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The Impact of Energy Consumption on Exports: The Turkish Case

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Abstract: This paper aims to determine the impact of domestic energy consumption on exports in Turkey by using annual data from 1970 to 2006. For this purpose cointegration and Granger causality tests and impulse-response functions are applied. According to obtained results there is a significant relationship between domestic energy consumption and exports in long term. Granger causality test shows there is a unidirectional causality running from energy consumption to exports. Impulse-response functions indicate that shocks to the energy consumption have a positive impact on exports. Therefore energy is an important factor for economic growth in Turkish economy.

Key words: Cointegration, energy, exports and Turkey's energy consumption

INTRODUCTION

Energy, among many inputs, plays a significant role in economical and social development. This input is heavily used nearly by all sectors in economy especially in industry which is the determinant factor of economy. After the industrial revolution at the end of 18th century and in the beginning of 19th century with the application of new inventions to the production, it was observed that the need for energy increased globally. Population growth and struggles to increase economic wealth caused everlasting use of energy sources. However, since the mentioned sources are limited, this makes it inevitable to increase the productivity of these sources and make new energy sources popular (Kadıoglu and Tellioglu, 1996).

As in the whole world, energy bears great importance for Turkey. Though Turkey has various energy sources, with its petrol, coal and natural gas reserves Turkey is not among the rich countries. On the other hand, Turkey has alternative energy sources, yet as reserve, such as uranium, thorium and boron.

For this reason, most of the energy need is imported to meet the needs of increasing population and to maintain development goals (Akbulut, 2008). Today, since external dependence on energy, which even leads international politics, may cause serious negations, the country should develop rational policies considering internal dynamics of the country. In addition, we need new regulations to increase the effectiveness and productivity principles within the frame of energy production. It is generally accepted that energy consumption appropriate to these principles supports the economic growth. The declared effect is explained through technology factor that is internalized among growth models. On the other hand, it will be possible to produce more goods and service with low cost by using effective and productive energy input during the production process. In this study, whether such effect on exports happened in Turkey is analyzed using cointegration and Granger causality tests and impulse-response functions.

Energy consumption in the world and turkey: Energy consumption in the world increases parallel to technological developments and population growth. On one hand, there are some studies for new energy sources and to use energy more effectively in order to meet the increasing energy demand and on the other hand there are studies for more effective usage of existing energy sources (DPT, 1996). As it is seen in Fig. 1 while the energy consumption all over the world was 283.3 quadrillion Btu in 1980 the amount increased to 472.5 quadrillion in 2006. This amount is estimated to reach to 678.3 quadrillion Btu in 2030 according to International Energy Agency (EIA, 2009).

Fig. 2, which reflects the energy consumption according to fuel types, shows that demand for preliminary energy sources such as petrol, coal and natural gas kept its improtance and will continue to be in high demand in the future. However, according to 2009 BP energy Statistics Report it is stated that the reserves of the mentioned sources are seriously in decline depending on the increasing consumption. Regarding the present consumption of the mentioned sources, the fact that the experts foresee that petrol has reserves that will meet the needs for 40 years, natural gas for 60 years and coal for 130 years led the countries to use alternative energy sources. Within this scope, it is thought that some renewable energy sources such as sunlight, wind, water

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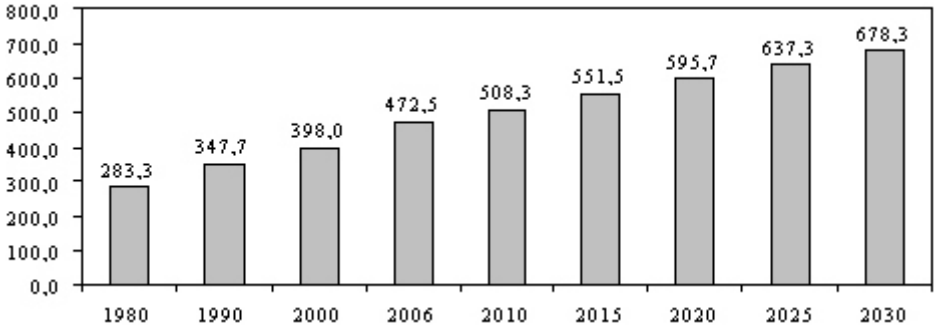

Fig. 1: World marketed energy consumption, 1980-2030

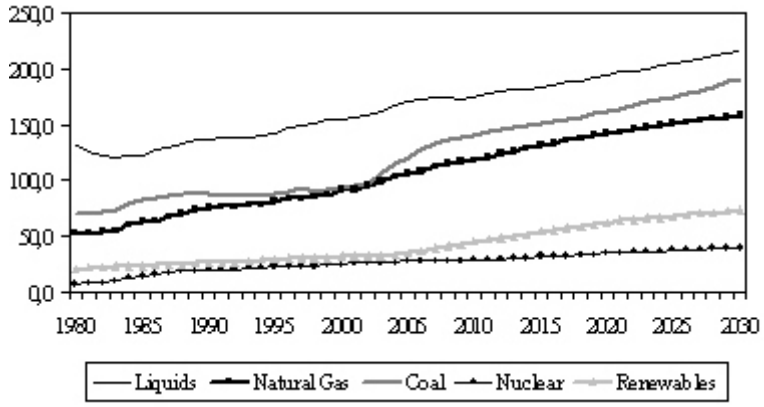

Fig. 2: World marketed energy use by fuel type, 1980-2030

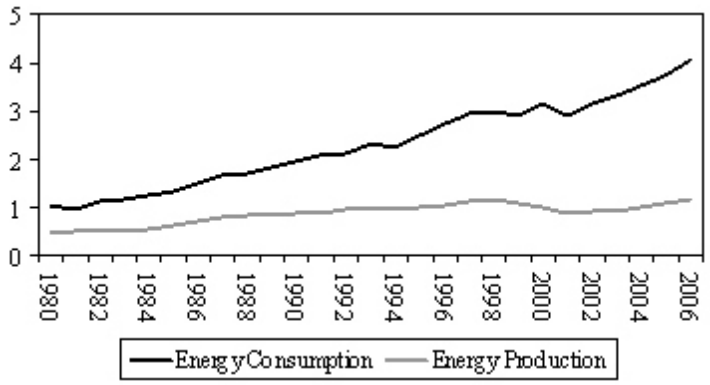

Fig. 3: Primary energy consumption and production in Turkey (quadrillion Btu)

and geothermal energy will be important in the future. Fig. 2 shows that since 2004 there has been an increasing trend on the use of renewable energy and they attract the attention that renewable energy will have more of the share in the future when compared to nuclear energy.

As the result of socio-economical developments in Turkey, it can be seen that, parallel to the consumption all over the world, energy consumption gradually increases in Turkey (Fig. 3). However, the energy production is highly beneath the consumption. Although the gap between them was low in the early 1980s, it increased with the population increase and investments.

The fact that consumption increased more than production means increasing of dependence to foreign countries. Nearly all of the petrol and natural gas was among this dependence. The mentioned sources, as shown in Fig. 4, compose of the mostly demanded sources of the country. Therefore, it bears great importance that on time,

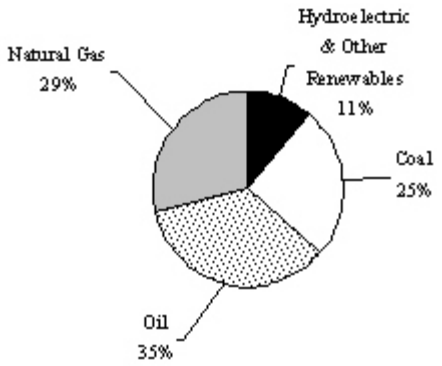

Fig. 4: Energy Consumption by Fuel in Turkey, 2006

reliable, quality and cheap energy is supplied. It is necessary to take into consideration that we should not depend on only one source of energy and one country in order to avoid any kind of problem. Therefore, we vary the countries that we buy these sources (Gürseler, 1994).

When we look at the priliminary energy demand for OECD in general in 2006, it is seen that petrol was in the first row with 41%, natural gas was in second row with 22%, coal was in the the third row with 19% and nucleer energy was in the fourth row with 10%. Similar to this in EU countries petrol was in the first row with 40%, natural gas and coal followed it with 25 and 17% consecutively (EIA, 2006). However, it is foreseen that nuclear and renewable energy sources will become more important in the future due to the decreasing amount of fossil fuels. Turkey, on the other hand, is one of the countries that have highest prices for petrol or petrol products. When compared to developed EU countries, the differences in prices can be seen cleary for all users in Table 1.

Energy consumption data according to sectors was given in Fig 5 by regarding the avarages of Turkey's and EU's. Statistics show that most of the energy consumption in Turkey and EU was in dwellings, service and industry. However, though Turkey uses more energy in production process, there are differences in the energy consumption which is the sign of social and economic development. This is resulted from the problems that bring inproductivity and ineffectiveness together such as inadequate energy management and planning, lack of official regulations, the fact that control mechanisms do not work properly (Üçüncü, 2008).

Theoretical framework: Effective and productive use of energy that is one of the extremely important inputs for industry will affect output level positively because of the fact that it takes more places in production process. It is seen that empirical studies on energy focus on the mentioned relation. There are not many studies in theory and application that deal with the relation between energy consumption and exports. However, since the amount of items and service related to exports will increase

Table 1: Prices of petroleum products in selected countries[a] ($/br)

Countries	Heavy fuel oil for industry (tonne)	Light fuel oil for households (1000 liters)	Automotive diesel oil (liter)	Unleaded premium (liter)
Germany	544,83	1076,91	1,630	2,099
France	567,66	1186,17	1,537	2,030
Italy	626,78	1857,81	1,616	2,055
United Kingdom	---	1047,45	1,854	2,067
Turkey	979,94	2061,24	2,180	2,599

[a]Prices are for 1st quarter 2008
Source: IEA (2008), Key World Energy Statistics, International Energy Agency, Paris.

depending on the amount of input, the institutional dimension of the issue can be explained in relation to economic growth. Generally, endogenous growth models are used for this purpose.

Before endogenous growth models, in Solow model, for example, though it is explained that techonological develoment is valid for increasing development rate it did not mention how this development will be achieved. However, some factors such as knowledge, human capital, research and technological developments, were effective on the level of development since past. On the other hand, in today's world the approaches which attribute the level of being underdeveloped to the lack of financial and real capital have lost their validity. Some factors such as not reaching updated information, not having human capital, and not using exisiting technology can be listed among the reasons of being less developed. The modelling of the mentioned variables shows them as endogenous growth (Taban, 2008).

Since it is not possible to explain the economic growth with just one model or variable, endogenous growth models are classifed within themselves in different groups (Berber, 2006). Referencing to Romer's production functoin that he prepared for a firm, it is possible to write total production formula as follows (Gbadebo and Okonkwo, 2009):

$$Y=F(A,K,L) \quad (1)$$

Y represents total real output level, A represents technology, K represents real capital stock and L represents total workpower. Energy factors that are regarded as the sign of economic growth in long term enable practical usage of technology. However, there are needs for highly expensive technological invesments that need large capitals in order to convert energy into usable form. These kinds of investments are done not only to produce energy but also to provide the effectiveness of this energy. As a result, it is accepted that energy that is obtained with low cost and used effectively during the production process will have positive effect on technology. Thanks to technological development the countries that make quality but low cost production will have more opportunities to transfer and market their products and services in intenational markets.

MATERIALS AND METHODS

In this study in which casual correlation between domestic energy consumption (ET) and exports (IH) and

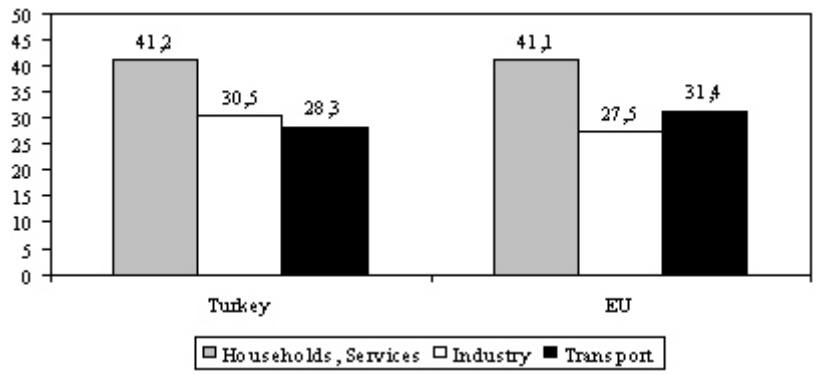

Fig. 5: Sectoral energy consumption in Turkey and EU Source: Austrian Energy Agency

its effect on Turkish economy was studied, the logarithmic values of the annual data obtained from TUIK and International Energy Agency (IEA) for 1970-2006 period were used. For the analysis cointegration test, Granger causality test and impulse-response functions were used.

Cointegration Test: The long term relationship between two or more unstable series in econometric models is analyzed with cointegration test. Unit root tests of every series have a random trend if these series are unstable and differences are taken, they brought to sample level stability then long term relationship is tested using Engle-Granger or Johansen-Juselius (JJ) techniques (Barışık and Demircioğlu, 2006).

In this study JJ multivariable cointegration test that enables prediction of the long term relation with maxium possibility in order to examine cointegration relation was used. JJ test uses two different statistical systems that are called Trace and Maximum eigenvalue in order to define the number of the vectors that have cointegration features. Where the Eq. 2 was taken into consideration, zero hyphothesis which means that in Trace test existing *r* numbered cointegration vectors are tested.

$$\lambda_{iz} = T\sum_{j=r+1,n} \ln(1-\lambda j) \qquad (2)$$

In this equation, T represents the observation number in the test, and,'s represent predicted characteristic roots under the assumption series as I(1). Maximum eigenvalue statistic is,

$$\lambda_{max} = -T\ln(1-\lambda_{r+1}) \qquad (3)$$

Regarding this, it tests two alternative hypothesis: there are r+1 cointegration vectors relationship and there are r numbered cointegration relation (Güneş, 2007).

Granger Causality Test: Causality test that was developed by Granger (1969) is among the most used techniques to define the way of the relation among the variables. For this test following two formulas are used:

$$Y_t = \alpha_0 + \sum_{i=1}^{p} \phi_i Y_{t-i} + \sum_{i=1}^{q} \delta_i X_{t-i} + \varepsilon_t \qquad (4)$$

$$X_t = \beta_0 + \sum_{i=1}^{p} \pi_i X_{t-i} + \sum_{i=1}^{q} \lambda_i Y_{t-1} + \mu_t \qquad (5)$$

Here:
α and β = constant terms,
ϕ, δ, π and λ= predicted coefficients of lagged variables,
p and *q*= optimal lagging length of X and Y series.

In the models above it has been tested whether coefficient of lagging values equal to zero or not ($\delta_1=\delta_2=-...=\delta_i=0$; $\lambda_1=\lambda_2=...=\lambda_i=0$). In Eq. 4 it is decided that if the hypothesis is refused using F test X is Y's Granger reason; in case of refusing the hypothesis in 1.5 Y is X's Granger reason equality (Barışık and Demircioğlu, 2006: 76).

Impulse-Response Functions: Impulse-response functions that enable us to analyze the dynamic relation between variables reflects the present and future effect of standard error shock in one of the random error terms on endogenous variable. The usage of impulse-response functions enable us to observe the dynamic reactions that any variable show in case of a standard error shock happened at any of the variables. Average moving vector's (VMA) showing, in Sims (l980) method, the effects of shocks on variables that exist in VAR system enables us to draw the time road. In two-variable VAR matris form of impulse-response function,

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} a_{10} \\ a_{20} \end{bmatrix} + \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \qquad (6)$$

Active average presentation for $\{\varepsilon_{yt}\}$ and $\{\varepsilon_{zt}\}$series,

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} \bar{y} \\ \bar{z} \end{bmatrix} + \sum_{i=0}^{\infty} \begin{pmatrix} \Phi_{11(i)} & \Phi_{12(i)} \\ \Phi_{21(i)} & \Phi_{22(i)} \end{pmatrix} \begin{bmatrix} \varepsilon_{yt-1} \\ \varepsilon_{zt-1} \end{bmatrix} \qquad (7)$$

This active average presentation is an effective tool especially to examine the interaction between yt and z_t series. Coefficients ofϕ_i' $\{\varepsilon_{yt}\}$ and $\{\varepsilon_{zt}\}$ its shocks can be used to reveal the effects of y_t and z_t series on whole time road. The four elements here $\phi_{jk}(0)$ are effect factors. For instance, the effect of one unit change in ϕ_{12} (0) $\{\varepsilon_{zt}\}$, on yt is sudden. In the same way $\phi_{11}(1)$, $\phi_{12}(1)$ are consecutively the effects of unit changes $\{\varepsilon_{yt}-1\}$ and $\{\varepsilon_{zt}-1\}$ on y_t for one term. These coefficient groups consisting of four terms $\phi_{11}(i)$, $\phi_{12}(i)$, $\phi_{21}(i)$, $\phi_{22}(i)$ are called as impulse-reaction functions. Diagrammatically impulse-response functions can be drawn as reactions of $\{y_t\}$ and $\{z_t\}$ series againts different shocks (Barışık and Kesikoğlu, 2006).

RESULTS AND DISCUSSION

In this study in which we tried to analyse the effect of domestic energy consumption on exports, the trend of the data, belonging to 1970-2006, was shown in Fig 6. According to this, it is seen that both energy demand and exports figures were interrupted especially during the periods when economic crisis happened and maintained their effects, depending on the decrease of capacity usage and investments. The results of the analysis whether the variables that show similar trends act together or not are shown in Fig. 6.

In order to predict the relationship between energy consumption and exports in Turkey first of all by using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) stationarity tests was performed.

The fact that the statistics of ADF and PP tests calculated at original levels were lower than MacKinnon critical values as absolute value show that series have unit root for this level. In the tests where the first differences were taken it can be seen that the condition of stationarity was achieved (Table 2). In order to determine whether energy consumption and exports that were seen to be stationary at the same level act together or not Johansen-Juselius cointegration test was used at the second step. In order to perform this test first of all optimal lag length (1) was defined and VAR model was predicted (Appendix). In Table 3 cointegration test results that were obtained after VAR analysis were given.

The fact that there was a cointegration vector among the variables that were studied as the result of JJ test meant that energy consumption and exports acted together for a long time. Cointegration equation normalized according to exports was given in Table 4.

In a cointegration equation that is normalized the coefficient of domestic energy consumption was statistically meaningful and positive. This result reflects the fact that energy that is considered as input during the production process bears similar importance in terms of foreign trade balance. Therefore, the effective and productive usage of energy sources creates positive effect both on exports and economic growth through exports. Within the scope of the period studied here, it was seen that energy demand in Turkey was used to make a contribution to exports. Granger causality test results, too, support this long term relationship of energy consumption and exports in Table 5.

In causality test the hypothesis that energy consumption is not the cause of exports is refused since the probability value was found below 10 and it has been concluded that energy consumption plays an effective role on exports. Impulse-response functions that are obtained from the predicted model were given in Fig. 7.

According to impulse-response functions, shocks to the energy consumption have a positive impact on exports.

Table 2: Results of unit root test

Levels	Variables	ADF Test Statistics	PP Test Statistics
Level	ET	-1.322760	-1.322760
	IH	-1.131977	-1.918228
First Difference	ET	-5.361342*	-5.361342*
	IH	-3.338248**	-6.193494*

* It doesn't include unit root on the 1%, 5% and 10% significant level.
** It doesn't include unit root on the 5% and 10% significant level.

Table 4: The estimation of cointegration relationship

IH=-	0,513	+	2,598 ET
	(0,091)		(4,995)

Table 5. Results of Granger causality test

Null Hypothesis	F-statistic	Probability
ET does not Granger cause IH	4.622374	0.0991
IH does not Granger cause ET	3.046640	0.2180

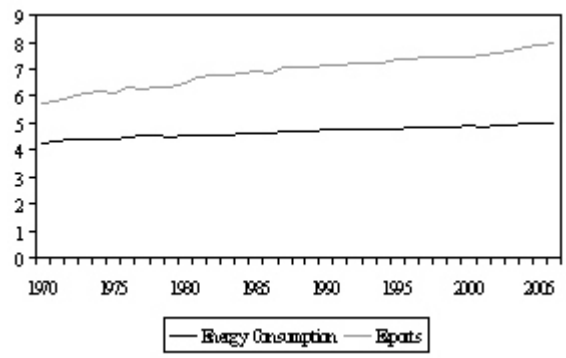

Fig. 6: Domestic energy consumption and exports performance in Turkey

Table 3: Results of cointegration test

Hypothesized No. of CE(s)	Trace Statistic	0.05 Critical Value	Prob.	Max-Eigen Statistic	0.05 Critical Value	Prob.
r = 0	30.40608	25.87211	0.0127	24.66854	19.38704	0.0077
r <= 1	5.737537	12.51798	0.4943	5.737537	12.51798	0.4943

r: indicates the number of cointegrating vectors.

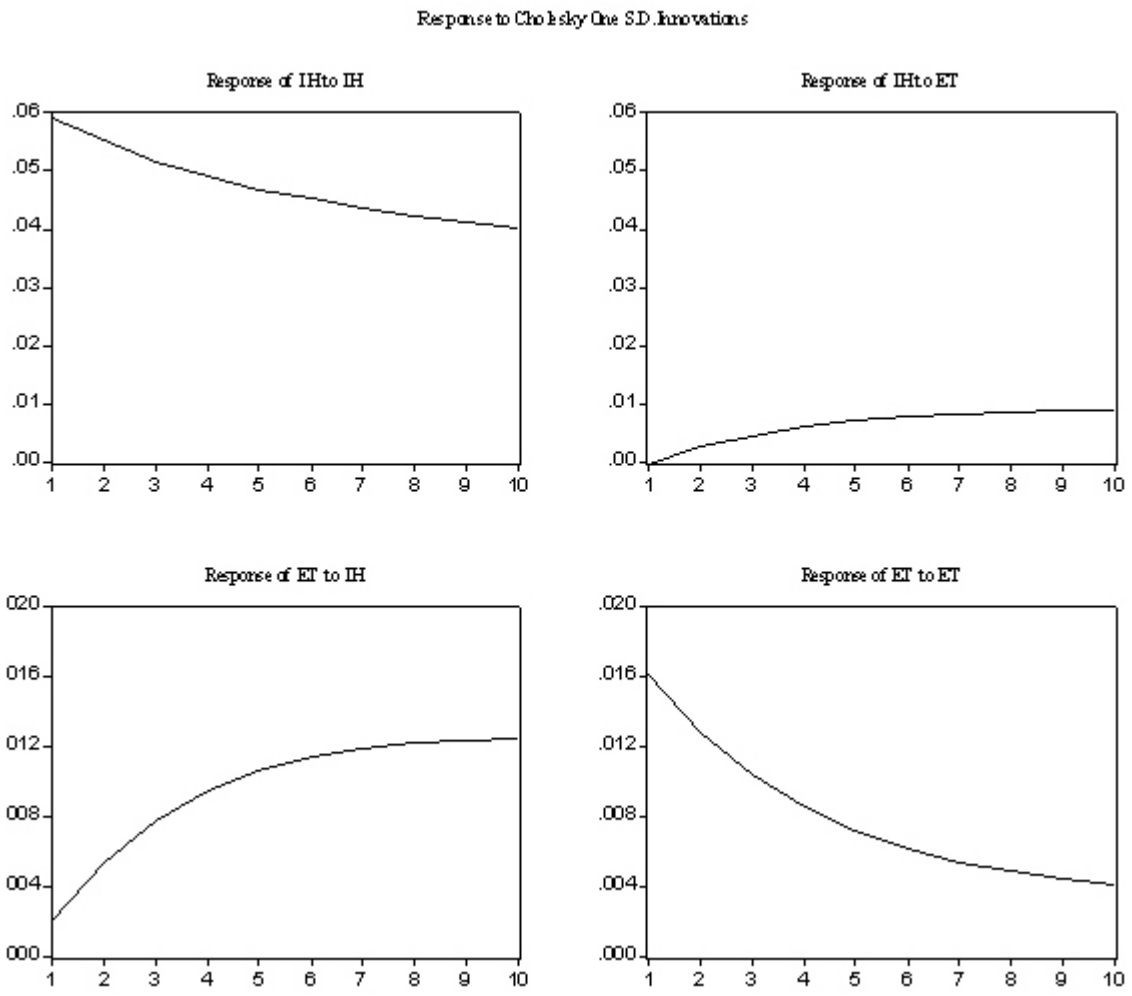

Fig. 7: Impulse-response functions

CONCLUSION

Energy is among today's priorities in economical and social development. This stituation can be explained with continual usage of energy as basic input during production process despite unbalanced distribution of the energy sources among the regions and limited reserves. Depending on population and industrialization energy consumption level will climb up and will maintain to be on the agenda. Energy consumption in Turkey has shown increase due to mentioned reasons. However, the most important thing to be questioned here is whether energy consumption contributed to economic development within the principles of effectivenes and productivity. In this study, too, the contribution of domestic energy consumption to exports, one of the basics of economic growth, is analyzed for Turkish economy using cointegration test, Granger causality test and impulse-response functions. In this context, firstly Augmented Dickey-Fuller and Phillips-Perron (PP) tests were used to test stationarity of the energy demand and exports series. According to this results it was seen that the variables include unit root at the original levels. In order to determine whether energy consumption and exports that were seen to be stationary at the first differences act together or not Johansen-Juselius cointegration test was used at the second step. The findings indicated that there is a long term relationship between this variables. Granger causality test and impulse-response functions showed that energy consumption makes a positive contribution to exports. This finding bears great importance in a country like Turkey which has current deficit that would cause economic crisis. Energy should be supplied to the production sectors to support exports in terms of foreign trade balance and economic growth. Therefore, energy prices should be kept lower with price and taxing policies. Since the foreign dependency in fossil fuel is quite high, investments on alternative energy production should be supported.

APPENDIX

VAR Lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	38.95753	NA	0.000340	-2.309846	-2.218237	-2.279480
1	134.5025	173.1752*	1.12e-06*	-8.031405*	-7.756580*	-7.940308*
2	135.4561	1.609237	1.36e-06	-7.841007	-7.382964	-7.689178
3	139.1972	5.845511	1.39e-06	-7.824827	-7.183568	-7.612268
4	143.5068	6.194956	1.39e-06	-7.844173	-7.019697	-7.570882
5	145.7651	2.964022	1.59e-06	-7.735317	-6.727623	-7.401295

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Results of estimation VAR model

	D(IH)	D(ET)
D(IH(-1))	0.923470	0.062765
	[9.43870]	[2.33328]
D(ET(-1))	0.172286	0.797018
	[4.59384]	[9.99196]
C	-0.213622	0.531360
	[-0.30699]	[2.77735]
R-squared	0.989894	0.993260
Adj. R-squared	0.989281	0.992852
F-statistic	52.21665	98.69999
Normality Tests	Skewness =0.755377 Kurtosis =1.342097 Jarque-Bera =2.097473	

t-statistics in [ ]

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