A Dynamic Approach to Demand for Energy in Turkey

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Abstract

This paper looks for the possible outcomes of the determinants of demand for electricity in Turkey. All variables are in per capita. Determinants are electricity production, price index of electricity and income, respectively. Electricity consumption is classified into residential and commercial electricity consumption and industrial electricity consumption. By employing Vector Error Correction Models (VECM) and impulse-responses for electricity consumptions, this paper results in a reduced form indicating that electricity consumption is affected by only electricity production in the long run for the annual period of 1954-2003.

Keywords: Electricity consumption, cointegration, VECM, generalized impulse-response
JEL classification codes: C51, C52, Q41, Q43, Q48

I. INTRODUCTION

This study examines the demand for electricity consumption using Turkish data, estimates the short run and long run parameters of the consumption. The consumption here analyzed in this study is assumed to be function of energy prices, income and electricity production. Production enters the consumption equation due to the fact that electricity is necessity with low substitution and consumption amount may just largely depend on the production. In the study, electricity consumption is used under two items; per capita Residential and Commercial Electric Power Consumption and per capita Industrial Electric Power Consumption. Explanatory variables are employed as per capita Production of Electric Power Plants, per capita deflated GDP and WPI for Energy. Study first employs VAR system and impulse response functions to track the dynamic affects of the determinants in the function on the consumption. Then cointegration analysis and equilibrium correction models (ECM) are run to estimate the short and long run parameters of the determinants. To this end, this study, first, searches the evidence from literature about the demand for energy done for some other countries, then, unit roots tests, and models vector auto regressions employing Turkish data. The data used in this work has been obtained from Turkish Statistical Institute (TURKSTAT). In the final section of this study, it is expected to achieve the information on the relative importance of prices, income and production on electricity consumption in Turkey.

II. LITERATURE EVIDENCE

Energy studies gained importance due to increasing demand but on the other hand scarcity of energy resources. In the literature there has been many works to understand the relationship between energy and the possible explanatory variables. Beenstock, Goldin and Nabot (1997) find no cointegration between energy consumption and price in Israel through Engle Granger Model, but find such long-run co movement in those variables by Johansen Cointegration Method.

Glassure and Lee (1997) compare the outputs of cointegrating and error correction model with the Engle Granger Model in analyzing the causality between energy consumption and GDP for South Korea and Singapore. The cointegrating and error correction model gives bidirectional causality between variables for both countries but Granger causality tests do not support this conclusion. Their conclusion is in favor vector error correction model.

Galindo (2005) searches short and long-run demand energy for industrial and residential sectors in Mexico and finds that there is long term relation between energy consumption and income and that in industrial sector there has been also such relation between consumption, income and relative prices.

Al-Faris (2001) concludes that both income and price have an impact on electricity consumption. He finds small elasticities of income and price in the short run due to majority of Golf people consider electricity as necessity good. In the long-run, however, he reaches larger elasticities.

Abdul Masih (1997) seeks the multivariate causality between income, energy consumption and price for Korea and Taiwan and finds that these employed variables in the system are jointly interactive in the considered causal chain.

Nasr, Badr and Dibeh (2000) employ an econometric model for electricity consumption in Post-war period of Lebanon. In the model, electricity consumption, total imports as proxy for income, and degree days are used. They reach the result that electrical energy consumption is demand driven rather than supply driven.

III. EMPRICAL ANALYSIS

In this section, I analyze the short-run and long-run dynamics of energy consumption for the Turkish Economy using annual data. The variables to be explained in this research are per capita Residential and Commercial Electric Power Consumption (PRESCOM) and per capita Industrial Electric Power Consumption (PINDO). Explanatory variables are chosen as per capita Production of Electric Power Plants (PPRD), per capita deflated GDP (PGDP) and natural log of WPI for Energy (LEPRC). Production enters the consumption equation due to the fact that electricity is necessity with low substitution and consumption amount may just largely depend on the production. On the basis of availability of data, Energy price index is from Wholesale Price index numbers for İstanbul. And therefore, the GDP with current prices is deflated by general index of Wholesale Price index numbers for İstanbul. The annual data covers the period of 1954 – 2003. The data is obtained from Turkish Statistical Institute (TURKSTAT). By using the data, this paper seeks to estimate the long run and short run parameters of electricity consumption and other variables if there exists a long run relationship among them. With this purpose, first impulse response analyses are conducted from an unrestricted stationary VAR system than cointegration, vector error correction tests are applied to variables. By exposing the results, it would be possible to understand the path of electricity consumption in Turkish Economy.

In time series analysis, it is required that either series be stationary or cointegrated. If the series are stationary, stochastic process of the data series is invariant with respect to time. When they are nonstationary, they exhibit trends in the mean and/or variance. Hence, regression results with nonstationary series would yield spurious results. Therefore, in analysis, stationary variables in levels or differences or cointegrated non-stationary variables in their levels can be employed. Although the variables of interest might be individually nonstationary, $I(1)$, as many macro variables do, one or more linear combinations of those might be stationary, $I(0)$. In presence of such linear combination(s), the variables are said to be cointegrated and therefore there exists a long-run relationship (equilibrium) among them (Granger, 1991). In literature, it is underlined that prerequisite for cointegration is to obtain

I(1) variables. Then, either naturally or due to this prerequisite, almost all cointegration applications refer to the *I*(1) series, hence a cointegration relation is denoted as *CI*(1,1). Before proceeding the analysis, it should be noted that the set of *I*(2) variables, on the other hand, might be candidates of cointegration relationship of order *CI*(2,1), so that there exist a linear combination that is *I*(1) (Enders, 1995:359-361; Jørgansen *et al.,* 1996).

Dickey Fuller/Augmented Dickey Fuller unit root test results of the variables are given in Table 1. All variables are found *I*(1) in their levels and *I*(0) in their differences, hence they are difference stationary. The next is to see whether there is linear combination between them through cointegration tests. I established two standard VAR systems. The first system, VAR(I), includes the endogenous variables of PRESCOM, PPRD, PGDP and LEPRC. The second system, VAR(II), consists of PINDO, PPRD, PGDP and LEPRC. In both systems, dummies of the prominent peaks of inflation of Turkish Economy are used. Besides the inflation peaks, dummies of D80, D94 and D01 represent in order, structural change in the economy through liberalization, financial crises; 5 April of 1994 and 22 February of 2001 in the data, respectively. In determining the lag numbers of the VAR systems, considering over-parameterization, the maximum lag number is chosen as 3. In lag order selection, Schwarz information criteria (SC), likelihood ratio (LR), final prediction error (FPE), Akaike information criteria (AIC) and Hannan-Quinn criteria (HQ) are used, together with the main concern of choosing the relatively smaller lag. In testing the Johansen's deterministic trend assumptions, the SC and AIC are observed.

III.1 Residential and Commercial Electricity Consumption

In VAR(I), the lag length is chosen as 2 by SC, HQ, FPE and LR whereas AI Criteria found 3 lags. I preferred SC and others rather than AIC to avoid over-parameterization problem. Some evidence from Monte Carlo studies also shows that SC dominates all other criteria named above in VAR process (Köse and Uçar, 1999). In the system, dummies of D80, D94 and D01 are found significant by LR test at 1% level. Chi square for D80, D94 and D01 are 21.333 with the probability of 0.000, 49.368 with the probability value of 0.000 and 149.420 with the probability of 0.000, respectively.

III.1a Impulse Response from Unrestricted Stationary VAR (1)

Impulse response functions reveal the dynamic response of each endogenous variable to a shock in the other variables in the system. This dynamic tracing enables us to observe the effect of a unit shock in one variable on current and future values of itself and another variable(s). Hence all variables in VAR system are all affected through one standard deviation shock occurred in innovations of any variable in the system. In impulse-response analysis, ordering the variables in VAR system is important and analysis is subject to change under different ordering, if we work with Choleski factorization. Then one should make decision on which variable behaves more exogenously, then that variable can come first (Doan, 1992: 8.14). One may follow this suggestion. I, however, use the generalized impulse responses that appear recently in the literature since this method does not impose a priori restrictions to the ordering of the variables (Pesaran and Shin, 1998; Ewing, 2003).

Figure1 exhibits the responses of PRESCOM to the impulse of PPRD. Figure 2 shows the responses of PRESCOM to the impulse of PGDP and Figure 3 gives the responses of PRESCOM to the impulse of LEPRC. By analyzing the impacts of PPRD, PGDP and LEPRC on PRESCOM, the expected affects occur. In other words to say, PPRD, PGDP have positive impacts on PRESCOM, whereas LEPRC has negative effect on PRESCOM at all periods. On the other hand, one can say that a unit positive innovation of PPRD has positive permanent affect on consumption and that of PGDP has positive but ignorable and tending to zero and that of LEPRC has negative permanent but seems to be slightly tending to zero mean in longer periods.

III.1b Cointegration and VECM

With VAR(1), after determining the optimal lag length, one needs to test the deterministic trend assumptions. By SC criteria, it is found that the series in VAR have quadratic trends but the cointegrating equations (CE) have linear trends. Then in a two variable system, the CE and Vector Error Correction (VEC) model which is a VAR including CE can be represented by Equations (1) and (2).

$$x_t = By_t + c_0 + c_1 t \tag{1}$$

$$\Delta x_t = \alpha_1 (x_{t-1} - By_{t-1} - c_0 - c_1 t) + \rho_1 (\lambda_0 + \lambda_1 t) + e_{1,t}$$

$$\Delta y_t = \alpha_2 (x_{t-1} - By_{t-1} - c_0 - c_1 t) + \rho_2 (\eta_0 + \eta_1 t) + e_{2,t} \tag{2}$$

Table 2 gives the result of unrestricted CE rank test and finds one rank (CE) by both Trace and Max-Eigenvalue statistics at both 5% and 1% levels.

Table 2: Cointegration Test

Hypothesized No. of CE(s)	*Eigenvalue*	*Trace Statistic*	*5 Percent Critical Value*	*1 Percent Critical Value*
None	0.671449	81.20918	54.64	61.24
At most 1	0.343004	27.78221	34.55	40.49
At most 2	0.127399	7.618467	18.17	23.46
At most 3	0.022192	1.077192	3.74	6.40

Hypothesized No. of CE(s)	*Eigenvalue*	*Max-Eigen Statistic*	*5 Percent Critical Value*	*1 Percent Critical Value*
None	0.671449	53.42696	30.33	35.68
At most 1	0.343004	20.16375	23.78	28.83
At most 2	0.127399	6.541275	16.87	21.47
At most 3	0.022192	1.077192	3.74	6.40

Table 3a has the result of normalized CE with respect to PRESCOM. The coefficients and corresponding standard errors and LR tests with *df* and probability values are given on the table.

Table 3a: Normalized CE Coefficient Tests ($B_{r,k}$ when $B_{1,1}$=1)

Variable	*Coefficient*	*Std.err.*	$\chi 2$	*df*	*Prob.*
PPRD	-0.550538	0.05815	13.533	1	0.000
PGDP	0.005665	0.00656	0.837	1	0.360
LEPRC	0.013704	0.00537	5.405	1	0.020

In CE, long-run coefficient of PRESCOM is found significant by chi-square of 8.890 and the null can be rejected %1 level. The long-run coefficients of PPRD and LEPRC are also found significant by *t* and LR statistics at %1 level. As for the coefficient of PGDP, it is not found significant by both *t* and LR statistics values. Table 3b gives the result of adjustment coefficients. Except the ΔPRESCOM, all coefficients are statistically insignificant at %10, %5 and %1 levels. The coefficient of ΔPRESCOM, α_{11}, is found to be significant at %1 level.

Table 3b: The Speed of Adjustment Coefficients ($\alpha_{k,r}$)

Variable	*Coefficient*	*Std.err.*	$\chi 2$	*df*	*Prob.*
ΔPRESCOM	-2.298111	0.03682	31.244	1	0.000
ΔPPRD	-0.051389	0.16853	0.102	1	0.748
ΔPGDP	-0.152102	2.69901	0.003	1	0.950
ΔLEPRC	-0.919892	1.08845	0.669	1	0.413

Upon these results, one runs a new restricted CE analysis. Table 4 provides the new **B** coefficients when the restriction of $B_{13} = \alpha_{21} = \alpha_{31} = \alpha_{41} = 0$ is applied. LR test of this restriction gave a chi-square of 2.048 with the prob. value of 0.726. Then restriction is not rejected at %1 level. In Table 4, the coefficients of PPRD and LEPRC are given. The *t* stats of PPRD and LEPRC are -12.145 and 2.391, respectively. The LR stats for PPRD and LEPRC are 18.353 and 7.700, respectively. In Table 5, by excluding LEPRC, the new results indicate that, in CE, only per capita electricity production, PPRD, is significant in determining the long run value of the per capita electricity consumption, PRESCOM. Equation (3) gives VECM of PRESCOM.

Table 4: Restricted CE Coefficients ($B_{r,k}$)Tests

$B_{r,k}$	*Coefficient*	*Std.err.*	$\chi 2$	*df*	*Prob.*
B_{12}	-0.549552	0.04525	18.353	5	0.002
B_{14}	0.012845	0.00537	7.700	5	0.173

Table 5: Final Restricted CE Coefficients ($B_{r,k}$)Tests

$B_{r,k}$	*Coefficient*	*Std.err.*	$\chi 2$	*df*	*Prob.*
B_{12}	-0.476566	0.01981	18.394	6	0.005

$$\begin{aligned}\Delta(\text{PRESCOM}) = &- 0.203735[\text{PRESCOM}(-1) - 0.476566\ \text{PPRD}(-1) \\ &+ 0.008769\ \text{TREND} - 0.051936] \\ &- 0.215749\ \Delta(\text{PRESCOM}(-1)) + 0.063805\ \Delta(\text{PPRD}(-1)) \\ &+ 0.006921\ \Delta(\text{PGDP}(-1)) - 0.005788\ \Delta(\text{LEPRC}(-1)) \\ &- 0.009249 + 0.000859\ \text{TREND} \\ &+ 0.005242\ \text{D80} - 0.025856\ \text{D94} - 0.048104\ \text{D01} \qquad (3)\end{aligned}$$

The coefficients of α_{11}, PPRD(-1), Δ(PRESCOM(-1)), Δ(PGDP(-1)), constant, TREND, D94 and D01 are found significant by t statistics, but other coefficients are found insignificant.

Final CE model has no autocorrelation with the Q stat of 167.877 (prob. = 0.3190) at 12 degrees of freedom. The model does not suffer from ARCH. The chi-square result is 197.924 (prob. = 0.331). As for normality tests, PRESCOM, PPRD and LEPRC's residuals are normally distributed at %1 and %5 levels. On the other hand, PGDP does not experience normality even at %10 level of significance.

III.2 Industrial Electricity Consumption

In VAR(2), the lag length is chosen as 1 by SC, and 2 by AIC, FPE, LR and HQ. For the same reason as it was mentioned, in VAR2 the SC criteria are considered having better statistical properties than other statistics obtained from the Monte Carlo evidence (Köse and Uçar, 1999). In the system, dummies of D80, D94 and D01 are found significant by LR test at 1% level. Chi square for D80, D94 and D01 are 23.122 with the probability of 0.000, 44.359 with the probability value of 0.000 and 110.488 with the probability of 0.000, respectively.

III.2a Impulse Response from Unrestricted Stationary VAR (II)

Figure 4 shows the responses of PINDO to the impulse of PPRD. Figure 5 yields the responses of PINDO to the impulse of PGDP and Figure 6 has the responses of PINDO to the impulse of LEPRC. Considering the VAR (II), one can reach that PPRD, PGDP have expected signs in the consumption equation. As for LEPRC, it has negative impact for 4 periods and then positive effect on industrial electricity consumption at all other periods. It might be concluded that a unit positive shock of PPRD has positive permanent affect on consumption and that PGDP has positive permanent but tending to decrease impact and that LEPRC has initially negative but later after four years has permanent positive effect on the consumption.

III.2b Cointegration and VECM

By SC criteria, it is found that the series in VAR have no deterministic trends and the cointegrating equations (CE) do not have intercepts. Then in a two variable system, the CE and Vector Error Correction (VEC) model can be given by Equations (4) and (5).

$$x_t = By_t \tag{4}$$

$$\Delta x_t = \alpha_1 (x_{t-1} - By_{t-1}) + e_{1,t}$$

$$\Delta y_t = \alpha_2 (x_{t-1} - By_{t-1}) + e_{2,t} \tag{5}$$

Table 6 gives the result of unrestricted CE rank test and finds one rank (CE) by both Trace and Max-Eigenvalue statistics at both 5% and 1% levels. Table 7a has the result of normalized CE with respect to PINDO. The coefficients and corresponding standard errors and LR tests with *df* and probability values are given on the table. In CE, long-run coefficient of PINDO is found significant by chi-square of 11.048 (prob.=0.000). The coefficient of

PPRD is also found significant by LR statistic at %5 level. The coefficients of PGDP and LEPRC are, however, are not found significant by both *t* and LR statistics values. Table 7b gives adjustment coefficients. All coefficients are statistically significant at %1 level.

Table 6: Cointegration Test

Hypothesized No. of CE(s)	*Eigenvalue*	*Trace Statistic*	*5 Percent Critical Value*	*1 Percent Critical Value*
None	0.946430	158.1288	39.89	45.58
At most 1	0.147694	14.71747	24.31	29.75
At most 2	0.097602	6.886819	12.53	16.31
At most 3	0.037140	1.854540	3.84	6.51

Hypothesized No. of CE(s)	*Eigenvalue*	*Max-Eigen Statistic*	*5 Percent Critical Value*	*1 Percent Critical Value*
None	0.946430	143.4114	23.80	28.82
At most 1	0.147694	7.830650	17.89	22.99
At most 2	0.097602	5.032279	11.44	15.69
At most 3	0.037140	1.854540	3.84	6.51

Table 7a: Normalized CE Coefficient Tests ($B_{r,k}$ when $B_{1,1}$=1)

Variable	*Coefficient*	*Std.err.*	*$\chi 2$*	*df*	*Prob.*
PPRD	-0.222211	0.05223	4.632	1	0.031
PGDP	0.006547	0.01280	0.199	1	0.654
LEPRC	-0.000781	0.00820	0.007	1	0.925

Table 7b: The Speed of Adjustment Coefficients ($\alpha_{k,r}$)

Variable	*Coefficient*	*Std.err.*	*$\chi 2$*	*df*	*Prob.*
ΔPINDO	0.081308	0.00861	53.010	1	0.000
ΔPPRD	0.186973	0.01068	98.322	1	0.000
ΔPGDP	1.170885	0.17241	34.344	1	0.000
ΔLEPRC	1.169019	0.07434	89.953	1	0.000

With these results, new restricted CE is obtained. Table 8 provides the new **B** coefficients when the restriction of $B_{13}=B_{14}=0$ is applied. LR test of this restriction gave a chi-square of 0.298 with the prob. value of 0.861. Restriction is not rejected at %10, %5 and %1 levels. In Table 8, the coefficient of PPRD is given. The *t* statistics of PPRD is -20.432. The LR value for PPRD is 6.334 (prob. = 0.096). The null is rejected only at %10 level according to LR. The t value is, however, great enough to reject the null that B_{12} is zero. As is in the case of residential and commercial consumption, the final results indicate that in CE, only per capita electricity production, PPRD, is significant in explaining the long run parameter of the per capita industrial electricity consumption. Equation (6) gives VECM of PINDO. VECM coefficients, except D80 are found significant.

Table 8: Final CE Coefficient Tests ($B_{r,k}$ when $B_{1,1}$=1)

$B_{r,k}$	*Coefficient*	*Std.err.*	*$\chi 2$*	*df*	*Prob.*
B_{12}	-0.216824	0.01061	6.334	3	0.096

$$\Delta(\text{PINDO}) = 0.090615[\text{PINDO}(-1) -0.216824\ \text{PPRD}(-1)] -0.012718\ \text{D80} - 0.0047945\ \text{D94} - 0.082744\ \text{D01} \quad (6)$$

IV. Summary and Conclusion

This paper investigates the electricity consumption of residential and commercial consumption of industrial sector electricity in the Turkish economy. It analyzes the short-run and long-run dynamics of energy consumption using annual data of 1954 – 2003. The variables are per capita Residential and Commercial Electric Power Consumption (PRESCOM) and per capita Industrial Electric Power Consumption (PINDO). Explanatory variables are chosen as per capita Production of Electric Power Plants (PPRD), per capita deflated GDP (PGDP) and natural log of WPI for Energy (LEPRC). The data is obtained from Turkish Statistical Institute (TURKSTAT). By using the data, this paper aims at estimating the long run and short run parameters of electricity consumption and other variables if there is a long run relationship among them. Through this purpose, first impulse response analyses are conducted from an unrestricted stationary VAR system, then, cointegration (CE), vector error correction (VECM) tests are applied to variables. Result is that in cointegration equation (CE) analysis using VAR (I), only per capita electricity production, PPRD, is significant in determining the long run value of the per capita electricity consumption, PRESCOM. In VAR(II) analysis in which industrial sector's consumption is considered, it is found that in CE, and VECM results, only per capita electricity production, PPRD, is significant in explaining the long run parameter of the per capita industrial electricity consumption. One may conclude that electricity consumption is supply driven rather than demand driven as just opposed to one in the literature by Nasr, Badr and Dibeh (2000).

Table:1.1 **DF/ADF tests for PRESCOM**		DF/ADF	Lag(L)	Q prob.	5% critical value
1	$\Delta X_t = \alpha X_{t-1} + u_t$	9.430	0	0.359(12)	-1.947
2	$\Delta X_t = a + \alpha X_{t-1} + u_t$	5.943	0	0.516(12)	-2.921
3	$\Delta X_t = a + bt + \alpha X_{t-1} + u_t$	1.036	0	0.609(12)	-3.502

Table:1.2 **DF/ADF tests for DPRESCOM**		DF/ADF	Lag(L)	Q prob.	5% critical value
1	$\Delta X_t = \alpha X_{t-1} + u_t$	-1.903(*)	0	0.420(12)	-1.947
2	$\Delta X_t = a + \alpha X_{t-1} + u_t$	-3.026	0	0.504(12)	-2.922
3	$\Delta X_t = a + bt + \alpha X_{t-1} + u_t$	-4.967	0	0.844(12)	-3.504

(*) hypothesis of unit root is rejected at %10 level of -1.619

Table:1.3 **DF/ADF tests for PINDO**		DF/ADF	Lag(L)	Q prob.	5% critical value
1	$\Delta X_t = \alpha X_{t-1} + u_t$	6.181	0	0.260(12)	-1.947
2	$\Delta X_t = a + \alpha X_{t-1} + u_t$	2.306	0	0.134(12)	-2.921
3	$\Delta X_t = a + bt + \alpha X_{t-1} + u_t$	-1.728	0	0.109(12)	-3.502

Table:1.4 **DF/ADF tests for DPINDO**		DF/ADF	lag(L)	Q prob.	5% critical value
1	$\Delta X_t = \alpha X_{t-1} + u_t$	-2.052	0	0.106(12)	-1.947
2	$\Delta X_t = a + \alpha X_{t-1} + u_t$	-7.189	0	0.333(12)	-2.922
3	$\Delta X_t = a + bt + \alpha X_{t-1} + u_t$	-8.394	0	0.365(12)	-3.504

Table:1.5 **DF/ADF tests for PPRD**		DF/ADF	Lag(L)	Q prob.	5% critical value
1	$\Delta X_t = \alpha X_{t-1} + u_t$	9.959	0	0.599(12)	-1.947
2	$\Delta X_t = a + \alpha X_{t-1} + u_t$	5.251	0	0.730(12)	-2.921
3	$\Delta X_t = a + bt + \alpha X_{t-1} + u_t$	-0.212	0	0.729(12)	-3.502

Table:1.6 **DF/ADF tests for DPPRD**		DF/ADF	lag(L)	Q prob.	5% critical value
1	$\Delta X_t = \alpha X_{t-1} + u_t$	-1.997	0	0.155(12)	-1.947
2	$\Delta X_t = a + \alpha X_{t-1} + u_t$	-3.664	0	0.334(12)	-2.922
3	$\Delta X_t = a + bt + \alpha X_{t-1} + u_t$	-5.774	0	0.746(12)	-3.504

Table:1.7 DF/ADF tests for PGDP		DF/ADF	Lag(L)	Q prob.	5% critical value
1	$\Delta X_t = \alpha X_{t-1} + u_t$	2.552	0	0.271(12)	-1.947
2	$\Delta X_t = a + \alpha X_{t-1} + u_t$	0.229	0	0.289(12)	-2.921
3	$\Delta X_t = a + bt + \alpha X_{t-1} + u_t$	-2.457(*)	0	0.407(12)	-3.502

(*) not significant event at %10 level of -3.180

Table:1.8 DF/ADF tests for DPGDP		DF/ADF	Lag(L)	Q prob.	5% critical value
1	$\Delta X_t = \alpha X_{t-1} + u_t$	-6.695	0	0.285(12)	-1.947
2	$\Delta X_t = a + \alpha X_{t-1} + u_t$	-7.839	0	0.450(12)	-2.922
3	$\Delta X_t = a + bt + \alpha X_{t-1} + u_t$	-7.879	0	0.359(12)	-3.504

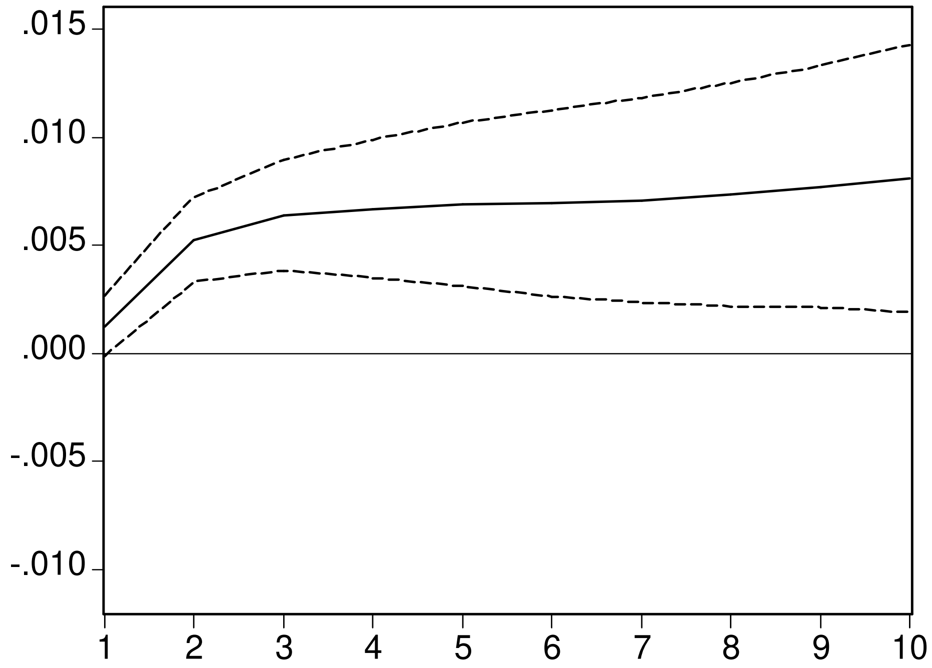
Table:1.9 DF/ADF tests for LEPRC		DF/ADF	lag(L)	Q prob.	5% critical value
1	$\Delta X_t = \alpha X_{t-1} + u_t$	12.101	0	0.130(12)	-1.947
2	$\Delta X_t = a + \alpha X_{t-1} + u_t$	5.368	0	0.124(12)	-2.921
3	$\Delta X_t = a + bt + \alpha X_{t-1} + u_t$	-1.437	0	0.972(12)	-3.502

Table:1.10 DF/ADF tests for DLEPRC		DF/ADF	Lag(L)	Q prob.	5% critical value
1	$\Delta X_t = \alpha X_{t-1} + u_t$	-1.524	0	0.857(12)	-1.947
2	$\Delta X_t = a + \alpha X_{t-1} + u_t$	-2.621(*)	0	0.974(12)	-2.922
3	$\Delta X_t = a + bt + \alpha X_{t-1} + u_t$	-3.249(**)	0	0.972(12)	-3.504

(*) hypothesis of unit root is rejected at %10 level of -2.599(**) hypothesis of unit root is rejected at %10 level of -3.181

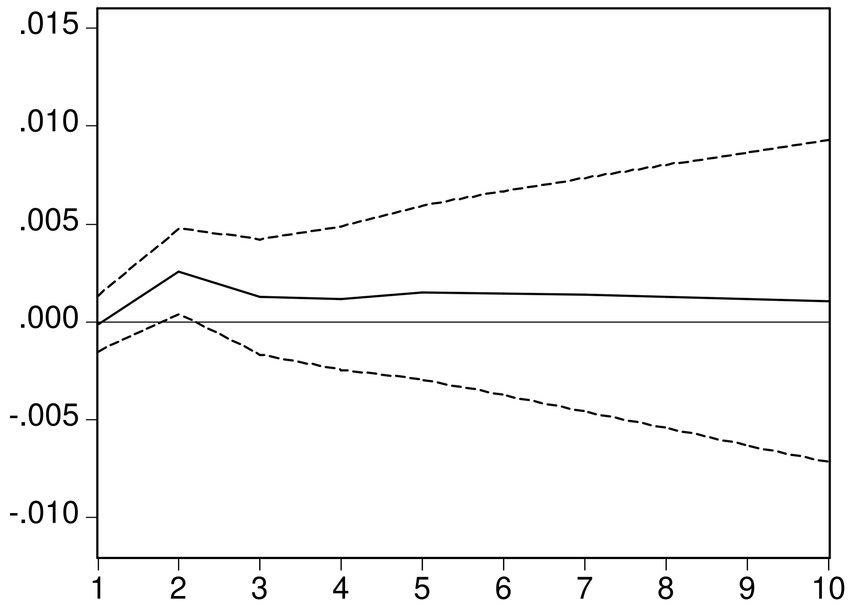
Response to Generalized One S.D. Innovations ± 2 S.E.

Figure 1: Response of PRESCOM to PPRD



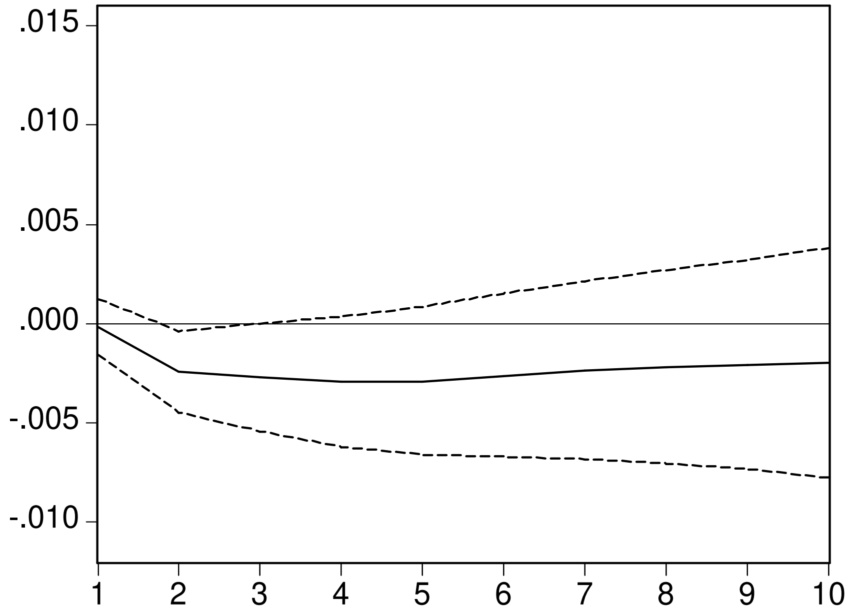
Response to Generalized One S.D. Innovations ± 2 S.E.

Figure 2: Response of PRESCOM to PGDP



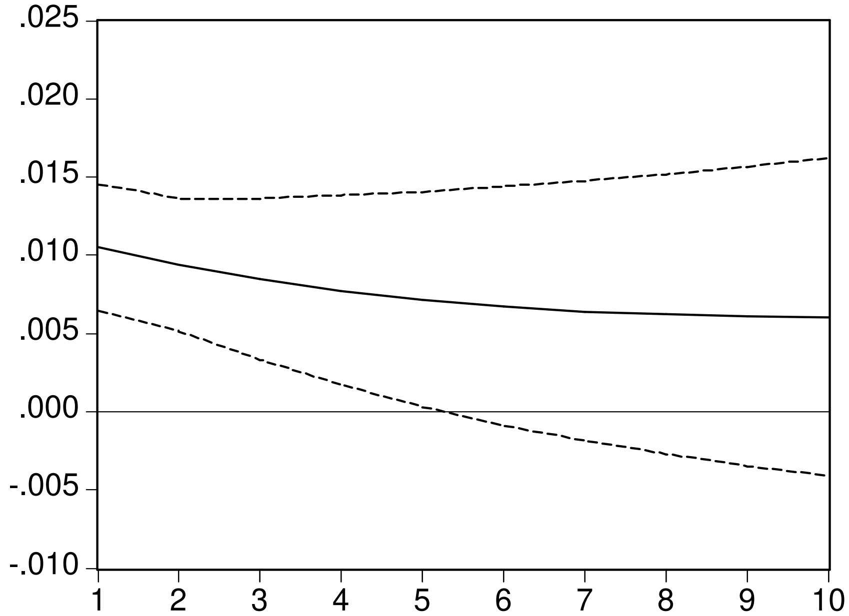
Response to Generalized One S.D. Innovations ± 2 S.E.

Figure 3: Response of PRESCOM to LEPRC



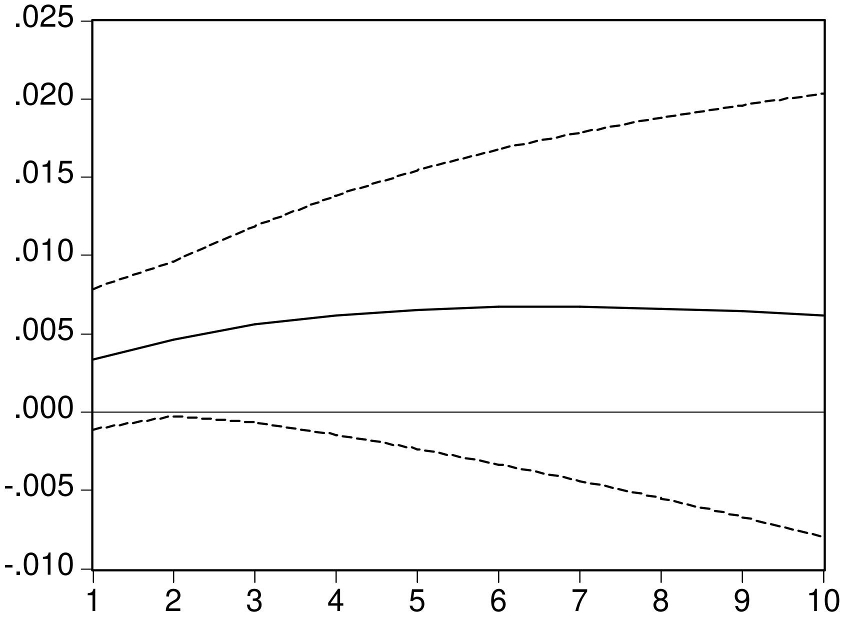
Response to Generalized One S.D. Innovations ± 2 S.E.

Figure 4: Response of PINDO to PPRD



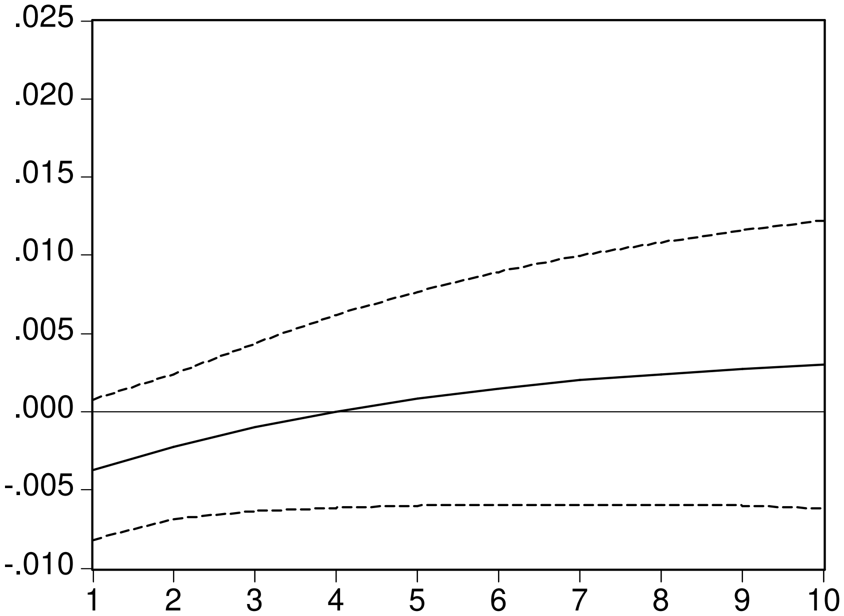
Response to Generalized One S.D. Innovations ± 2 S.E.

Figure 5: Response of PINDO to PGDP



Response to Generalized One S.D. Innovations ± 2 S.E.

Figure 6: Response of PINDO to LEPRC



References

Al Faris Abdul Razak F., 2002. The demand for electricity in the GCC countries, ***Energy Policy****, Volume 30, Issue 2, January, 117-124.*

Beenstock Michael, Ephraim Goldin, Dan Nabot, 1999. The demand for electricity in Israel, ***Energy Economics****, Volume 21, Issue 2, April, 168-183.*

Cardona E., A. Piacentino**,** 2006. A new approach to exergoeconomic analysis and design of variable demand energy systems**,** ***Energy****, Volume 31, Issue 4, March, 490-515.*

Christenson M., H. Manz, D. Gyalistras, 2006. Climate warming impact on degree-days and building energy demand in Switzerland, ***Energy Conversion and Management****, Volume 47, Issue 6, April, 671-686.*

Ediger Volkan Ş., Ozkan Huvaz, 2006. Examining the sectoral energy use in Turkish economy (1980–2000) with the help of decomposition analysis, ***Energy Conversion and Management****, Volume 47, Issue 6, April, 732-745.*

Enders Walter, 1995. ***Applied Econometric Time Series****, John Wiley & Sons, Inc., Canada.*

Ewing, Bradley T., 2003. The response of the default risk premium to macroeconomic shocks, ***The Quarterly Review of Economics and Finance***, *Elsevier, Volume 43(2), 261-272.*

Galindo Luis Miguel, 2005. Short- and long-run demand for energy in Mexico: a cointegration approach**,** ***Energy Policy****, Volume 33, Issue 9, June, 1179-1185.*

Jorgensen Clara, Hans C. Kongsted, Anders Rahbek, 1996. Trend-stationarity in the I(2) cointegration model, ***Institute of Economics, University of Copenhagen***, *Vol. 26.*

Köse Nezir, Nuri Uçar, 1999. Durağan vektör otoregresif süreçlerde gecikme uzunluğunu belirleyen kriterlerin karşılaştırılması: Hata terimleri arasındaki çapraz korelasyon derecesi ve parametre matrisi özdeğerlerinin sıfıra yakınlığının etkileri, ***IV. Ulusal Ekonometri ve İstatistik Sempozyumu Bildirileri****, Antalya, 619-632.*

Masih Abul M. M., Rumi Masih, 1997. On the temporal causal relationship between energy consumption, real income, and prices: Some new evidence from Asian-energy dependent NICs based on a multivariate cointegration/vector error-correction approach**,** ***Journal of Policy Modeling****, Volume 19, Issue 4, August, 417-440.*

Masih Abul M. M., Rumi Masih**,** 1996. Energy consumption, real income and temporal causality: results from a multi-country study based on cointegration and error-correction modelling techniques, ***Energy Economics****, Volume 18, Issue 3, July, 165-183.*

Masih Rumi, Abul M. M. Masih, 1996. Stock-Watson dynamic OLS (DOLS) and error-correction modelling approaches to estimating long- and short-run elasticities in a demand function: new evidence and methodological implications from an application to the demand for coal in mainland China, ***Energy Economics****, Volume 18, Issue 4, October, 315-334.*

Nasr G.E., E. A. Badr, G. Dibeh, 2000. Econometric modeling of electricity consumption in post-war Lebanon**,** ***Energy Economics****, Volume 22, Issue 6, December, 627-640.*

Pesaran, M. Hashem, Y. Shin, 1998. Generalized impulse response analysis in linear multivariate models, ***Economic Letters****, Volume 58, January, 17-29.*

Sayın Cengiz, M. Nisa Mencet, Burhan Ozkan, 2005. Assessing of energy policies based on Turkish agriculture: Current status and some implications, ***Energy Policy****, Volume 33, Issue 18, December, 2361-2373.*

Simpson R., C. Cortés, A. Teixeira, 2006. Energy consumption in batch thermal processing: model development and validation, ***Journal of Food Engineering****, Volume 73, Issue 3, April, 217-224.*

Tunç Murat, Ünal Çamdali, Cem Parmaksizoğlu**,** 2006. Comparison of Turkey's electrical energy consumption and production with some European countries and optimization of future electrical power supply investments in Turkey, ***Energy Policy****, Volume 34, Issue 1, January, 50-59.*

Ueno Tsuyoshi, Fuminori Sano, Osamu Saeki, Kiichiro Tsuji**,** 2006. Effectiveness of an energy-consumption information system on energy savings in residential houses based on monitored data, ***Applied Energy****, Volume 83, Issue 2, February, 166-183.*