The Relationship between Energy Consumption and Economic Growth: Turkey Case

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Abstract

This study investigates the relationship between energy consumption and economic growth. Especially energy resources must crucial input for developing countries. Also energy resources are not balanced distribution around the countries. The direction of causation of this relationship is controversial. Because, the energy consumption affect the economic growth but also economic growth leads to the energy consumption. Empiricallythis paper tries to find the direction of causality between energy consumption and economic growth for Turkey. For the empirical analysis is used to be co-integration analysis.

Key words: economic growth, Turkey, energy consumption.

Review of Literatures

Empirically some papers have been investigated direction causality between energy consumption and economic growth in the literature. So thesepapers' results are mixed. For example, Kraft's (1978) found that unidirectional causality from growth to energy consumption for USA. Yet, Yu, et. (1988), found no relationship between growth and energy consumption in case of USA. Yu and Chai, (1985), also found causality from energy consumption to economic growth. For Taiwan was found bi-directional causality between energy and growth (Aqeel and Butt, 2001, 202).

MucukandUysal (2009), in Turkey,the causal relationship betweenenergyconsumption and economic growthexaminedusingco-integrationand Grangercausality tests. In their study,the results obtainedwithstationaryseriesare co-integratedin the long termsothat they move togetherfound.

Akan,Doğan andIşık(2010),studiesof economic growthand energyconsumption variablesare examinedfor the period1970-2007. As a result ofresearchin Turkeybetweeneconomic growth andenergy consumptionhave revealedthata two-waycausal relationship.

Alptekin and Güvenek(2010),studiesthe causalrelationshipbetween economic growth andthe finalenergy consumptionfor25OECD member countrieshas beenestimated usingPanelDataAnalysis. The result of analysisofenergy consumption andeconomic growthin these countriesis a remarkablerelationship between variables.

KerimoğluandYanar(2011), examined to the between Turkey's energyconsumption, economic growth and the current account deficitwith usingthe co-integrationtest. As a result ofanalysis, increase inenergy consumptionaffects thehigh rate ofGDP. Alsoin this study was found bi-directional causality growthand current account deficitbut correlation was weak.

Yapraklı andYurttançıkmaz(2012), studiesin Turkeyfor the period1970-2010, the relationship between total electricity consumption and economicgrowth have been analyzed with theco-integration and errorcorrectiontest. As a result ofanalysis,bi-directional causalitybetweenelectricity consumption and economicgrowthhas been concluded.

Turkey's Energy Profile and Strategy

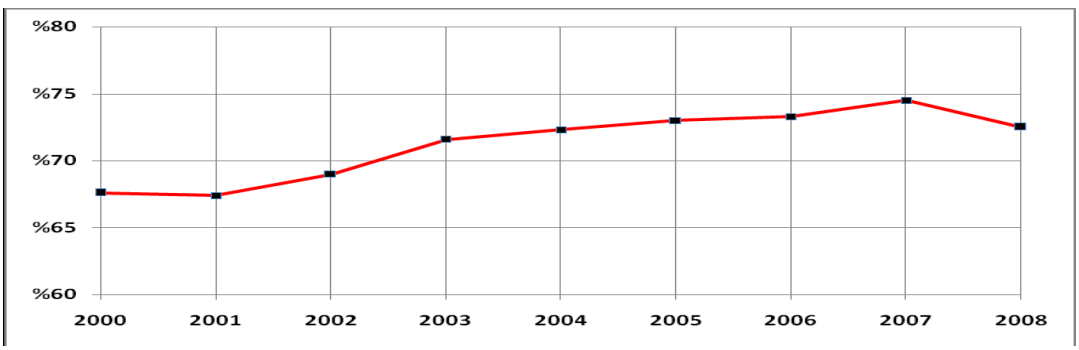
Turkey is a developing country so energy needs to be increases. The relative insufficiency of the domestic resources of our country especially in terms of oil and natural gas in proportion to the rising energy demand in our country brings about the importation of oil and natural gas. In the year 2008 the total primary energy consumption of our country has been 106,3 million Ton Equivalent Petroleum (TEP), and its production has been 29,2 million TEP (EB, 2010:12).

Table 1 Energy Supply and Demand of Turkey (2008) (Keskin, 2010: 14)

Resources	*Coal*	*Oil*	*Natural Gas*	*Wood, Waste*	*Hydro*	*Wind*	*Geothermat*	*Sun*	*Total (TEP)*
Primary Energy Demand (000 Tep)	31.391	31.784	33.807	4.814	2.861	73	1.011	420	**106.273**
Share of Total Demand (%)	29.5	29.9	31.8	4.5	2.7	0.1	1.0	0.4	-
Primary Energy Supply (000 Tep)	16.674	2.268	1014	4.814	2.861	73	1.011	420	**29.192**
Share of Total Supply (%)	57.1	7.8	3.2	16.5	9.8	0.2	3.5	1.4	-
Ratio of production to demand (%)	**53.1**	**7.1**	**2.8**		**100.0**	**100.0**	**100.0**	**100.0**	**27.5**

In the year 2008 the total primary energy consumption of our country has been 106,2 million Ton Equivalent Petroleum (TEP), and its production has been 29,1 million TEP. The relative insufficiency of the domestic resources of our country especially in terms of oil and natural gas in proportion to the rising energy demand in our country brings about the importation of oil and natural gas. Currently, Total energy dependence of our country is 73 pct. Oil and natural gas dependence are higher, 90 % and 98 % respectively. In this context, great importance is given to the improvement of the diversification of resources, technologies and infrastructure (EB, 2010:13).

Graph 1 Rate of Foreign Dependence 2000-2008 (%) (EB, 2010: 13)

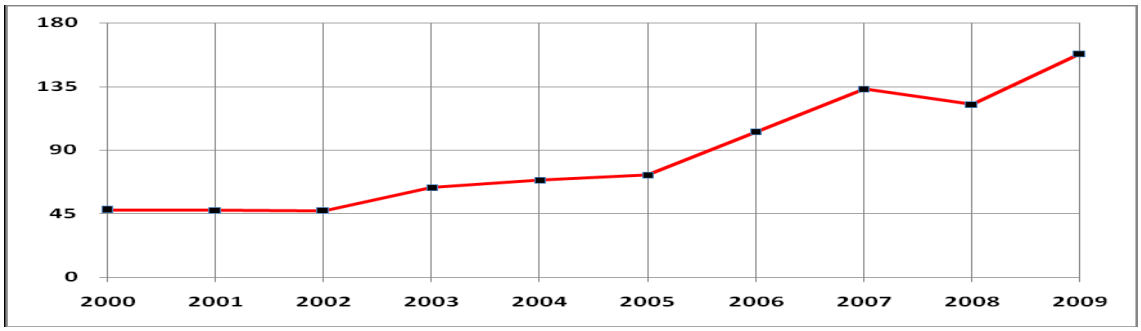


As Turkey, EU-27 dependency on energy imports increased to reach 54.1 % by 2010. The highest energy dependency rates in 2010 were recorded for crude oil (85.2 %) and for natural gas (62.4 %) (Eurostat, 2013).

The energy supply security, which sets the basis for the debates on the energy sector both across the world and for Turkey. Within the context of the energy supply security of Turkey, in recent years, the legal and technical studies have been intensified for the purpose of restructuring our energy market with a market understanding that is based on competition and transparent, detecting and using our domestic and renewable resources potential, integrating the nuclear energy into the electricity production, and utilizing the new energy technologies. For this reason, the oil and natural gas exploration operations both at home and abroad have been intensified in the recent years(EB, 2010;12).

With the moves of investment in the exploration works both at home and abroad that have been accelerated in 2003, the exploration and drilling operations have been improved. In line with the changing exploration strategy and the rising exploration investments, the exploration works at home in the land as well as the hydrocarbon explorations in the seas abroad are given much importance. In line with this strategy, especially in the Black Sea, from 2004 to 2009, an intensive seismic program was implemented in our waters and the studies will be sustained increasingly. The graphics on the oil and natural gas drilling amounts conducted in the period from 2000 to 2009 are given below (EB, 2010: 13).

Graph 2Oil and Natural Gas Drilling Total Amount 2000-2009 (1,000 meters) (EB, 2010: 14)

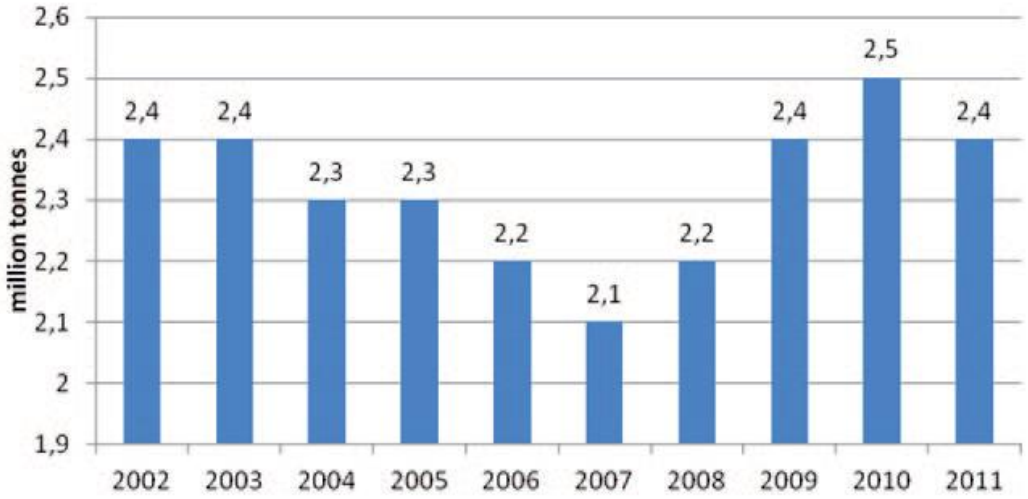


In 2011, As a result of oil and natural gas drilling, in total 201 wells being as 101 exploration wells, 35 appraisal wells, 60 production wells and 5 natural gas storage wells were drilled. So 2.4 million tonnes of oil and 793 million m³ natural gas was produced in 2011 and totally 137.9 million tonnes of oil and 12.8 billion m³ natural gas were produced by now (TP, 2011:26).

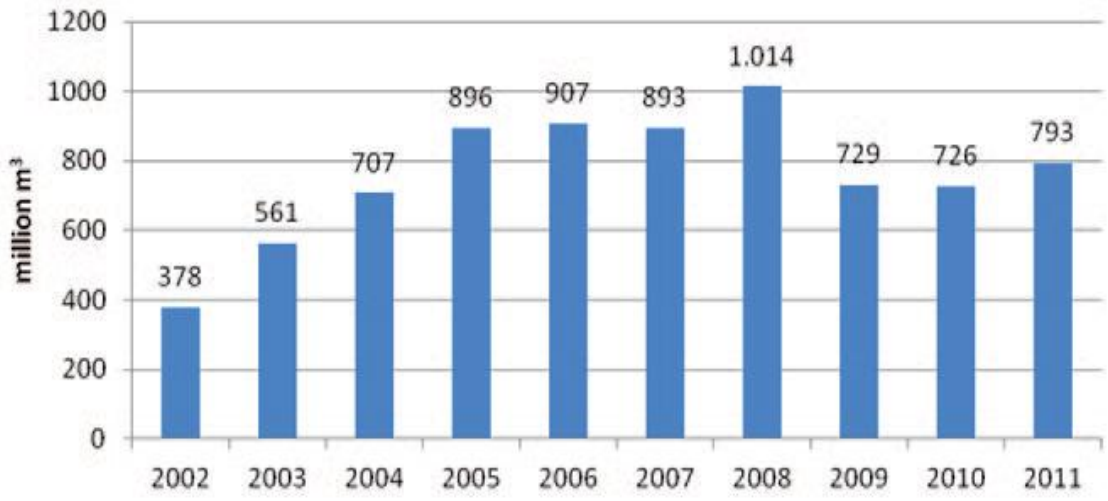
Furthermore, through new production wells drilled in old fields and new natural gas explorations conducted and partnerships in Thrace since 2002; gas production that declined in 2001 started to increase again and reached its peak level in 2008 with production rate of 1,014 million m^3. In 2011 natural gas production recorded as 793 million m^3(TP, 2011:26).

By the year 2011, recoverable oil reserve reached 310.4 million barrels (45.43 million tonnes) and in case of no new exploration; estimated R/P ratio of domestic crude oil is 19.2 years with the current production level. Also, domestic natural gas reserves were 7.17 billion m^3. In case of no new discovery and with the current production level, estimated R/P ratio of domestic natural gas reserves is 9 years (TP, 2011:26).

Graph 3 Crude Oil Productions in Turkey (2002-1012) (TP, 2011:28)



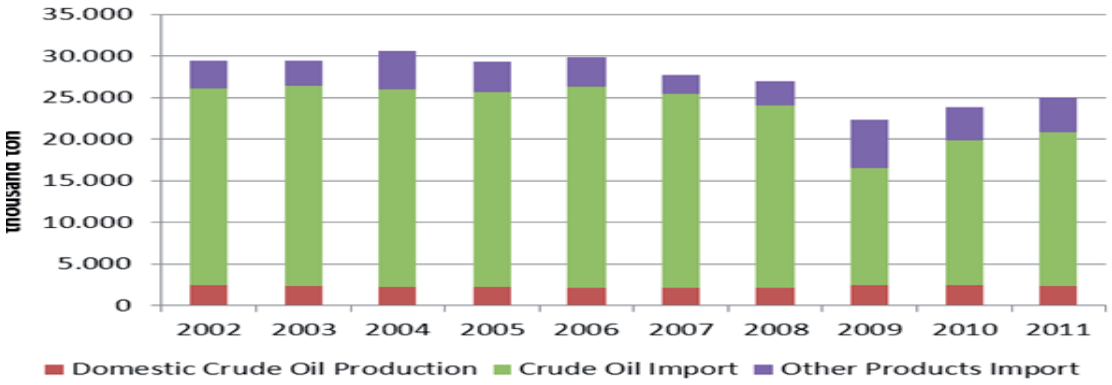
Graph 4 Natural Gas Productions in Turkey (2002-2012) (TP, 2011:28)



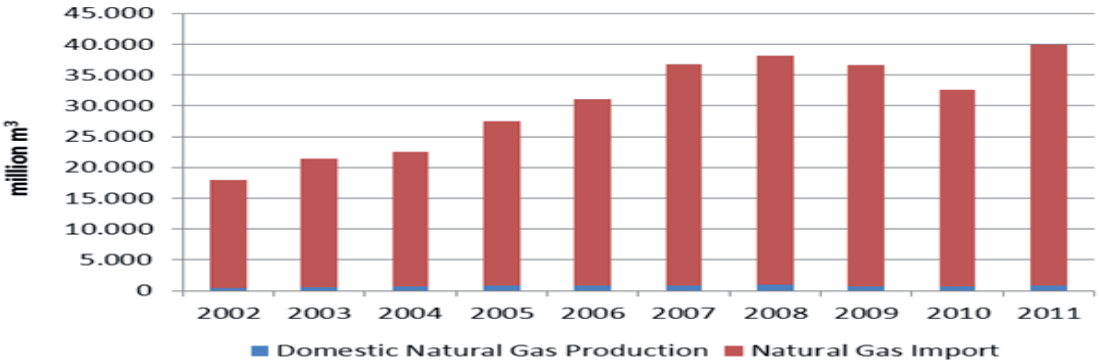
In the last decade, crude oil supply of Turkey has decreased by 15%, whereas natural gas supply has increased by 121%. But, 9.5% of crude oil demand and 2% of natural gas demand have been met by local supply in 2011(TP, 2011:28).

The exploration and drilling operations have been improved by the years, production of primary energy very less. Especially, there are very high foreign dependence on oil and natural gas for Turkey.

Graph 5 Crude Oil Supply in Turkey (2002-2011) (TP, 2011:30)

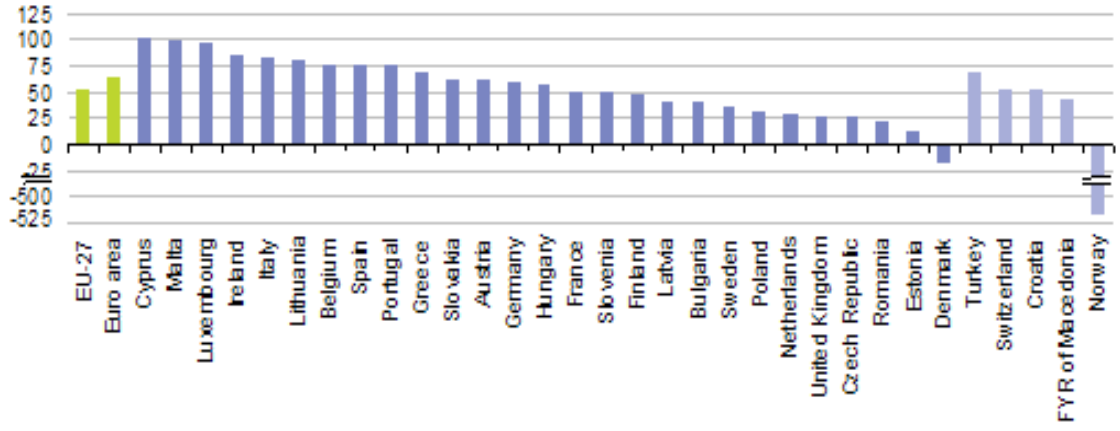


Graph 6 Natural Gas Supply in Turkey (2002-2011)



Graph 7 shows us dependence of energy ratio of EU27. EU-27's net imports of energy have been greater than its primary production; in other words, more than half of the EU-27's gross inland energy consumption was supplied by net imports. Denmark was the only EU-27 Member State in 2010 with a negative dependency rate. Among the other Member States, the lowest dependency rates were recorded by Estonia, Romania, the Czech Republic and the United Kingdom, but Cyprus, Malta and Luxembourg were almost entirely dependent on primary energy imports.

Graph 7 EU-27 Energy Dependency Rate (Eurostat, 2013)



Source: Eurostat (online data codes: tsdcc310 and nrg_100a)

Turkey has become one of the fastest growing energy markets in the world. Turkey has been experiencing rapid demand growth in all segments of the energy sector for decades. Now Turkey has been the second country, after China, in terms of natural gas and electricity demand increase. Turkey is expected to become one of the most dynamic energy economies of the world in terms of increase in energy demand.The limits of Turkey's domestic energy sources in light of its growing energy demand have resulted in dependency on energy imports, primarily of oil and gas. At present, around 26 % of the total energy demand is being met by domestic resources, while the rest is being provided from a diversified portfolio of imports (DB,2013).

The primary aim of Turkey is to realize its own energy security. To this end, Turkey has for objective to (DB,2013).

- diversify its energy supply routes and source countries,
- increase the share of renewables and include the nuclear in its energy mix,
- take significant steps to increase energy efficiency,
- Turkey's role as a reliable transit country on the East-West as well as North-South energy axis

Turkey is geographically located in close proximity to more than 70% of the world's proven oil and gas reserves so the importance of Turkey is getting increasing for energy corridor to carry the energy resources to the world market. Especially, considerations that have gained increased significance in today's Europe. The purpose of forming a natural energy bridge between the source countries and consumer markets that was initiated construction of pipeline projects in Turkey.

Turkey's Role as a Pipeline Projects

1 Oil Pipeline

-Baku-Tbilisi-Ceyhan (BTC) pipeline

The transportation of oil produced in Caspian Region, especially from Azeri-Chirag-Guneshli (ACG) Project in Azerbaijan to a terminal at Ceyhan on the Mediterranean coast of Turkey,, in a safe, secure, reliable and environmentally friendly way is continuing through the BTC Project which is the first step of East-West Energy Corridor.

BTC pipeline, which has a capacity of 1 million barrels per day, and at 1760 kilometers is the second longest of its kind in the world. The first cargo of oil, which had travelled through the BTC pipeline to Ceyhan, has been loaded onto a tanker on 4 June 2006. As of 15 October 2012, over 1.5 billion barrels of Azeri oil was loaded to tankers from Ceyhan and shipped to international markets (DB,2013).

-Iraq - Turkey (Kirkuk – Yumurtalık) Crude Oil Pipeline

It transports the oil produced in Kirkuk and other areas of Iraq to the Ceyhan Marine Terminal. The pipeline system is with an annual transport capacity of 35 Million tons in 1976. The capacity of the line was increased to 46.5 Million tons/year in 1984. With the completion of the second pipeline, parallel to the first one, the annual capacity reached 70.9 million tons as of 1987. Turkey has concluded the negotiations with the Iraqi side

aiming at extending the duration of the transportation agreement via this pipeline on 19 September 2010 (DB,2013).

2 Natural Gas Pipeline

- Blue Stream Gas

The Blue Stream gas pipeline is designed to supply Russian gas directly to Turkey via the Black Sea. The Blue Stream supplements the gas transportation corridor from Russia to Turkey. Pipeline's construction was completed and natural gas supplies through Blue Stream began in February 2003.

The total length of the Blue Stream pipeline is 1213 km, design capacity 16 billion cubic meters of gas a year. At the end of 2010 the total volume of gas delivered through Blue Stream exceeded 54.5 billion cubic meters of gas (GASPROM, 2013).

- South Caucasus Natural Gas Pipeline (SCP) Project

Within the scope of SCP Project, Shah Deniz natural gas is being transported to Georgian-Turkish border. The SCP passing through the same corridor with BTC is about 690 km in length. After commencement of the construction of the pipeline physically in 2004, construction activities have been completed. In parallel with the production activities of Shah Deniz, continuous gas transportation was started on March 7th, 2007. The pipeline having an investment cost of 1.4 billion USD, is transporting natural gas through Azerbaijan, Georgia, Türkiye and BTC's pump stations in Azerbaijan and Georgia. The pipeline has a transportation capacity of 9 billion m3 of natural gas to Turkish border with one compressor station in Sangachal Terminal in line with the terms of AGSC-BOTAŞ Sales and Purchasing Agreement (SPA). However, it is possible to expand this capacity up to 22 billion m3 in a year by adding new compressor stations and/or looping. In 2010, totally 6.8 billion m3 natural gas was transported and 4.4 billion m3 of this amount was sold to BOTAŞ (TP, 2013)

- Baku-Tbilisi-Erzurum (BTE) Natural Gas Pipeline,

It has become operational as of 3 July 2007. Designed to transport natural gas from the Shah Deniz field in the Azerbaijan sector of the Caspian Sea, through Georgia to Turkey, it is envisaged that the pipeline will export 6,6 billion cubic meters a year according to the Agreement between our country and Azerbaijan for Shah Deniz Phase I. As for Phase II, a common understanding was reached between the parties on 7 June 2010 in Istanbul in terms of both Azeri natural gas amount to be exported by Turkey, and Azeri natural gas amount to be exported to Europe via Turkey, and also price and transit tariffs.

Methodology and Data

The time series analyses have suggested some improvements in the standard Granger test. The first step is to check for the stationary of the original variables and then test co-integration between them. According to Granger (1986), the test is valid if the variables are not co-integrated. Second, the results of Granger causality are very sensitive to the

selection of lag length. We chose lag length is used to the Akaike's Final Prediction Error (Aqeel and Butt, 2001,103).

The basic model relates economic growth to energy consumption. The model is:

$$\log Y = f(\log Xi) \qquad (1)$$

Y is GDP and X is primary energy consumption. All the variables are in per capita log form. The relevant data were available for the period **1975-2011** from Republic of Turkey Ministry of Energy and Natural Resources. The procedures to estimate the model are discussed below.

- Engle-Granger Test

The aim is to explore the existence of a long-run relationship between the variables namely, trade openness and income inequality. To do so, we use Engle-Granger's (1988) two step procedure. First, co-integrated regressions are estimated by the Ordinary Least Squares (OLS) method (Örnek and Elveren,2010:66):

$$X_t = \alpha_0 + \beta_0 Y_t + \mu_t \qquad (2)$$

$$Y_t = \alpha_1 + \beta_1 X_t + \mu_t^{'} \qquad (3)$$

Where α_0 and α_1 are constants, and μ_t and $\mu_t^{'}$ are error terms. In the paper, first, it is tested whether the series are co-integrated or not, and then, in the second step, using the Error Correction Model (ECM) we apply the Granger Causality Test for variables based on the significance of coefficients of the error terms. The ECM can be formulized as following

$$\Delta X_t = a_0 + b_0 \mu_{t-1} + \sum_{i=1}^{m} c_{0i} \Delta X_{t-i} + \sum_{j=1}^{n} d_0 \Delta Y_{t-j} + e_t \qquad (4)$$

$$\Delta Y_t = a_1 + b_1 \mu_{t-1}^{'} + \sum_{i=1}^{q} c_{1i} \Delta Y_{t-i} + \sum_{j=1}^{r} d_{1i} \Delta X_{t-j} + e_t^{'} \qquad (5)$$

In equations μ_{t-1} and $\mu_{t-1}^{'}$ the lagged residuals are estimated by the co-integrated regressions of equations of (3) and (4). "Δ" shows that we make the variables stationarybydifferencing variables. If b_0 and b_1 are statistically significant a time series X is said to be Granger-cause Y and Y is said to be Granger-cause X. The ECM states that if two variables are co-integrated there is at least one-way causality between variables.

In this paper, the causality relationship between growth (gdp), primary energy consumption (cons) and secondary (electricity) energy consumption (elec) is examined.

The investigation of stationary is closely related to the tests for unit roots. We employ Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) to test the stationary. The results of DF and ADF unit roots tests are provided in Table 2.

Table 2 DF and ADF Unit Roots Analysis

	Test Statistics		Critical Values		
	Level Value	First Difference	%1	%5	%10
cons	-0.53 [9]	-5.77 [9]	-3.63	-2.95	-2.61
gdp	-0.039 [9]	-6.20 [9]	-3.63	-2.95	-2.61
elec	1.74 [9]	5.80 [9]	-3.63	-2.95	-2.61

[1] Number of Lagged Residuals with respect to the Schwarz Information Criterion

In Table 2 the results of DF and ADF tests shows that the levels of variables are non-stationary. Applying the same tests to first differences to determine the order of integration, it is concluded that series are stationary in first differences. That is, the series are integrated order of one, I(1). Therefore, the co-integration test can be applied in order to investigate the existence of a long-run relationship between variables.

Table 3 shows result of the Engle-Granger (1988) co-integration test. The absolute values of the calculated test statistics for all the residuals are less than its critical value at the 5 per cent level. So, it's mean that there is no relationship between growth and primary energy consumption.

Table 3 Two-way Co-integrations Analysis

Co-integrated Regressions	Calculated ADF Residuals	Critical Value %5	%10	Results
gnp = f (cons)	-2,62 [7]	-2,99	-2,63	**Non-Co-integrated**
cons = f(gdp)	-2,62 [7]	-2,99	-2,63	**Non-Co-integrated**

[1] Number of Lagged Residuals with respect to the Schwarz Information Criterion

We made other analysis that causality relationship between the growth and secondary (electricity) energy consumption is examined for Turkey. As Table 4 shows, there is a two-way log-run relationship between gdp and electricity energy consumption.

Table 4 Two-way Co-integrations Analysis

Co-integrated Regressions	Calculated ADF Residuals	Critical Value %5	%10	Results
gdp = f (elec)	--3.32 [7]	-2,94	-2,61	**Cointegrated**
cons = f(gdp)	-3,32 [7]	-2.94	-2,61	**Cointegrated**

However, existence of a long-run relationship does not necessarily imply a short-run relationship. Therefore, an error-correction mechanism as in equations (4) and (5) is needed.

Table 5 Error Correction Models and Granger Causality Test

Dependent Variable	Wald Test	**ECM-1(t-test)**	Wald Test
	ΣΔelec		(ΣDelec, ECM-1)
Δgdp	χ^2 (2)=164,70(0,0000) ***	**-0,014 (2,70)**	χ^2_{***}(3)=165(0,0000)
	Δgdp		(Σgdp, ECM-1)
ΣΔelec	χ^2_{***}(2)=268(0,0000)	**-0,16 (-3,18)**	χ^2_{***}(3)=178(0,0000)

*,** and ***, show 10%, 5% and 1% level of significances, respectively.

In Table 5 "Δ" shows first differences of variables and values in parenthesis show p-value. Number of lags for variables was chosen by the Schwartz Criterion. The Error Correction Model (ECM) shows the strength of adjustment toward equilibrium in the short-run. As shown in Table 5, the sources of causality are examined in three ways. All these tests show a significant causality between economic growth and electricity energy consumption inequality. The signs of coefficients of error correction terms of both variables are negative and t-value is statistically significant. Therefore, there is a strong two-way causality between variables in question.

Conclusion

In this study we attempt to provide some empirical evidence on the relationship between economic growth, primary and secondary energy consumption for Turkey for the period of 1975-2011. Our analysis shows that there is no causality growth and primary energy consumption but we found that there is a strong two-way causality between growth and electricity energy consumption.

Consequently, in the progress of growth of Turkey need to the energy demand increasingly. Also, within the context of the energy supply security of Turkey should be make the legal and technical studies, thus Turkey have been intensified for the purpose of restructuring our energy market with a market understanding that is based on competition and transparent, detecting and using their domestic and renewable resources potential, integrating the nuclear energy into the electricity production, and utilizing the new energy technologies.

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