Macroeconomic Issues

Oil Consumption and GNP Relationship In Turkey: An Empirical Study

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This paper will investigate the causal relationship between oil consumption and GNP. For this purpose, we will investigate the presence of cointegration among the variables and use a vector error correction model to test causality relationship. Empirical results for Turkey over the period 1971–2003 suggest that there is cointegration relationship between GNP and oil consumption. We found no causal relationship between oil consumption and GNP in short run whereas there is a long run unidirectional causality running from GNP to oil consumption.

Introduction

Until the oil crises in 1970's the role of energy in economic growth was ignored. Economic growth theories till the oil crises(Cobb-Douglas type) focused on labor and capital in production function; energy, technology and other factors is assumed exogenously. After oil crises, energy is assumed as a production factor and added the production function. Development in applied econometrics caused to reveal huge literature about energy consumption and GDP or economic growth. Although the relationship between energy consumption and output has been investigated over the past three decades, the empirical evidences are still ambiguous.

The pioneering study of Kraft and Kraft (1978) investigated the causality relationship for USA and found unidirectional causality from GNP to energy consumption for the period 1947-1974. However, Akarca and Long (1980) found no causality using the same data, but for the period 1947-1972. Stern (2000) investigated Granger causality between energy and GDP in a multivariate model with energy, GDP, capital and labor for the USA in the post-war period. He found no granger causality between energy consumption and GDP but after changing fuel composition he found univariate granger causality running from GDP to energy consumption.

Energy consumption not only investigated aggregately but also disaggregately. For example, Altinay and Karagol (2005) investigated electricity consumption and GDP relationship for the period between 1950 and 2000 in Turkey. They found unidirectional causality running from electricity consumption to GDP. However, Mozumder and Marathe (2006) investigated same relationship for Bangladesh and found unidirectional causality running from GDP to electricity consumption for the period of 1971-1999. In the literature, there is not enough study which investigates oil consumption and GNP interaction except Zou and Chau (2005).

Zou and Chau (2005) found no cointegration between oil consumption and GDP, in China for the period of 1953-2002. Due to liberalization of China's economy in 1984; they separate these period into 1953-1984 and 1985-2002. They found cointegration relationship between oil consumption and GDP. In 1953-1984 period, they found no causality between oil comsumption and GDP in the short run, conversely, they found bidirectional causality in the long run. In 1985-2002 period; in short run they found unidirectional causality from oil consumption to GDP, however, in long run there is bidirectional causality as 1953-1984 period.

Due to the lack of studies about this topic, we try to investigate oil consumption and GNP relationship for Turkey. Like other developing countries, Turkey also faces an increasing oil demand. For example, between 1971 and 2003 the average growth rate of total oil consumption has increased by % 4.1, whereas the real GNP has grown about % 3.8 per annum.

This paper tries to investigate the relationship between oil consumption and GNP for Turkey 1971-2003 period due to the lack of study for Turkey about. The paper proceeds as follows. Section 2 deals with methodological issues and data used in this empirical analysis. The empirical evidences are presented in Section 3. Finally, the conclusions of the analysis and policy implication are given in Section 4.

Variables and Data Sources

The study uses the annual time series of real GNP (Y hereafter) and oil consumption (P hereafter), for Turkey from 1971 to 2003, with two variables measured in natural logarithms. The real GNP series in 1987 constant billion Turkish Liras (the local currency) were obtained from State Planning Organization, *Economic and Social Indicators: 1950-*

2003. Oil consumption is measured as thousand barrels per days and the data are obtained from International Energy Agency Statistics(2005). Two variables are transformed to natural logs denoted as LY, and LP.

Emprical Results
Unit Roots Tests

We use the ADF(1979) and PP(1988) test for the existence of unit roots and identify the order of integration for each variable.The results of the ADF and PP tests for stationarity properties of the variables are presented in Table 1.

Table 1. Results of the ADF and PP unit roots tests

Variable	Augmented Dicky-(ADF) Fuller test		Philips-Perron test (PP test)	
	Level form	First Differences	Level Form	First differences
LY	-2.483	-6.576*	-2.588	-6.576*
LP	-2.960	-5.308*	-2.981	-5.308*
Significant level	Critical values			
1%	-4.273	-3.661	-4.273	-3.661
5%	-3.557	-2.960	-3.557	-2.960
10%	-3.212	-2.619	-3.212	-2.619

*denotes %1 significance level
**denotes %5 significance level
***denotes %10 significance level

The Table 1 shows that the calculated t statistics for two variables (LY and LP) are less than the critical values at, respectively, 1%, 5% and 10% levels for both ADF and PP tests. Thus, the results show that the null unit roots hypothesis cannot be rejected, suggesting that two variables are nonstationary in their level forms. The results of the first differenced variables show that the ADF and PP test statistics for two variables are greater than critical values at 1%, 5%, 10% levels and the two variables are staionary after differenced, suggesting that two variables are integrated of order I(1).

Cointegration Tests

The full information maximum likelihood procedure of Johansen (1988) and Johansen and Juselius (1990) performs better than others according to several criteria, we use the maximum likelihood estimation method of Johansen and Juselius (1990) to test for cointegration.

Consider a VAR and the corresponding VECM:

$$X_t = c + x_1X_{t-1} + x_2X_{t-2} + \ldots\ldots x_pX_{t-p} + \ + \varepsilon_t \qquad (1)$$

Where $X =$ GNP (Y), oil consumption (EC). Moreover, c is a constant term (3x1 in our case), $\pi = nxn$ matrices of autoregressive coefficients for i = 1, 2…p, To distinguish between stationarity by linear combinations and differencing, a reparametrisation of equation (1) is needed. Thus the system is equation (1) can be rewritten equivalently as:

$$\Delta X_t = c + \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \ldots\ldots \Gamma_{p-1} \Delta X_{t-p+1} + \Pi X_{t-p} + \varepsilon \quad (2)$$

Where $\Gamma_i = -(I - \pi_1 - \ldots.\pi_i)\ (i = 1\ldots, p\text{-}1)$ and $\Pi = -(I - \pi_1 - \ldots - \pi_p)$ (3)

By examining the Π matrix, we can detect the existence of cointegrating relations among the X variables. The most interesting case is that if rank (Π) = r < n, then there are matrices β' and α of dimension nxr such that H_0: $\Pi = \alpha \beta'$ and there are r cointegrating relations among the elements of βX_t is interpreted as a matrix of cointegration vectors and provides the property that elements in $\beta' X_t$ are stationary even though X_t is non-stationary.

The second step indicates to test the cointegration using the Johansen maximum likelihood approach Johansen (1988) and Johansen and Juselius (1990) if there is cointegration the either unidirectional or bi-directional Granger causality must exist, at least in the I (0) variables. Engle and Granger (1987) Table 2 indicates the results of cointegration using Johansen maximum likelihood approach employing both maximum eigenvalue and trace statistic for VAR=1. We report the results of cointegration analysis obtained by the estimation (a) with the lag length k=1. The maximal eigenvalue (λ max) and trace eigenvalue (λ trace) statistics reject the null of no cointegration (r=0) but not the null of at most one cointegrating vector (r=1) so there appears to be a single cointegrating vector for the system. Table 2 gives the cointegration analysis, where Max and Trace denote the associated maximum eigenvalues and trace statistics respectively.

Table 2. Johansen and Juselius Cointegration Test

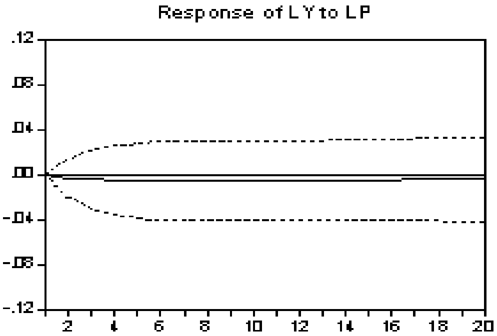
Cointegration Rank	Trace Statistics			Max Statistics		
		5 %	1%		5%	1%
r=0	17.255**	15.41	20.04	16.844**	14.07	18.63
r≤1	0.410	3.76	6.65	0.410	3.76	6.65
Normalized cointegration equation : LY=1.069LP						

*Denotes for 1% significance level. ** Denotes for 5% significance level.

The results of the cointegration tests are reported in Table 2. The results indicate that there is one cointegration vector because the trace test rejects both the null hypothesis of zero cointegration rank and the null of at most one cointegration rank with no linear trend, but it does not reject the null of at most one cointegration rank with a linear trend. The eigenvectors presented in Table 2 are normalised by LY.

An impulse response function traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables. A shock to the *i* th variable directly affects the *i* th variable, and is also transmitted to all of the endogenous variables though the dynamic structure of the VAR.

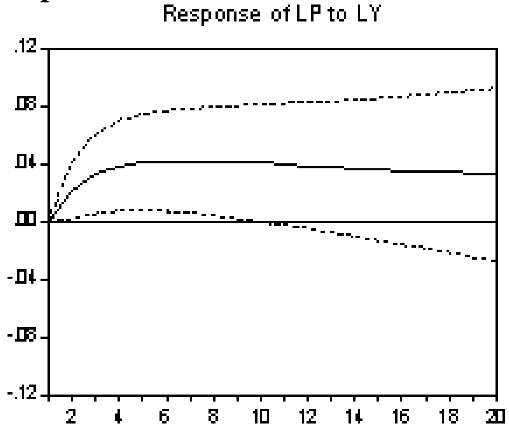
Figure 1. Impulse response functions a one standart deviation shock in LP



The results of the impulse- response functions, which showed the effects of one standart deviation shocks to the innovations in current and futures values of endogenous variables, are investigated for the 30 step ahead years in Figure (1)

In Figure1, shows that the effects of one standart deviation shock given to the oil consumption(LP) on the GNP (LY). It is clear from figure above that there is not significant effects oil consumption shock on GNP.

Figure 2. Impulse response functions: a one standart deviation shock in LY



In Figure 2 , shows that the effects of one standart deviation shock given to the GNP (LY) on oil consumption(LP). We can say that when one standart deviation shock is given to the LY, this shock did not affect on LP first year however from the second year this shock positively affect LP and the effect of the shock is permenant.

Granger Causality Tests

If the variables are cointegrated, a VECM should be estimated rather than a VAR as in a standard Granger causality test Granger (1988). Therefore, we estimate a VECM for the Granger causality test because we found a cointegration relationship between oil consumption and GNP.

$$\Delta LY = \alpha_1 + \sum_{i=1}^{n} \delta_{yi} \ \Delta LP_{t-i} + \sum_{i=1}^{n} \sigma_{yi} \Delta LY_{t-i} + \theta_1 ECT_{t-i} + \varepsilon_{yt} \quad (4)$$

$$\Delta LP = \alpha_2 + \sum_{i=1}^{n} \Omega_{zi} \ \Delta LY_{t-i} + \sum_{i=1}^{n} \phi_{zi} \Delta LP_{t-i} + \theta_2 ECT_{t-i} + \varepsilon_{yt} \quad (5)$$

Where LP and LY oil consumption and GNP respectively. As we showed the series to be cointegrated, there must be either unidirectional or bidirectional Granger causality, since at least one of the error correction terms (ECT) is significantly nonzero by the definition of cointegration. First, by testing for all δ_{yi} equals 0 in equation (4) or for all Ω_{zi} equals 0 in equation (5), we evaluate Granger weak causality. This can be implemented using a standard Wald test. Masih and Masih (1996) and Asafu-Adjaye (2000) interpreted the weak Granger causality as 'short run' causality in the sense that the dependent variable responds only to short-term shocks to the stochastic environment.

The other possible causality is added the ECT in equation (4) and (5). The coefficients on the ECT represent how fast deviations from the long run equilibrium are eliminated following changes in each variable. In order to test Granger causality, we will investigate whether the two sources of causation are jointly significant. This can be done by testing the joint hypotheses that all δ yi and θ_1(ECT) are jointly zero in equation (4) or all Ω_{zi} and θ_2(ECT) are jointly zero (0) in equation (5). This is referred to as a strong Granger causality test. The joint test indicates which variable(s) bear the burden of short run adjustment to re-establish long run equilibrium, following a shock to the system Asafu-Adjaye (2000).

Table 3. Granger Causality Tests

Dependent Variable	Source of Causation (Independent Variable)				
	Short Run-Causality		Long Run-Causality		
	ΔLY	ΔLP	ECT	ECT/ ΔLY	ECT / ΔLP
ΔLY		0.634	0.001	------	0.337
ΔLP	2.623	------	7.778**	4.235**	------

The appropriate lag lengths are chosen using Akaike's Information Criteria (AIC).
 * Denotes for 5% significance level.
 ** Denotes for 1% significance level.

Table 3 shows the result of a Granger causality test between oil consumption and GNP. As we find the coefficients on lagged oil consumption in the LY equation are not significant 1% and %5 level, while those on lagged GNP in the LP equation are not significant, we conclude that there is no short run causal relationship between oil consumption and GNP as Zou and Chau (2005) for China 1953-1984 periods. We cannot reject the null hypotheses that the coefficients on the ECTs and the interaction terms are jointly zero in LY equation while we can reject the null hypotheses that the coefficient on the ECT and the interaction terms are jointly zero in the LP equation. The coefficients of the ECTs in the LP equation are significant at the 1% level. So we found unidirectional long- run causality between oil consumption and GNP from GNP to oil consumption using Wald test whereas Zou and Chau (2005) found bidirectional long run causality for China 1953-1984 and 1985-2002 period.

Summary and Conclusion

This paper examined the causal relationship between oil consumption and GNP for Turkey over the period 1971–2003 using a bivariate model of GNP and oil consumption. To test Granger causality, we employed a VECM instead of a VAR model because we found strong evidence that the variables are cointegrated and we wanted to study the short run relationship as well as the long run dynamics. The empirical results suggest that there is a unidirectional causal relationship between oil consumption and GNP from GNP to oil consumption in long run, and short run there is no causality between GNP and oilconsumption. The source of causation in the long run points to the ECT in both directions. We can infer that oil conservation policy do not harm economic growth in Turkey. So that the polices which try to protect environment by reducing oil consumption can be supported by the government. Finally, we can say that oil consumption continou growing as long as economy grows in Turkey .

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