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Causal Relationship Between Oil Consumption And Economic Growth In Turkey

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Abstract: Beside of the manufacturing industries, oil is one of the main inputs for many other sectors. Oil is also very important for the Turkey's economic growt. In this paper was tried to examine the short- and long-run causality between oil consumption and Gross National Product for Turkey using annual data covering the period of 1970-2004. As economic growth and oil consumption variables used in empirical analysis was same order of integration (I(1)) employed Granger causality test. In this study was found that exists bidirectional Granger causality between oil consumption and economic growth in the short and long run.

Keywords: Oil Consumption, Economic Growth, Causality, Cointegration

1. Introduction

Oil now constitutes a critical factor in sustaining the well-being the Turkey's as well as the nation's economic growth. Production in industries such as manufacturing, transportation, and electricity generation demands a substantial amount of oil. Therefore, oil-supply side measures in harmony with economic growth are needed. In addition to supply side measures, demand side management measures are also needed. The oil intensity in Turkey is much larger than those in the developed countries. High oil intensity in Turkey reflects inefficient oil usage in industries and/or agriculture and indicates that there are high oil-saving potentials. Thus, improving oil consumption efficiency of automobiles and machines and introducing various kinds of tariff reforms aiming to control oil consumption patterns through leveling projected oil demand and saving supply

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costs of oil can induce a high degree of efficiency in the existing facilities without adversely affecting a high level of oil consumption for economic growth.

The direction of causality between energy consumption and economic growth has significant policy implications for countries, enjoying implicit generous subsidies (low domestic prices) for energy. If, for example, there exists unidirectional Granger causality running from income to energy, it may be implied that energy conservation policies such as phasing out energy subsidies or elimination of energy price distortions have little adverse or no effects on economic growth. On the other hand, if unidirectional causality runs from energy consumption to income, reducing energy consumption, for example through bringing domestic energy prices in line with market prices, could lead to a fall in income and employment. And lastly, no causality in either direction would indicate that policies for increasing energy consumption do not affect economic growth. (Mehrara, 2007:2940)

In the past two decades, numerous studies have been conducted to examine the relationship between energy consumption and economic growth. The overall findings show that there is a strong relationship between energy consumption and economic growth. For example, Kraft and Kraft (1978), Ghosh (2002), and Mozumder and Marathe (2007) found unidirectional causality running from GNP to energy consumption. Shiu and Lam (2004) reported unidirectional causality running from energy consumption to GNP. Jumbe (2004) found bidirectional causality between energy consumption and GNP. However, Akarca and Long (1980), Erol and Yu (1987a), Yu and Choi (1985), and Yu and Hwang (1984) found no causal relationships between GNP and energy consumption. Recently, Yang (2000) found unidirectional causality running from economic growth to coal consumption in Taiwan. Yoo (2006) found unidirectional long-run causality from economic growth to coal consumption, and bidirectional strong causality from coal consumption to economic growth in Korea.

In a summary of the literature on the causal relationship between energy consumption, including oil consumption, and economic growth, there are a number of evidences to support bidirectional or unidirectional causality between energy consumption and economic growth. Despite the expanding literature on the study of causal relationships between energy consumption and economic growth, to the best of the author's knowledge, there have been only a few studies specifically addressing the causal relationship between oil consumption and economic growth. Recently, Yang (2000a) investigated the causal relationship between real gross domestic product (GDP) and several disaggregate categories of energy consumption, including coal, oil, natural gas, and electricity, and found that there is unidirectional causality running from economic growth to oil consumption in Taiwan without any feedback effect (Yoo, 2006: 235).

The purpose of this paper is, therefore, to investigate the causality between oil consumption and economic growth, and to obtain policy implications from the results. The paper is organized in the following fashion. Section 2 describe the econometric methodology. Section 3 presents data and empirical study. Final section contains the conclusions.

2. Econometric Methodology

2.1. ADF Unit Root Test

Many macroeconomic time series contain unit roots dominated by stochastic trends, as developed by Nelson and Plosser (1982). Unit root tests are important in examining the stationarity of a time series because a nonstationary regressor invalidates many standard empirical results and thus requires special treatment. Granger and Newbold (1974) have found by simulation that the F-statistic calculated from the regression involving the nonstationary time-series data does not follow the Standard distribution. This nonstandard distribution has a substantial rightward shift under the null hypothesis of no causality. Thus the significance of the test is overstated and a spurious results is obtained. The presence of a stochastic trend is determined by testing the presence of unit roots in time-series data. Non-stationarity or the presence of a unit root can be tested using the Dickey and Fuller (1981) tests.

The test is the t statistic on ϕ in the following regression:

$$\Delta Y_t = \alpha_o + \alpha_1 . t + \phi . Y_{t-1} + \sum \psi_i \Delta y_{t-i} + \varepsilon_t \quad (1)$$

where Δ is the first-difference operator, ε_t is a stationary random error (Chang, at all, 2001: 1047).

2.2. Tests of Cointegration

The cointegration test is based in the methodology developed by Johansen (1991), and Johansen and Juselius (1993). Johansen's method is to test the restrictions imposed by cointegration on the unrestricted variance autoregressive, VAR, involving the series.

The mathematical form of a VAR is

$$y_t = A_1 y_{t-1} + ... + A_p y_{t-p} + Bx_t + \varepsilon_t \quad (2)$$

where y_t is an n-vector of non-stationary *I(1)* variables, x_t is a d-vector of deterministic variables, A_1,.., A_p and B are matrices of coefficients to be estimated, and ε_t is a vector of innovations that may be contemporaneously correlated with each other but are uncorrelated with their own lagged values and other right-hand side variables. We can rewrite the VAR as (Eq. (3)):

$$\Delta_{yt} = \Pi_{yt-1} + \sum \Gamma_i \Delta_{yt-i} + B_{x_t} + u_t \quad (3)$$

where (Eq. (4))

$$\Pi = \sum A_i - I_t \quad \text{ve} \quad \Gamma_{\mathrm{i}} = -\sum A_j \quad (4)$$

Granger's representation theorem asserts that if the coefficient matrix n has reduced rank r<n, then there exist n x r matrices α and β each with rank r such that π = $\alpha\ \beta'$ and $\beta' y_t$ is stationary. Here, r is the number of cointegrating relations and each column of β is a cointegrating vector. For n endogenous non-stationary variables, there can be from (0) to (n-1) linearly independent, cointegrating relations (Yin and Xu, 2003: 307).

2.3 Error Correction Modeling (ECM)

The existence of cointegration relationships indicates that there are long-run relationships among the variables, and thereby Granger causality among them in at least one direction. The ECM was introduced by Sargan (1964), and later popularized by Engle and Granger (1987). It is used for correcting disequilibrium and testing for long and short-run causality among cointegrated variables. The ECM used in this paper is specifed as follows:

$$\Delta OIL_t = a_0 + \sum_{i=1}^{m} a_{1i}\Delta OIL_{t-i} + \sum_{i=1}^{n} a_{2i}\Delta GNP_{t-i} + \lambda ECM_{t-1} + u_t \tag{5}$$

$$\Delta GNP_t = b_0 + \sum_{i=1}^{m} b_{1i}\Delta GNP_{t-i} + \sum_{i=1}^{n} b_{2i}\Delta OIL_{t-i} + \theta ECM_{t-1} + \varepsilon_t \tag{6}$$

where Δ is the difference operator, m and n are the numbers of lags, a's and b's are parameters to be estimated and, λ and θ are the error correction term, which is derived from the long run cointegration relationship.

In each equation, change in the endogenous variable is caused not only by their lags, but also by the previous period's disequilibrium in level. Given such a specification, the presence of short and long-run causality could be tested (Shiu and Lam, 2004 : 50).

3. Data And Empirical Resuls

3.1 Data

The data used in this study consist of annual time series of GNP and oil consumption for Turkey 1970 to 2004. The GNP data was obtained from the National Statistical Office in Turkey. Oil consumption data was obtained from the Turkish Ministry of Energy and Natural Resources.

GNP: Gross National Product (1.000.000$),

OIL: Oil Consumption (1000 Ton).

Figure 1. and 2., respectively, describes oil consumption and GNP over the period of 1970-2004.

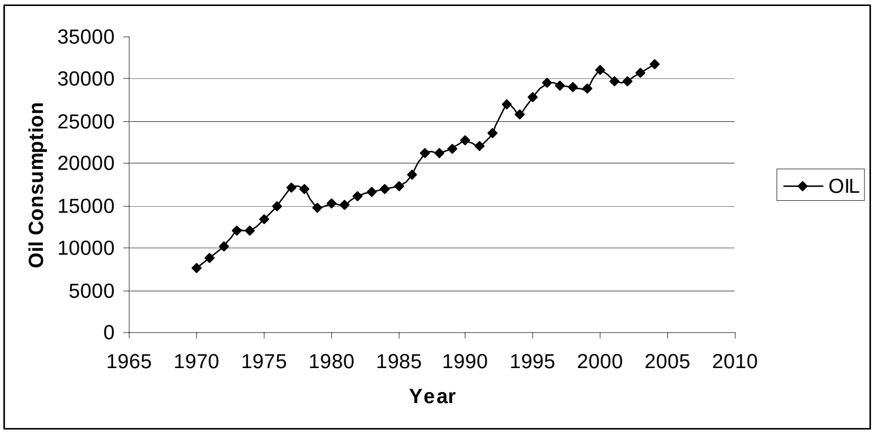

Figure 1. Oil Consumption in Turkey

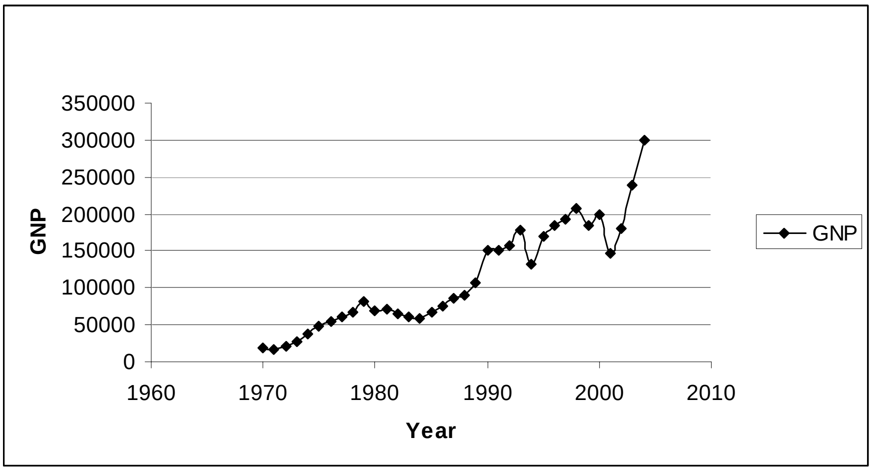

Figure 2. GNP in Turkey

3.2 Result of unit Roots and Cointegration Test

The results of the unit root tests for the series of OIL and GNP variables are shown in Table 1. The ADF test provides the formal test for unit roots in this study. The p-values corresponding to the ADF values calculated for the two series are larger than 0.05. This indicates that the series of all the variables are non-stationary at 5% level of significance and thus any causal inferences from the two series in levels are invalid.

Table 1. Results of ADF Test for Unit Roots

Variables	Trend and Intercept	CV(LL)*
OIL	-2,697235(0)	-3,5468
GNP	-1,962472(0)	-3,5468

* CV stands for critical values, which are at the 5% level. The critical values are calculated from MacKinnon. LL stands for lag length. The lag lengths are selected using the AIC criterion.

The analysis of the first differenced variables show that the ADF test statistics for all the variables are less than the critical values at 5% levels (Table 2). The results show that all the variables are stationary after differencing once, suggesting that all the variables are integrated of order I(1).

Table 2. Results of ADF Test for Unit Roots According to First Difference

Variables	Trend and Intercept	CV(LL)*
Δ OIL	-6,081071(0)	-3,5514
Δ GNP	-5,336986(0)	-3,5514

* CV stands for critical values, which are at the 5% level. The critical values are calculated from MacKinnon. LL stands for lag length. The lag lengths are selected using the AIC criterion.

As indicated, the basic idea behind cointegration is to test whether a linear combination of two individually non-stationary time series is itself stationary. Given that integration of two series is of the same order, it is necessary to test whether the two series are cointegrated over the sample period. The results of the Johansen cointegration test for the series OIL and GNP are reported in Table 3.

Table 3. Results of Johansen's Cointegration Test

Null Hypotheses	Alternative Hypotheses	Trace Statistic	Critical Value (5%)
H_0	H_1		
r=0	r=1	26.72866	15.41
r≤1	r=2	6.508407	3.76

The likelihood ratio tests show that the null hypothesis of absence of cointegrating relation (r = 0) can be rejected at 5% level of significance, and that the null hypothesis of existence of at most one cointegrating relation (r ≤ 1) can be rejected at 5% level of significance. We can see that both tests suggest the existence of two cointegrating vectors driving the series with two common stochastic trends in the data. Thus, we can conclude that oil consumption and GNP are cointegrated. That is, there is a long-run relationship between oil consumption and GNP for Turkey.

3.3. Results of Error-Correction Model

If the series of two variables are non-stationary and the linear combination of these two variables is stationary, then the error correction modeling rather than the standard Granger causality test should be employed. Therefore, an ECM was set up to investigate both short-run and long-run causality. In the ECM, first difference of each endogenous variable (GNP and OIL) was regressed on a period lag of the cointegrating equation and lagged firrst differences of all the endogenous variables in the system, as shown in Eqs. (5) and (6). The results of error correction model are presented in Table 4.

Table 4. The Result of Error Correction Model

	Lag Lengths		F Statistics	t statistics for ECM_{t-1}
Δ GNP- Δ OIL	m=1	n=1	12.9798*	-4.9393*
Δ OIL- Δ GNP	m=2	n=2	8.78132*	-4.9573*

Notes: The lag lengths are chosen by using AIC information criterion. * Denotes the rejection of the null hypothesis at 5% level of significance.

According to results of the Table 4, short-run causality is found to run from oil consumption to GDP. In addition, the reverse short-run causality also exits. That is, there is bidirectional short-run Granger-causality oil consumption and economic growth. The coefficient of the ECM is found to be significant in Eq. (5) and in Eq. (6), which indicates that exists bidirectional Granger causality between oil consumption and economic growth in long run.

4. Conclusion

This paper has investigated the ECM model to examine the causal relationship between oil consumption and GNP in Turkey using the annual data covering the period of 1970-2004. Prior to testing for causality, the ADF test and Johansen maximum likelihood test were used to examine for unit roots and cointegration. Our estimation results indicate that there are bidirectional short-run causality between oil consumption and economic growth, bidirectional long-run causality between economic growth and oil consumption.

Oil consumption could be thought of as a leading factor of the economy in the short run as well as in the long run. The basic reason for this may be that the enormous use of oil mostly in the industry and transportation sector has directly pushed the economy. Production in industries such as manufacturing, construction and transportation demands a substantial amount of oil. Consequently, increased oil consumption also directly affects employment. In conclusion, for the newly industrializing countries in general, oil is an important ingredient of economic development. On the other hand, reducing oil consumption could lead to fall in income and employment.

Türkiye'de Petrol Tüketimi Ve Ekonomik Büyüme Arasindaki Nedensellik Ilişkisi

Özet: İmalat sanayii başta olmak üzere pek çok sektör için temel girdilerden biri olan petrol, Türkiye'nin ekonomik büyümesi bakımından da önem arzetmektedir. Bu makalede, Türkiye'nin 1970-2004 dönemindeki yıllık verilerle petrol tüketimi ve GSMH arasındaki kısa ve uzun dönemli nedensellik ilişkisi araştırıldı. Yapılan analiz sonunda petrol tüketimi ve ekonomik büyüme değişkenleri aynı derecede (I(1)) bütünleşik olduklarından Granger nedensellik testi uygulandı. Çalışmada, kısa ve uzun dönemde petrol tüketimi ve ekonomik büyüme arasında iki yönlü nedensellik bulundu.

Anahtar Sözcükler: Petrol Tüketimi, Ekonomik Büyüme, Nedensellik, Eşbütünleşme

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