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Aggregate and Disaggregate Energy Consumption Relation with GDP: Evidence for Iran

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Abstract

In this paper we investigated total energy consumption and its individual forms (oil, natural gas, electricity, renewable energies and coal) relationship with real gross domestic product (GDP) in Iran. We employed Hsiao's (1981) methodology and annual data which cover 1967-2010 for investigation. The empirical findings indicate there is bidirectional causality effect with real GDP and total energy consumption as well as its three individual forms including, oil, natural gas and electricity. Therefore we can accept feedback hypothesis about total energy consumption-GDP linkage. There is not any causality effect with other individual forms of energy such as renewable energies and coal with GDP. These results are not too surprising for Iran, because share of oil, natural gas and electricity is higher than other forms of energy.

Keywords: Energy Consumption, Iran, Causality Test.

1. Introduction

Islamic republic of Iran is one of the major energy rich countries in the Middle East and in the world. According to British Petroleum Statistical Review of World Energy 2014,Iran has about 157 billion barrels of oil (proved reserves) almost 9.3% world's total oil reserves as well as 1192.9 trillion cubic feet of gas (almost 18.2% of total world gas). By counting oil and gas reserves Iran holds about 27.5% of world's total energy and even can be the number one country of the world in hydrocarbon reserves. Iran is also one of the major energy consumer countries with respect to its population. This is one of the most important challenges of Iran's economy specifically in recent decades. Energy export income (oil and gas) forms country's major

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export income and every year major part of government budget is financed by this income, for this reason Iran's economy is vulnerable to energy shocks. Energy intensity in Iran is high in comparison with other oil exporting countries such as OPEC member countries; Fig (2) shows this issue. In recent decades, low prices for energy, population growth and growth of industrialization and urbanization has increased energy consumption tremendously. Fig (1) shows total energy consumption versus GDP in Iran. However the government in recent years wants to decrease energy consumption subsidies in order to reform energy consumption situation. Iran is planning to build nuclear power plants in order to its future needs. The above mentioned points highlight the importance of this study. The main goal of this paper is to examine the relationship of total energy consumption and its individual forms with GDP in Iran. This relationship has been tremendously a subject of ongoing debate in the energy economics literature .In this context we confront with four different hypotheses: Neutrality hypothesis, conservation hypothesis, growth hypothesis and feedback hypothesis. Neutrality hypothesis indicates no causality between energy consumption and economic growth in any directions. Conservation hypothesis indicates a unidirectional causality running from economic growth to energy consumption. Growth hypothesis indicates a unidirectional causality running from energy consumption to economic growth. Feedback hypothesis indicates a bi-directional causality between economic growth and energy consumption. Each hypothesis has its own importance in policy implications (Wei Zhang & Shuyun Yang, 2013).

If, for example, there exists unidirectional Granger causality running from income to energy, it may be implied that energy.

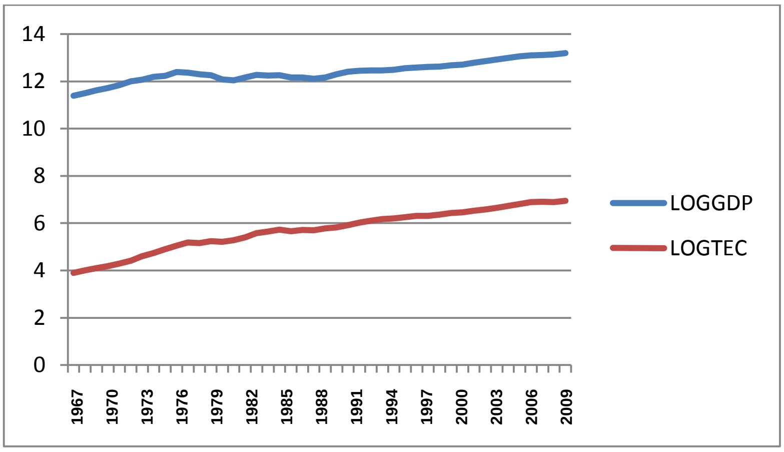

Fig. 1: Total Energy Consumption versus GDP in Iran in Logarithmic Form

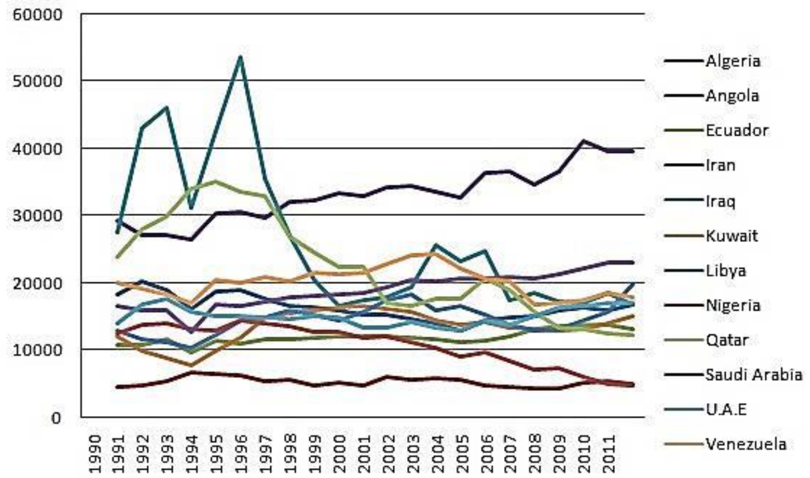

Fig. 2: Energy Intensity - Total Primary Energy Consumption per Dollar of GDP (Btu per Year 2005 U.S. Dollars)

Conservation policies may be implemented with little adverse or no effects on economic growth. If unidirectional causality runs from energy consumption to income, reducing energy consumption could lead to a fall in income or employment. The finding of no causality in either direction, the so-called 'neutrality hypothesis' would imply that energy conservation policies do not affect economic growth (Asafu-Adjaye, 2000). This paper's contribution is twofold in comparison with past literature, investigation of individual forms of energy consumption and employing Hsiao's (1981) methodology. The remainder of this paper is organized as follows. Section2 presents a review of literature.Section3 introduces the data and methodology.Section4 presents empirical findings and their analysis and the final section adds up the results.

2. Review of Literature

In this section we review some of the past studies about the relationship of energy consumption and GDP. Many studies have been done about causality relation between energy consumption and GDP in the energy economics literature. We can divide these studies for energy dependent and energy exporting countries or in another view we can divide them for developed and developing economies. The results of some of these studies are conflicting because of methodological and data differences.

Specifically in recent decade because of non-stationary variables researchers have employed cointegration and error correction models (ECM) (Mahmoud A. Al-Iriani , 2006; Asafu-Adjaye, 2000; Lise & Montfort, 2007;

Yoo, 2005; Glasure, 2002) to get rid of spurious regression or Toda and Yamamoto (1995) methodology (Hondroyianais et al, 2002 ; Fatai et al, 2002; Wolde-Rufael, 2004; Lee, 2006; Ziramba, 2009; Bowden & Payne, 2009; Payne, 2009; Soytas & Sari, 2009; Wolde-Rufael, 2009; Tsani, 2010; Wolde-Rufael & Menyah, 2010) .In studies for a group of countries many researchers have used panel cointegration methods (Narayan et al, 2010; Lee, 2005; Soytas et al, 2001; Soytas & Sari, 2003).

In this section we focus on Asian and developing countries because of Iran's economic situation. One of the major studies about this issue goes back to the Kraft and Kraft (1978) study about the USA economy, in their analysis, the authors used data on gross energy inputs and GNP for the USA and found that causality runs from GNP to energy consumption. Cheng (1995) found a unidirectional causality running from economic growth to energy consumption in India. Masih & Masih (1996) used cointegration analysis to study this relationship in a group of six Asian countries and found cointegration between energy use and GDP in India, Pakistan, and Indonesia. No cointegration is found in the case of Malaysia, Singapore and the Philippines. The flow of causality is found to be running from energy to GDP in India and from GDP to energy in Pakistan and Indonesia. Glasure & Lee (1997) examined the causality issue between GDP and energy consumption for South Korea and Singapore. In their results, granger causality tests showed no causal relationship between energy and GDP for South Korea, but a causal relationship from energy to GDP for Singapore. Asafu-Adjaye (2000) investigated causal relationships between energy consumption and income for India, Indonesia, the Philippines and Thailand by cointegration methods. The results reveal that in the short-run, unidirectional Granger causality runs from energy to income for India and Indonesia, while bidirectional Granger causality runs from energy to income for Thailand and the Philippines. In the case of Thailand and the Philippines, energy, income and prices are mutually causal. The study results do not support the view that energy and income are neutral with respect to each other, with the exception of Indonesia and India.

Aqeel & Butt (2001) investigated the causal relationship between energy consumption and economic growth as well as between energy consumption and employment for Pakistan. Cointegration and Granger causality tests inferred that economic growth causes total energy consumption. Further independent investigation revealed unidirectional causality from economic growth to petroleum consumption and showed no causality between economic growth and gas consumption, but it did indicate unidirectional causality from electricity consumption to economic growth. Lee (2005) re-investigated the co-movement and the causality relationship between energy consumption and GDP in 18 developing countries. The empirical results provided clear support for a long-run cointegration relationship after allowing for the heterogeneous country effect. The evidence showed that there were long-run and short-run causalities running from energy consumption to GDP, but not vice versa. This result indicated that energy conservation might harm economic growth in developing countries regardless of being transitory or permanent. Mahmoud A. Al-Iriani (2006) investigated the causality relationship between GDP and energy consumption in the six countries of the Gulf Cooperation Council (GCC). Empirical results indicate a unidirectional causality running from GDP to energy consumption. Evidence shows no support for the hypothesis that energy consumption is the source of GDP growth in the GCC countries. Mehrara (2007) examined the causal relationship between the per capita energy consumption (PCEC) and the per capita GDP in a panel of 11 oil-exporting countries (Iran, Kuwait, Saudi Arabia, United Arab Emirates, Bahrain, Oman, Algeria, Nigeria, Mexico, Venezuela and Ecuador) by using panel unit root tests and panel cointegration analysis. The results showed a unidirectional strong causality from economic growth to energy consumption for the oil-exporting countries. Mozumder & Marathe (2007) examined the causal relationship between the per capita electricity consumption and the per capita GDP for Bangladesh using a cointegration and vector error correction model. Their results showed that there was unidirectional causality running from per capita GDP to per capita electricity consumption. Reynolds & Kolodziej (2008) examined the relationship between GDP and production of some energy sources for the former Soviet Union by Granger causality and found unidirectional causality from energy consumption to GDP and unidirectional causality from GDP to coal production and natural gas. Behmiri & Manso (2012) analyzed the relationship between oil consumption and economic growth for OECD countries and found that there is bi-directional causality between them.

3. Data and Methodology

Based on the type and goal of research researchers have used different approaches to investigate the energy consumption and real GDP linkage. In this paper we investigate total energy consumption (TEC, hereafter) and individual forms of energy including oil (OIL, hereafter), natural gas (NG, hereafter), coal (COAL, hereafter), renewable energies (REE, hereafter) and electricity (ELEC, hereafter) causality relation with GDP in Iran. The data were obtained from central bank of Iran time series database and energy balance sheet of Iran, from ministry of energy. All data are annual and cover the period 1974-2010. TEC and individual energy forms are in million barrels of oil equivalent and GDP is in constant price (billion rials).All variables are in natural logarithm form. In the first step we must identify integration degree of the variables. To this end we employ KPSS[1] unit root test. Table1 shows the results. As we can see all of the variables are stationary at 5% and 1% significance level. We included a constant and a time trend for variables except LnREE which trend was not statistically significance, but for other variables time trend and constant were statistically significance. The results can provide the information about the long-run causal relationship among the variables in the model because all of the variables are in level.

Table 1: KPSS Unit Root Test Results

Variable	LM-test	C.V* (5%)	C.V (1%)	Result
LnTEC(C,T**)	0.1852	0.146	0.216	I(0)
LnREE(C)	0.129	0.463	0.739	I(0)
LnCOAL(C,T)	0.1375	0.146	0.216	I(0)
LnOIL(C,T)	0.2039	0.146	0.216	I(0)
LnNG(C,T)	0.0729	0.146	0.216	I(0)
LnELEC(C,T)	0.2037	0.146	0.216	I(0)
LnGDP (C,T)	0.1018	0.146	0.216	I(0)

*.C.V indicates critical value (5% and 1% significance level)

**.C indicates an intercept and T indicates a time trend

***. The Kwiatkowski, Phillips, Schmidt, and Shin (1992)

Thanks to the stationary variables we can use conventional granger causality test. The variable X is said not to granger cause the variable Y if all the coefficients of lagged X are significantly zero (H0) because it implies that the history of X doesn't improve the prediction of Y and conversely the variable Y is said not to granger cause the variable X if all the coefficients of lagged Y are significantly zero (H0) .Equ.(1) and Equ.(2) show this issue respectively.

$$Y_t = \sum_{j=1}^{m} \beta_j Y_{t-j} + \sum_{i=1}^{n} \alpha_i X_{t-i} + \varepsilon_t \qquad H_0: \Sigma\, \alpha_i = 0, H_1: \Sigma\alpha_i \neq 0 \qquad (1)$$

$$X_t = \sum_{i=1}^{n} \alpha_i X_{t-i} + \sum_{j=1}^{m} \beta_j Y_{t-j} + v_t \qquad H_0: \Sigma\, \beta_j = 0, H_1: \Sigma\, \beta_j \neq 0 \qquad (2)$$

One of the most important issues in this approach is identification of optimal lag length, because this method is very sensitive to lag length. For this reason we use Hsiao's (1981) methodology, which combines the Akaike

(1969) final prediction error (FPE) criterion with granger's causality test to guide the selection of the appropriate lag specifications. This method consists from two steps: in the first step we run an equation for a variable with its past lags. In this step we discern appropriate number of lags based on minimum Final Prediction Error (FPE).For example in Equ.(3) we identify optimal number of lags for LnGDP based on FPE formula in this equation. In this formula T is total number of observations, m is number of lags for LnGDP and SSR (m, 0) is sum of squared residuals only with m lags. In the second step we add the other variable to the equation(for example LnTEC), and discern appropriate number of lags for the new variable(n) with identified lags of the first variable(m) and based on minimum FPE. In this step we calculate the FPE with new formula. Equ.(4) shows this formula, in this formula n is number of lags for new added variable, and also SSR(m,n) is sum of squared residuals based on m and n lags. Now we can judge about causality. If calculated FPE in the second equation or in the second step be smaller than first equation's FPE we can say there is a causality relation which runs from new added variable(for example LnTEC) to the first variable (for example LnGDP).We employ the same procedure for other variables.

$$LnY_t = \lambda + \sum_{j=1}^{m} \beta_j LnY_{t-j} + \varepsilon_t \quad , FPE\ (m,0) = \left(\frac{T+m+1}{T-m-1}\right)\left(\frac{SSR(m)}{T}\right) \tag{3}$$

$$LnY_t = \mu + \sum_{j=1}^{m} \beta_j LnY_{t-j} + \sum_{i=1}^{n} \alpha_i \ LnX_{t-i} + v_t \tag{4}$$

$$FPE(m,n) = \left(\frac{T+m+n+1}{T-m-n-1}\right)\left(\frac{SSR(m,n)}{T}\right)$$

$$LnX_t = \theta + \sum_{i=1}^{n} \alpha_i LnX_{t-i} + e_t \tag{5}$$

$$LnX_t = \delta + \sum_{i=1}^{n} \alpha_i LnX_{t-i} + \sum_{j=1}^{m} \beta_j \ LnY_{t-j} + \mu_t \tag{6}$$

4. Empirical Results

Table2 shows the results for LnGDP and LnTEC. According to this table second equation's FPE is smaller than first equation's FPE (0.003857 < 0.004036). This indicates a causality relation from total energy consumption to GDP (LnTEC → LnGDP).And also final prediction error of fourth equation is smaller than third (0.001869 < 0.0020844) and indicates a causality relation from LnGDP to LnTEC.

(LnGDP → LnTEC). According to the results of table2 we have bidirectional causality relation between total energy consumption and

GDP.This issue supports the feedback hypothesis about Iran and indicates a high level of economic growth leads to high level of energy demand and vice versa. This result has conflict with Mohsen Mehrara (2007) findings about three oil exporting countries(Iran, Kuwait and Saudi Arabia).His findings show that there is a unidirectional long-run causality running from economic growth to energy consumption and energy conservation is a feasible policy with no damaging repercussions on economic growth for Iran. The difference of the results with some of previous studies may be attributed to the new method proposed by Hsiao (1981) and period of study.

Table2: Total Energy Consumption and GDP Causality Results

Equation	Causality Relation	Minimum FPE
$LnGDP_t=\lambda+\sum_{j=1}^{2}\beta_j LnGDP_{t-j}$	LnGDP → LnGDP	0.004036
$LnGDP_t=\mu+\sum_{j=1}^{2}\beta_j LnGDP_{t-j}+\sum_{i=1}^{6}\alpha_i LnTEC_{t-i}$	LnTEC → LnGDP	0.003857
$LnTEC_t=\theta+\sum_{i=1}^{4}\alpha_i LnTEC_{t-i}$	LnTEC → LnTEC	0.0020844
$LnTEC_t=\delta+\sum_{i=1}^{4}\alpha_i LnTEC_{t-i}+\sum_{j=1}^{2}\beta_j LnGDP_{t-j}$	LnGDP → LnTEC	0.001869

Table3 shows the results for other energy consumption forms with GDP.In this Table we show number of lags of GDP with m, and number of lags of other variables (LnOIL, LnNG, LnCOAL, LnREE and LnELEC) with n. As we can see there is a bidirectional causality relation between LnGDP and other variables except LnREE and LnCOAL. It seems that these results are not surprising because share of oil, natural gas and electricity is higher than coal and renewable energies in total energy consumption of Iran.

Table3: Hsiao’s (1981) Causality Test Results

Relation	Optimal lag length	Minimum FPE	Causality Result
LnGDP → LnGDP	m=2	0.004036	-
LnTEC → LnGDP	m=2,n=6	0.003857	accept
LnTEC → LnTEC	n=4	0.002084	-
LnGDP → LnTEC	m=2,n=4	0.001869	accept
LnGDP → LnGDP	m=2	0.004036	-
LnOIL → LnGDP	m=2 ,n=5	0.00312	accept
LnOIL → LnOIL	n=4	0.0029426	-
LnGDP → LnOIL	m=2 ,n=4	0.002915	accept
LnGDP → LnGDP	m=2	0.004036	-
LnELEC → LnGDP	m=2 ,n=1	0.0038801	accept
LnELEC → LnELEC	n=7	0.000766	-

Relation	Optimal lag length	Minimum FPE	Causality Result
LnGDP $\rightarrow$ LnELEC	m=3 ,n=7	0.000662	accept
LnGDP $\rightarrow$ LnGDP	m=2	0.004036	-
LnREE $\rightarrow$ LnGDP	m= 2,n=1	0.004228	reject
LnREE $\rightarrow$ LnREE	n=1	0.106003	-
LnGDP $\rightarrow$ LnREE	m=1 ,n=1	0.109325	reject
LnGDP $\rightarrow$ LnGDP	m=2	0.004036	-
LnNG $\rightarrow$ LnGDP	m=2 ,n=1	0.003602	accept
LnNG $\rightarrow$ LnNG	n=5	0.015980	-
LnGDP $\rightarrow$ LnNG	m=1 ,n=5	0.0129190	accept
LnGDP $\rightarrow$ LnGDP	m=2	0.004036	-
LnCOAL $\rightarrow$ LnGDP	m=2 ,n=6	0.004050	reject
LnCOAL $\rightarrow$ LnCOAL	n=5	0.2040361	-
LnGDP $\rightarrow$ LnCOAL	m=1 ,n=5	0.210713	reject

5. Conclusions

In this paper we examined the relationship of total energy consumption and it's individual forms (oil, natural gas, coal, renewable energies, electricity) with real GDP in Iran over the period 1974-2010.We employed the Hsiao's (1981) methodology because of stationary variables and also choosing appropriate number of lags for the model. Empirical findings show there is bidirectional causality relation between total energy consumption and its three individual forms (oil, natural gas and electricity) with GDP. Therefore we can accept the feedback hypothesis for GDP and these forms of energy. There is not any evidence for causality relation between GDP and two other energy consumption forms including coal and renewable energies.

References

Al-Iriani, M. A. (2006). Energy–GDP Relationship Revisited: an Example from GCC Countries Using Panel Causality. *Energy Policy*, *34*(17), 3342-3350.

Aqeel, A., & Butt, M. S. (2001). The Relationship between Energy Consumption and Economic Growth in Pakistan. *Asia Pacific Development Journal*, *8*, 101-110.

Asafu-Adjaye, J. (2000). The Relationship between Energy Consumption, Energy Prices and Economic Growth: Time Series Evidence from Asian Developing Countries. *Energy Economics*, *22*, 615-625.

Behmiri, NB., & Mansu, JRP. (2012). Crude Oil Conservation Policy Hypothesis in OECD Countries: a Multivariate Panel Granger Causality Test. *Energy*, *43*, 213-260.

Bowden, N., & Payne, J. E. (2009). The Causal Relationship between US energy consumption and real output: a disaggregated analysis. *Journal of Policy Modeling, 31* (2), 180-188.

Cheng, B. (1995). An investigation of cointegration and causality between energy consumption and economic growth. *Journal of Energy Development, 21*, 73-84.

Fatai, K., Oxley, L., & Scrimgeour, F. (2002, June). *Energy Consumption and Employment in New Zealand: Searching for Causality*. Paper Presented at NZAE Conference, Wellington, New Zealand.

Glasure, Y. U. (2002). Energy and national income in Korea: further evidence on the role of omitted variables. *Energy Economics, 30*, 271-289.

Glasure, Y. U., & Lee, A. R. (1997). Cointegration, error correction and the relationship between GDP and energy: the case of South Korea and Singapore. *Resource and Energy Economics, 20*, 17-25.

Gudarzi, F., & Soheili Ghasemi, B. (2012). Relationship between Energy Consumption and GDP in Iran. *Journal of Energy Technologies and Policy, 2*, 34-38.

Hondroyianais, G., Lolos, S., Papapetrou, E. (2002). Energy Consumption and Economic Growth Assessing the Evidence from Greece. *Energy Economics*, *24*, 319-336.

Hsiao, C. (1981). Autoregressive Modeling and Money Income Causality Detection. *J. Mon. Econ., 7*, 85-106.

Kayıkçı, F., & Elif Bildirici, M. (2013). Effects of Oil Production on Economic Growth in Eurasian Countries: Panel ARDL Approach. *Energy, 49*, 156-161.

Kraft, J., & Kraft, A. (1978). On the Relationship between Energy and GNP. *Journal of Energy Development, 3*, 401-403.

Lee, C. C. (2006). The Causality Relationship between Energy Consumption and GDP in G-11 Countries Revisited. *Energy Policy, 34*, 1086–1093.

---------- (2005). Energy Consumption and GDP in Developing Countries: a Cointegrated Panel Analysis. *Energy Economics, 27*, 415-427.

Lise, W., Montfort, K. V., (2007). Energy Consumption and GDP in Turkey: is there a Co-integration Relationship?. *Energy Economics, 29*, 1166-1178.

Masih, A. M. M., & Masih, R. (1996). Energy Consumption, Real Income and Temporal Causality: Results from a Multi-Country Study based on Cointegration and Error-Correction Modeling Techniques. *Energy Economics*, *18*, 165–183.

Mehrara, M. (2007). Energy Consumption and Economic Growth: the Case of Oil Exporting Countries. *Energy Policy, 35* (5), 2939-2945.

Mehrara, M. (2007). Energy-GDP Relationship for Oil Exporting Countries: Iran, Kuwait and Saudi Arabia. *OPEC Review, 31*, 1-16.

Mozumder, P., & Marathe, A. (2007). Causality Relationship between Electricity Consumption and GDP in Bangladesh. *Energy Policy, 35*, 395-402.

Narayan, P. K., Nayayan, S., & Popp, S. (2010). A Note on the Long-Run Elasticities from the Energy Consumption–GDP Relationship. *Applied Energy, 87*, 1054-1057.

Payne, J. E. (2009). On the Dynamics of Energy Consumption and Output in the US. *Applied Energy, 86* (4), 575–577.

Reynolds, D. B., & Kolodziej, M. (2008). Former Soviet Union Energy Consumption and GDP Decline: Granger Causality and the Multi-Cycle Hubbert Curve. *Energy Economics*, *30*(2), 271-289.

Shiu, A., & Lam, P. L. (2004). Electricity Consumption and Economic Growth in China. *Energy Policy, 32*, 47–54.

Soytas, U., & Sari, R. (2009). Energy Consumption, Economic Growth, and Carbon Emissions: Challenges Faced by an EU Candidate Member. *Ecological Economics, 68* (6), 1667–1675.

---------- (2003). Energy Consumption and GDP: Causality Relationship in G-7 Countries and Emerging Markets. *Energy Economics, 25*, 33–37.

Soytas, U., Sarı, R., & O zdemir, O. (2001). Energy Consumption and GDP Relation in Turkey: a Cointegration and Vector Error Correction Analysis. *Economics and Business in Transition: Facilitating Competitiveness and Change in the Global Environment Proceeding*, Global Business and Technology Association, 838–844, Retrieved from https://www.researchgate.net/profile/Ugur_Soytas/publication/268295053_ENERGY_CONSUMPTION_AND_GDP_RELATION_IN_TURKEY_A_COINTEGRATION_AND_VECTOR_ERROR_CORRECTION_ANALYSIS/links/550a87fa0cf20ed529e3614e.pdf.

Toda, H. Y., & Yamamoto, Y. (1995). Statistical Inference in Vector Auto Regressions with Possibly Integrated Process. *Journal of Econometrics, 66*, 225-250.

Tsani Stela, Z. (2010). Energy Consumption and Economic Growth: a Causality Analysis for Greece. *Energy Economics, 32*, 582-590.

Wolde-Rufael, Y. (2009). Energy Consumption and Economic Growth: the Experience of African Countries Revisited. *Energy Economics, 31*, 217-224.

---------- (2004). Disaggregated Industrial Energy Consumption and GDP: the Case of Shanghai, 1952–1999. *Energy Economics, 26*, 69-75.

Wolde-Rufael, Y., & Menyah, K. (2010). Nuclear Energy Consumption and Economic Growth in Nine Developed Countries. *Energy Economics, 32*, 550-556.

Yoo, S. H. (2005). Electricity Consumption and Economic Growth: Evidence from Korea. *Energy Policy, 33*, 1627-1632.

Zhang, W., & Yang, S. (2013). The Influence of Energy Consumption of China on its Real GDP from Aggregated and Disaggregated Viewpoints. *Energy Policy, 57*, 76-81.

Ziramba, E. (2009). Disaggregate Energy Consumption and Industrial Production in South Africa. *Energy Policy, 37*, 2214-2220.