780	**0.90**
Independent Variable: Log(Coal Consumption)				
Coefficients	**Standard Error**	**t-statistics**	**Prob.**	**Quantile**
1.20155	0.84732	1.41806	0.1587	**0.25**
0.36847	0.61404	0.60007	0.5496	**0.50**
-0.60359	0.42745	-1.41208	0.1605	**0.75**
-0.27931	0.52055	-0.53658	0.5925	**0.90**
Independent Variable: Log(Hydroelectricity Consumption)				
Coefficients	**Standard Error**	**t-statistics**	**Prob.**	**Quantile**
0.50099	0.68153	0.73509	0.4637	**0.25**
0.74852	0.29096	2.57261	0.0113**	**0.50**
0.94919	0.37364	2.54042	0.0123**	**0.75**
1.16335	0.47797	2.43393	0.0164**	**0.90**
Independent Variable: Log(Primary Energy Consumption)				
Coefficients	**Standard Error**	**t-statistics**	**Prob.**	**Quantile**
-5.61032	3.31461	-1.6926	0.0931***	**0.25**
-3.77713	2.16151	-1.74746	0.0831***	**0.50**
-0.85748	1.64593	-0.52097	0.6033	**0.75**
-1.15564	1.02653	-1.12578	0.2625	**0.90**

*1%, **5%, ***10% statistical significance level

Figure 1. Graphics of Estimated Coefficients



When Table 2 and Figure 1 are analyzed, it can be seen that coefficients of oil consumption are statistically significant in 0.25 and 0.50 quantiles (τ = 0.25; 0.50). Also, the impact of oil consumption on economic growth is falling at high quantiles of GDP growth. It means that oil consumption is effecting less when the country's growth rate is high in VISTA countries. It is obvious that positive impact of hydroelectricity consumption and negative impact of primary energy consumption on economic growth is rising at high quantiles. But, coefficient of hydroelectricity consumption is not statistically significant in 0.25 quantile and coefficients of primary energy consumption are not statistically significant in 0.75 and 0.90 quantiles (τ = 0.75; 0.90). According to the hydroelectricity consumption results, it is effecting more when the country's growth rate is high. In terms of primary energy consumption, negative effect of consumption is decreasing for high growth rate VISTA countries. The impact of coal consumption is not statistically significant in all quantiles. To sum up, the effects of energy consumption variables are changing on economic growth for different growth rate levels. As the growth rate of a sample country increases, hydroelectricity consumption positively effects the growth more than oil consumption.

5.CONCLUSION

There is a growing literature that examines the relationship between energy consumption and economic growth. Usually, this literature focuses on developing, developed and emerging countries. Researchers are investigated this relationship with different methods including time-series, panel data analysis, etc. In this study, we investigated the relationship between energy consumption and economic growth with panel quantile regression method on VISTA countries. VISTA is an abbreviation of country names which are Vietnam, Indonesia, South Africa, Turkey and Argentina and it is used in economics for describing these five emerging markets. The aim of paper is examining the relationship between energy consumption different levels of growth rates of VISTA countries.

According to the analysis results, the impact of coal consumption is not statistically significant in all quantiles. However, the hydroelectricity consumption is effecting more when the country's growth rate is high and the negative effect of primary energy consumption is decreasing for high growth rate. Also, oil consumption is effecting less when the country's growth rate is high in VISTA countries.

Also results show that the effects of energy consumption variables are changing on economic growth for different growth rate levels. Moreover, it can be said easily that energy consumption policies can be determined based on the different growth rate levels.

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