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Energy Consumption and Stock Market Relationship: Evidence from Turkey

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ABSTRACT: A large number of studies on the relationship between financial indicators and macroeconomic variables such as economic growth and energy as a result of the increase in the energy prices and their volatility in recent years have emerged. The aim of this study, apart from the other studies in the area, is to investigate the interaction between energy consumption and stock exchange index in Turkey. Ceteris paribus, economic growth with the increase of energy consumption, the growth of the economy impact will also affect the stock exchange which is accepted as the barometer of the economy (vice versa). The interaction between the BIST National 100 index, BIST National Industrial Index and energy consumption is investigated by Johansen Cointegration Test, Granger Causality Test tests based on VAR for the period of 1995-2011. Unidirectional causality relationship is detected from BIST 100 Index and BIST Industrial Index towards energy consumption.

Keywords: Energy Consumption; Stock Market; BIST 100 Index; Cointegration; Causality
JEL Classifications: E44; O4; Q4

1. Introduction

As of 2011, Turkey is the sixth biggest economy in Europe with its more than \$376 billion foreign trade volume and exports its goods to more than 100 countries, two thirds of them being advanced economies (EPDK, 2012). As stated in the EPDK 2012 report that in conjunction with rapid economic growth and urbanization, energy demand and the need for new investment in energy sector has also been increasing and the sector becomes increasingly attractive for investors, domestic and foreign alike. The primary energy consumption in Turkey has been steadily growing within the last decade and reached at 83.4 MTOE in 2010. In 2011, Turkish economy consumed 229.3 billion kWh electricity and 44.2 BCM natural gas. Crude oil refined in Turkish refineries in 2011, on the other hand, was almost 21 million tons. Turkey still has lower per capita production levels compared to the averages prevail in OECD and EU countries. Turkey still lags behind the developed countries in terms energy consumption per capita. With its rapid and stable economic growth, Turkey is expected to catch up with the developing world in per capita energy consumption in the foreseeable future since higher levels of per capita energy consumption is one of the major tenets of the developed economies.

Access to the energy resources and having control of them, energy dependence and energy consumption are known to play an important role in the global economy and world politics. The energy which may affect the economy and even the politics significantly and the emerging changes in its price, supply, demand and consumption may have important effects on the economies of the countries. Knowing the relation between the energy, macroeconomic and financial indicators will be guiding policy-makers in the creation of energy policy. For these reasons, there have emerged a large number of studies on the relationship between financial development and macroeconomic variables such as economic growth and energy. However, the findings from the studies are conflicting. For

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example, in some of the studies we have found out that economic growth and/or financial developments affect energy consumption, in some other studies we have reached the opposite conclusion.

The link between energy consumption and financial development has been certainly well documented (Sari and Soytas, 2007; Mankiw and Scarth, 2008; Karanfil, 2008; Narayan and Smyth, 2008; Sadorsky, 2010, 2011; Apergis and Payne, 2010; Narayan et al., 2010; Pirlogea and Cicea 2012; Coban and Topcu ,2013; Ozturk and Acaravci, 2013). Theoretically, Sadorsky (2011) explains how financial development affects energy consumption three ways. First, financial development can affect the demand for energy is by making it easier and cheaper for consumers to borrow money to buy big ticket items like automobiles, houses, refrigerators, air conditioners, and washing machines. Secondly, businesses also benefit from improved financial development because it makes it easier and less costly to gain access to financial capital. Lastly, stock market development is particularly attractive to businesses because it allows them access to an additional source of funding and equity financing. Thus, increased stock market activity also creates a wealth effect that in turn affects consumer and business confidence.

Recent studies have well documented for a lot of countries that financial development can affect energy consumption. Islam et.al (2013) find that energy consumption is influenced by economic growth and financial development, both in the short and the long run, but the population energy relation holds only in the long run. Shahbaz and Lean (2012) analyses the relationship among energy consumption, financial development, economic growth, industrialization and urbanization in Tunisia from 1971 to 2008. The study results show that the existence of long-run relationship among energy consumption, economic growth, financial development, industrialization and urbanization in Tunisia. Binh (2011) finds that energy consumption is not a limiting factor to economic growth in Vietnam and also finds that government can pursue the conservation energy policies that aim at curtailing energy use for environmental friendly development purposes without creating severe effects on economic growth. Bartleet and Gounder (2010) examine the energy consumption–growth nexus in New Zealand. They show that economic growth causes energy consumption and economic activity determines the increase of energy demand. Sadorksy (2010) investigates the impact of financial development on energy consumption in a sample of emerging countries using generalized method of moments estimation techniques covering the period 1990– 2006. He shows a positive and statistically significant relationship between financial development and energy consumption.

It is expected that revival of the economic activities and the positive economic growth reflected stock exchange that is considered as a barometer of the economy. In an economy, the increase of the amount of consumption the energy used as an input in the production is the indicative of the increase of the amount of goods and services produced by firms, profitability of firms and the growth of the companies and therefore the growth of the economy (vice versa).

Ceteris paribus, economic growth with the increase of energy consumption, the growth of the economy impact will also affect the stock exchange which is accepted as the barometer of the economy (vice versa). Also, in the event that companies make use of more energy sources, they are expected to have an increase in their production of goods and services, besides in their capacity utilization ratios, assets and profitability. Their growth and increase in their profitability are expected to have a positive impact on the stock exchange index.

The aim of this study is to investigate empirically whether energy consumption affected the stock exchange which is considered to be a barometer of the economy in Turkey, an emerging country, for the period of 1995-2011. There is no study the link between stock market and energy consumption in Turkey. In this respect the paper contributes to empirical literature as an emerging country Turkey and we try to show the relationship between stock market and energy consumption in Turkey. The rest of the paper proceeds as follows: we present data and methodology in section 2, empirical findings in section 3 and conclusion in section 4.

2. Data and Methodology

The purpose of this study is to determine the interaction between BIST (Borsa Istanbul, Istanbul Stock Exchange) National 100 Index, BIST National Industrial Index and energy consumption. The energy consumption data is collected from World Bank online database. The stock market data based on US Dollars is collected from Istanbul Stock Exchange official web-site. Energy consumption is measured in kilogram (kg) of oil equivalent. The relationship between the variables is analyzed by Johansen Cointegration Test and Granger Causality Test based on VAR.

In order to examine the long-run steady relationship between the energy consumption and stock market by used Johansen Cointegration Test, the series must be tested for stationarity. ADF (Augmented Dickey-Fuller) (1981) and PP (Phillips-Perron) (1988) unit root test use widely for stationarity analysis.

ADF unit root test can be used to determine the order of integration of series. To test for the presence of unit root is used the following ADF regression models with intercept and intercept-trend:

$$\Delta y_t = \mu + \delta y_{t-1} + \sum_{i=1}^{n} \delta_i \Delta y_{t-i} + e_t \tag{1}$$

$$\Delta y_t = \mu + \beta_t + \delta y_{t-1} + \sum_{i=1}^{n} \delta_i \Delta y_{t-i} + e_t \tag{2}$$

The ADF test for a unit root tests the null hypothesis H0 : $\delta = 0$ against alternative hypothesis H1 : $\delta < 0$. The rejection of null hypothesis states that the series y_t is stationary.

The Dickey-Fuller tests assumes that errors are statistically independent and have a constant variance. Thus, in using this methodology, an error terms must be uncorrelated and has constant variance. Phillips and Perron (1988) developed a generalization of the Dickey-Fuller procedure that allows for fairly mild assumptions about the distribution of the errors. The following regression equations briefly explain the procedure;

$$y_t = a_0^* + a_1^* y_{t-1} + \mu_t \tag{3}$$

$$y_t = \tilde{a}_0 + \tilde{a}_1 y_{t-1} + \tilde{a}_2 (t - T/2) + \mu_t \tag{4}$$

where T: number of observations and the disturbance term μ_t is such that $E\mu_t = 0$, but there is requirement that the disturbance term is serially uncorrelated or homogeneity, the Phillips-Perron test permits the disturbances to be weakly dependent and heterogeneously distributed (Enders, 1995, 239,).

If the results of the unit root tests indicate that variables are integrated of same order, Johansen cointegration test can be used to determine the long-run equilibrium relationship between variables. There are two test statistics (trace (λ_{trace}) and maximum eigenvalue (λ_{max}) test statistics) for investigate the cointegration under the Johansen approach, which are formulated as

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln(1 - \hat{\lambda}_i) \tag{5}$$

$$\lambda_{max}(r, r+1) = -T \ln\left(1 - \hat{\lambda}_{r+1}\right) \tag{6}$$

where r is the number of cointegration vectors under the null hypothesis and $\hat{\lambda}_i$ is the estimated value for the ith ordered eigenvalue from the Π matrix. Trace statistics is a joint test where the null hypothesis is that the number of cointegrating vectors is less than or equal to r against an unspecified or general alternative that there are more than r. Maximum eigenvalue conducts separate tests on each eigenvalue, and has as its null hypothesis that the number of cointegrating vectors is r against an alternative of $r + 1$. If the test statistic is greater than the critical value from Johansen's tables, reject the null hypothesis that there are r cointegrating vectors in favour of the alternative that there are $r + 1$ (for λ_{trace}) or more than r (for λ_{max}) at the 5 % level of significance (Brooks, 2006, 404).

If variables are not stationary in the level (I(0)) but stationary in the first difference (I(1)) and cointegration test results indicated that variables are cointegrated, then causality between variables can be examined by vector error correction models. But, if variables are I (1) and cointegration test results indicated that variables are not cointegrated, then causality between variables can be examined by VAR (vector autoregressive) models.

Generally, in economics to have models where some variables are not only explanatory variables for a given dependent variable, but they are also clarified by the variables that they are used to determine. In such cases we have models of simultaneous equations, in which it is essential to obviously identify which are the endogenous and which are the exogenous or predetermined variables. The decision concerning such a differentiation among variables was heavily criticized by Sims (1980). According to Sims (1980), if there is simultaneity among numerous variables, then all these variables should be treated in the same way. In other words there should be no difference between endogenous and exogenous variables. Therefore, once this difference is abandoned, all variables are treated as endogenous. This means that in its general reduced form each equation has the same set of regressors that lead to the development of the VAR models. One of the good features of VAR models is that they permit to test for the direction of causality (the ability of one variable to predict the other. Suppose that there are two variables, y_t and x_t, affect each other with distributed lags. The relationship between these variables can be captured by a VAR model. As a result, it is possible to have that (a) y_t causes x_t, (b) x_t causes y_t, (c) there is a bi-directional feedback (causality among the variables), and finally (d) the two variables are independent (Asteriou and Hall, 2007, 279-280).

It can be tested the Granger causality by estimating the following VAR model:

$$y_t = \alpha + \sum_{i=1}^{k} \theta_i y_{t-i} + \sum_{i=1}^{k} \beta_i x_{t-i} + e_{1t} \tag{7}$$

$$x_t = \alpha' + \sum_{i=1}^{k} \delta_i y_{t-i} + \sum_{i=1}^{k} \gamma_i x_{t-i} + e_{2t} \tag{8}$$

Equation (7) and (8) is the standard form of VAR model that contain two-variable, k lag values of y_t and x_t, and e_{1t} and e_{2t} are white-noise process. VAR models stated that independent variables is affected by past values of its own lags and the lags of the other variables. So, null and alternative hypothesis in the Granger causality test based on the VAR model is

$H0: \beta_1 = \beta_2 = \beta_3 = \ldots\ldots = \beta_k = 0$ $\quad$ $H0: \delta_1 = \delta_2 = \delta_3 = \ldots\ldots = \delta_k = 0$

$H1: \beta_1 = \beta_2 = \beta_3 = \ldots\ldots = \beta_k \neq 0$ $\quad$ $H1: \delta_1 = \delta_2 = \delta_3 = \ldots\ldots = \delta_k \neq 0$

For equation (7), H_0 hypothesis stated that "x_t does not Granger cause y_t". For equation (8), H0 hypothesis stated that "$y_t$does not Granger cause x_t". If H_0 hypothesis is rejected, it is accepted granger causality.

3. Empirical Findings

In order to examine the interaction between the energy consumption and stock market, firstly the series must be tested for stationarity. For logarithmic series, Table 1 presents ADF unit root test. ADF and PP unit root test results for regression model with intercept and also the model with both intercept and trend terms are presented at the Table 1 and Table 2. ADF and PP test results showed that the null hypothesis cannot be rejected for the variable's level value, because of ADF and PP test statistics value is greater than the critical values at the 1% and 5% levels. However, the null hypothesis can be rejected, because of ADF and PP test statistics value is smaller than the critical values at the 1% and 5% levels. Thus, BIST 100 Index, BIST National Industrial Index and energy consumption series are integrated of the first order, that is, I(1).

Table 1. ADF Unit Root Test Results

	Level		First Difference	
Series	**Intercept**	**Trend and Intercept**	**Intercept**	**Trend and Intercept**
BIST 100 Index	-2.466045	-3.501130***	-6.007198*	-5.791523*
BIST Industrial Index	-2.192783	-3.636293	-6.280210*	-6.048596*
Energy Consumption	-0.291748	-1.860464***	-4.145439*	-4.185663**

*, **, *** indicates the rejection of the null hypothesis at the 1%, 5% and 10% level of significance respectively.

Table 2. Phillips-Perron Unit Root Test Results

	Level		First Difference	
Series	**Intercept**	**Trend and Intercept**	**Intercept**	**Trend and Intercept**
BIST 100 Index	-2.401955	-3.501130***	-6.698214*	-6.382877*
BIST Industrial Index	-2.089270	-3.636293	-10.07153*	-10.33435*
Energy Consumption	-0.015330	-1.860464***	-4.237697*	-6.767732*

*, **, *** indicates the rejection of the null hypothesis at the 1%, 5% and 10% level of significance respectively**.**

For the all variables are integrated of the first order, Johansen cointegration test developed by Johansen (1988) is used to present the long-run stable relationship among the variables. First of all, lagged length of the variables is determined by VAR model before the cointegration test. Lagged length is taken as 1 according to the information criteria that FPE (final prediction error), AIC (Akaike information criterion), SC (Schwarz information criterion) and HQ (Hannan-Quinn information criterion). VAR residuals serial correlation LM test is used to investigate the presence of autocorrelation up to the 12^{th} order. LM test results indicated that there is not significant serial correlation in the residuals.

Johansen Cointegration Test uses trace and maximum eigenvalue test statistics to examine the cointegration relationship between variables. The results of the λ_{trace} and λ_{max} test is presented in Table 3 and Table 4. Since the λ_{trace} and λ_{max} test statistics are not greater than critical values and probability values are not statistically significant, the null hypotheses suggesting no cointegration between the series cannot rejected at the 5 % level of significance. These results showed that the BIST 100 Index-BIST National Industrial Index and energy consumption series are not cointegrated.

Table 3. Johansen Cointegration Test Results for the BIST 100 Index and Energy Consumption

Test	**Hypothesized No. of CE(s)**	**Test Statistics**	**0.05 Critical Values**	**Prob****
λ_{trace}-Test	None	8.545714	15.49471	0.4090
	At most 1	0.371596	3.841466	0.5421
λ_{max}-Test	None	8.174117	14.26460	0.3613
	At most 1	0.371596	3.841466	0.5421

*Trace and Max-eigenvalue test indicated no cointegration at the 5% level of significance.
** MacKinnon-Haug-Michelis (1999) p-values.

Table 4. Johansen Cointegration Test Results for the BIST Industrial Index and Energy Consumption

Test	**Hypothesized No. of CE(s)**	**Test Statistics**	**0.05 Critical Values**	**Prob****
λ_{trace}-Test	None	9.212096	15.49471	0.3461
	At most 1	0.129991	3.841466	0.7184
λ_{max}-Test	None	9.082105	14.26460	0.2794
	At most 1	0.129991	3.841466	0.7184

Trace and Max-eigenvalue test indicated no cointegration at the 5% level of significance.
** MacKinnon-Haug-Michelis (1999) p-values.

Because of all variables are I (1) but the variables are not cointegrated, causality between energy consumption and stock market is examined by VAR (vector autoregressive) models. Lag order selection criteria were used to determine the optimal lag length for the VAR model. FPE, AIC, SC and HQ information criteria indicated that the optimal lag length for the VAR model is one. There is not a problem of autocorrelation and heteroskedasdicity in the estimated VAR model. Addition the VAR model satisfied the stability condition. Granger causality test results for energy consumption and BIST

100 index reported in Table 5 in Panel A. Granger causality test results for energy consumption and BIST Industrial index reported in Table 5 in Panel B. As can be seen Table 5, the null hypothesis that energy consumption does not Granger cause BIST 100 Index and energy consumption does not Granger cause BIST Industrial Index are not rejected. But the null hypothesis that BIST 100 Index does not Granger cause energy consumption and BIST Industrial Index does not Granger cause energy consumption are rejected at the 5 % level of significance. Thereby, unidirectional causality relationship is detected from BIST 100 Index and BIST Industrial Index towards energy consumption. This result can be said to be consistent with the results of causal relationship studies from economic growth towards energy consumption. The growth of the economy will increase the stock market index and due to increased production it will also lead to further consumption of energy resources.

It can be said that, this result is in close relations with the results of the papers find that causality relationship from economic growth towards energy consumption. The growth of the economy will lead to increase the stock exchange and also depend on the increase of the production of further energy consumption

Table 5. VAR Granger Causality/Block Exogeneity Test Results

Panel A
H_0: Energy consumption does not Granger cause BIST 100 Index.
Chi-Square: 0.136618 Prob : [0.7117]
H_0: BIST 100 Index does not Granger cause energy consumption.
Chi-Square: 4.781002** Prob : [0.0288]
Panel B
H_0: Energy consumption does not Granger cause BIST Industrial Index.
Chi-Square: 0.001378 Prob : [0.9704]
H_0: BIST Industrial Index does not Granger cause energy consumption.
Chi-Square: 6.284872** Prob : [0.0122]

** indicates significance at the 5% level.

4. Conclusion

It is expected that revival of the economic activities and the positive economic growth reflected stock exchange that is considered as a barometer of the economy. In an economy, the increase of the amount of consumption the energy used as an input in the production is the indicative of the increase of the amount of goods and services produced by firms, profitability of firms and the growth of the companies and therefore the growth of the economy (vice versa). The recovery in economic activity and the economic growth are expected to materialize the stock market index which is considered to be a barometer of the economy in a positive way. The relationship between energy consumption, economic growth and financial indicators has been the subject of numerous studies in literature review. The findings from these studies are conflicting with each other. The reason for the contradictory findings are, whether or not the lack of being an exporter or an importer of the countries and may be the factors such as countries' level of development, and energy dependence. The objective of this study, apart from the other studies in the area, is to investigate the interaction between energy consumption and stock exchange index in Turkey, as an emerging country, for the period of 1995-2011. The results show that there is unidirectional causality relationship from BIST 100 Index and BIST Industrial Index towards energy consumption. This result is consistent with the results from economic growth or financial indicators to energy consumption which find causal relationship. When the stock index rises, in other words when the economy grows, and thus the energy consumption used in the economy increases. When the stock market index as an indicator of the economy, it may be said that the energy consumption is not a cause of economic growth, but it is the result of economic growth.

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