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Asymmetries in the dynamic interrelationship between energy consumption and economic growth: Evidence from Turkey

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ABSTRACT

In this study we examine possible nonlinearities in dynamic interrelationship between energy consumption and economic growth in Turkey for the 1960–2010 period by using a smooth transition vector autoregressive model. In order to trace the effects of one variable on another, we calculate Generalized Impulse Response Functions (GIRFs). The computed impulse response functions demonstrate asymmetric effects of positive versus negative and small versus large energy consumption shocks on output growth and vice versa. Specifically, we find that negative energy shocks have a greater effect on output growth than positive energy shocks, and that big negative energy shocks affect output much more than small negative energy shocks. Similarly, we find that positive output shock has a greater effect on energy consumption whereas negative shocks have almost no effect on energy consumption. The results of this study have clear and important implications for energy economists and policymakers in Turkey.

1. Introduction

The knowledge of the dynamic interaction between energy consumption and economic growth plays a crucial role in design and implementation of energy policies. If, for instance, a decrease in energy consumption hampers economic growth, then adopting of energy conserving policies designed to reduce energy consumption will not be desirable. On the other hand, if reducing energy consumption does not affect economic growth, energy conserving policies may be implemented without deteriorating economic growth. In this study we aim to analyze the dynamic interaction between energy consumption and economic growth in Turkey.

There are different views on interrelationship between energy consumption and economic growth in the energy economics literature (see, for example, Ozturk, 2010). Proponents of the so-called "neutrality hypothesis" argue that there is no relationship between energy use and output growth (Yu and Jin, 1992). This hypothesis is supported by the absence of causality between energy consumption and output growth rate, and implies that energy conversing policies will not affect output and hence employment adversely. Supporters of the "growth hypothesis" view energy as a compliment to labor and capital in the production function. Hence, reducing energy use will hamper output (Beaundreau, 2005; Ghali and El-Sakka, 2004; Lee and Chang, 2008; Oh and Lee, 2004; Stern, 2000). Supporters of the "conservation hypothesis", on the other hand, argue that positive relationship between energy use and output growth stems from positive effect of output on energy, but not vice-versa. Therefore, energy conversing policies may be implemented without hampering employment and output (Apergis and Payne, 2009; Lee and Chang, 2008). Finally, "feedback hypothesis" implies that there is bidirectional causality between energy use and output growth. Hence, reducing energy use may hamper output growth.[2]

Due to the importance of the issue both for policymakers and economists, the dynamic interaction between energy consumption and economic growth has been intensively investigated in energy economics literature since the seminal work of Kraft and Kraft (1978). However, the empirical evidence is mixed (see also literature surveys by Ozturk, 2010; Payne, 2010). For example, Kraft and Kraft (1978), Akarca and Long (1979, 1980), Yu and Hwank (1984), Abosedra and Baghestani (1989), Yu and Choi (1985), Erol and Yu (1987), Masih and Masih (1996), Cheng and Lai (1997), Ang (2008), Zhang and Cheng (2009), Zamani (2007) and Mehrara (2007) found unidirectional causality running from economic growth to energy consumption. On the other hand, Yu and Choi (1985), Masih and Masih

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[2] For a thorough discussion of the issue, see, for example, literature surveys by Ozturk (2010) and Payne (2010).

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(1996), Asafu-Adjaye (2000), Bowden and Payne (2009), Belloumi (2009), Stern (2000), Oh and Lee (2004), Wolde-Rufael (2004) and Ho and Siu (2007) found unidirectional causality running from energy consumption to economic growth. Glasure (2002), Erdal et al. (2008) and Belloumi (2009) found bidirectional causal relationship between energy consumption and economic growth, whereas Halicioglu (2009) and Payne (2009) found no causality between them.

A common feature of the aforementioned studies is that all of them used linear models. Conflicting findings regarding the dynamic interactions between energy consumption and economic growth may be attributed to the assumption that the relationship between energy consumption and economic growth is linear. In linear models the parameters assumed to be constant over the sample period which implies that the relationship between energy consumption and economic growth is stable. However, some events such as changes in the policies, energy crises and economic crises could affect the parameters. Hence, in time series framework these changes must be taken into consideration in order to avoid spurious results.

Recently, a growing number of theoretical and empirical studies have taken into consideration nonlinearity to analyze the dynamic interactions between the macroeconomic series in question. Moon and Sonn (1996), Lee and Chang (2007), Chiou-Wei et. al. (2008), Huang et. al. (2008), Cheng-Lang et al. (2010), Rahman and Serletis (2010), among others, have investigated possible nonlinear relationships between energy use and macroeconomic variables. By introducing an endogenous growth model that emphasizes energy requirements to support potential growth, Moon and Sonn (1996) claim that at the beginning, economic growth rate increases with productive energy expenditures but it subsequently decreases. They estimated their theoretical model with Korean data to confirm the validity of their hypotheses. Taking account of the fact that level of development may affect the interrelationship between energy use and economic growth, Lee and Chang (2007) examined energy consumption output growth causality by categorizing countries into different groups by level of development. Their results suggest that the causality between energy consumption and output level is not linear, and varies with output level.

Chiou-Wei et al. (2008) used nonlinear causality tests besides linear causality tests to examine causality between energy consumption and economic growth in the case of eight Asian countries and the USA. They argue that changes in the economic events and regime changes such as changes in energy policy or fluctuations in energy price can cause structural changes in the pattern of energy consumption, which in turn, creates a room for a nonlinear relationship between energy use and economic growth. When they take into account nonlinearity in the interrelationship between energy consumption and output, the direction of causality between the variables is reversed in the cases of Taiwan, Singapore, Malaysia and Indonesia. On the other hand, in the cases of Korea, Hong Kong, Philippines, Thailand and the USA both linear and nonlinear causality tests imply the same direction of causality or non-causality. Based on the arguments of Chiou-Wei et al. (2008) that changes in economic environment, policy alterations and world energy prices may lead to a nonlinear interrelationship among electricity consumption and economic activity, Cheng-Lang et al. (2010) analyzed causality between total and sectoral electricity consumption levels and output in Taiwan. They concluded that there is bidirectional nonlinear causality between total electricity consumption and real output. In addition, they find that there is unidirectional nonlinear causality from output level to residential electricity consumption.

In order to investigate nonlinear relationships between energy consumption and economic growth for 82 countries, Huang et al. (2008) employed threshold regression models. Their results suggest a significant positive relationship between energy consumption and output growth for regimes associated with lower threshold values. However, when the threshold variables are higher than certain threshold levels, they found either no significant relationship or a significant but negative relationship between energy consumption and economic growth.

Rahman and Serletis (2010) examined asymmetric effects of oil price and monetary shocks using data for the United States. In particular, they employ a nonlinear VAR model by using realized oil price volatility as a regime switching variable. They find that both oil prices and oil price volatility have impacts on macroeconomic activity. In addition, they find that monetary policy not only reinforces the effects of oil price shocks on output, but it also contributes to the asymmetries in the effects of oil price shocks on output.

Hasanov and Telatar (2011) analyzed stationarity properties of per capita total primary energy consumption across 178 countries around the world allowing for both structural breaks and nonlinearities in the data generating process, and found that allowing for breaks and nonlinearities in the data generating process leads to more frequent rejection of the null hypothesis of unit root. They also tested linearity of the series under investigation and found that all series under consideration are characterized by some type of nonlinearity. They suggested taking account of possible nonlinear dynamics in analyzing relationship between energy use and macroeconomic variables.

The results obtained in these empirical studies imply that nonlinearity may stem from level of development or changes in energy policies or fluctuations in world energy markets. In fact, Hasanov and Telatar (2011) argue that fluctuations in energy prices may lead nonlinear dynamics in presence of adjustment costs. As they point out, a change in input prices affects firms' input demands. Firms react to increases in energy prices by reducing energy use in the short run, and adopting energy saving production technologies in the long run. However, adoption of new technologies is costly. Hence, if the costs of adoption of new technology are greater than the costs of operation with energy-intensive technology, then firms shall not adjust their production processes. On the other hand, if the gains from adopting new technology cover the costs of adjustment, then firms will incur adjustment costs and adopt energy-saving technology. This implies that the adjustment of energy consumption to the desired level might be inherently nonlinear.

The purpose of this study is to examine possible nonlinearities in the dynamic interaction between energy consumption and economic growth in Turkey. Several authors have examined energy consumption and economic growth nexus and reported conflicting results in the case of Turkey. Soytaş and Sarı (2003) employed a vector error correction model (VECM) and concluded that unidirectional causality runs from energy consumption to economic growth for the 1960–1995 period. Altinay and Karagol (2004), using Hsiao' version of Granger method over the period 1950–2000, found no causal relationship between energy consumption and economic growth. Altinay and Karagol (2005) focused on the 1960–2003 period and used a VAR model and standard Granger test and found unidirectional causality running from electricity consumption to economic growth. Jobert and Karanfil (2007) employed a cointegration and Granger causality analysis and found no evidence of causality between energy consumption and economic growth in the long run. Lise and Van Montfort (2007), using an error correction model (ECM) for the 1970–2003 period, concluded that unidirectional causality runs from economic growth to energy consumption. Erdal et. al. (2008), employing a pairwise Granger causality for the 1970–2006 period, concluded that bidirectional causality exists between energy consumption and economic growth. Halicioglu (2009) undertook an autoregressive distributed lag (ARDL) approach for the 1960–2005 period and found that energy consumption and economic growth are neutral to each other. Yalta (2011), using a maximum entropy bootstrap over the period 1950–2006, found an evidence supporting the neutrality between energy consumption and economic growth.

Our approach in this paper differs from previous researches on energy-output relationship for the case of Turkey. As briefly discussed in Section 2, Turkey has undergone serious structural changes during the analyzed period. In addition, Turkey has limited energy sources