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THE EFFECT OF NATURAL GAS IMPORTS ON GDP FROM A FINANCIAL PERSPECTIVE: EVIDENCE FROM TURKEY

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Abstract: *The paper analyses the relationship between natural gas imports and GDP in Turkey. Natural gas is the major source of energy consumption for Turkey. Turkey's GDP is in a middle income trap , and most of the problems with the economic growth can be associated with the natural gas imports. This paper has the goal of modelling this relationship, with Ganger causality of vector autoregression(VAR) and vector error correction models(VECM). The author also propose financial and policy suggestions based on the outcomes.*

Keywords: *Natural gas; Energy modelling; Energy finance; Foreign trade.*

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1. INTRODUCTION

Natural gas is a thermal and finite source of energy, produced in thousands of years as a result of fossil remains of plants and animals. fossil fuel formed when layers of buried plants and animals are exposed to intense heat and pressure over thousands of years. The energy can be extracted by combustion. This is mostly in the form of electricity generated in power plants. This can be done either with a boiler or a turbine. A more recent technique is combined cycle with the use of steam to increase energy efficiency. The natural gas is extracted with wells from ground, raw gas is treated at gas plants and then transported by pipelines.(EPA, United States).

Natural gas is the major source of energy consumption for Turkey. Turkey doesn't have enough natural gas locally, so it is imported. The major source of this import is Russia, 57,9% ; Iran 18,7%, and Azerbaijan, 8,6%. (PPA, Turkey).

GDP(Gross domestic product) is the monetary amount of goods and services sold and produced by a country within a specified period of time. GDP in level, or its growth is an indicator of total good and services produced is decreasing or increasing which is an indicator of stability of an economy. Most of the time GDP increases together with employment strong correlation. (Callen, 2012)

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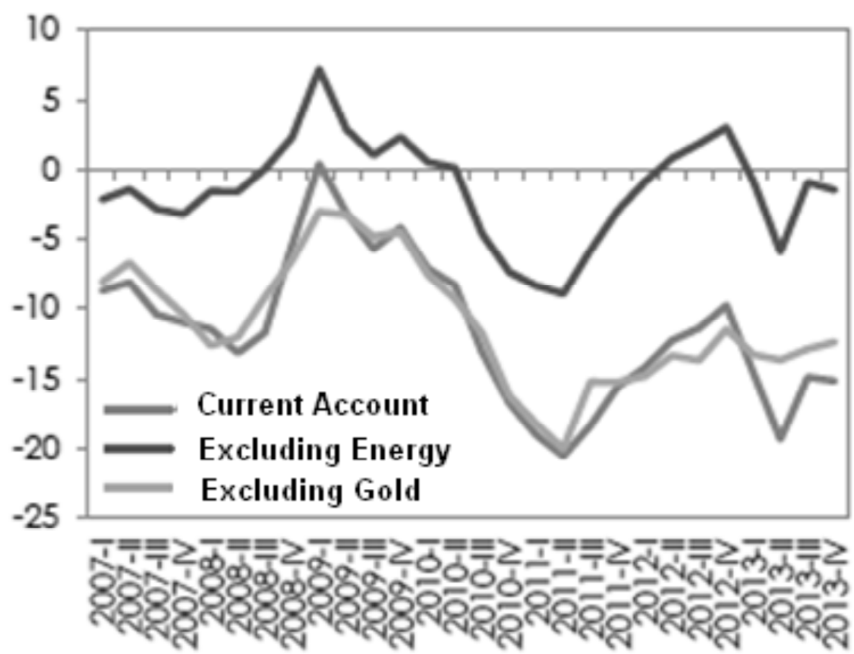
Turkey's GDP is in a middle income trap , and most of the problems with the economic growth can be associated with the energy imports and current account deficit which has direct and indirect effects. Foreign investors would eveluate current account deficit as a risk in their feasibilities. Therefore it is important consider the relationship between GDP and natural gas imports which is a major souce of energy in Turkey. This paper has the goal of modelling this relationship and proposing financial and policy suggestions depending on the results. Turkey's economy is facing a chronical current account deficit due to insufficient structural reforms to adapt current World economy and international competition. Turkey's current account deficit is $ 65 Billion as of 3Q14. Much of this deficit is due to energy import $ 55,9 Billion. Turkey is basicly unable to meet the demand local energy demand to support its economic growth. The below table shows quarterly data on current account deficit, and it is clear that gold and energy constitutes a major portion of this.

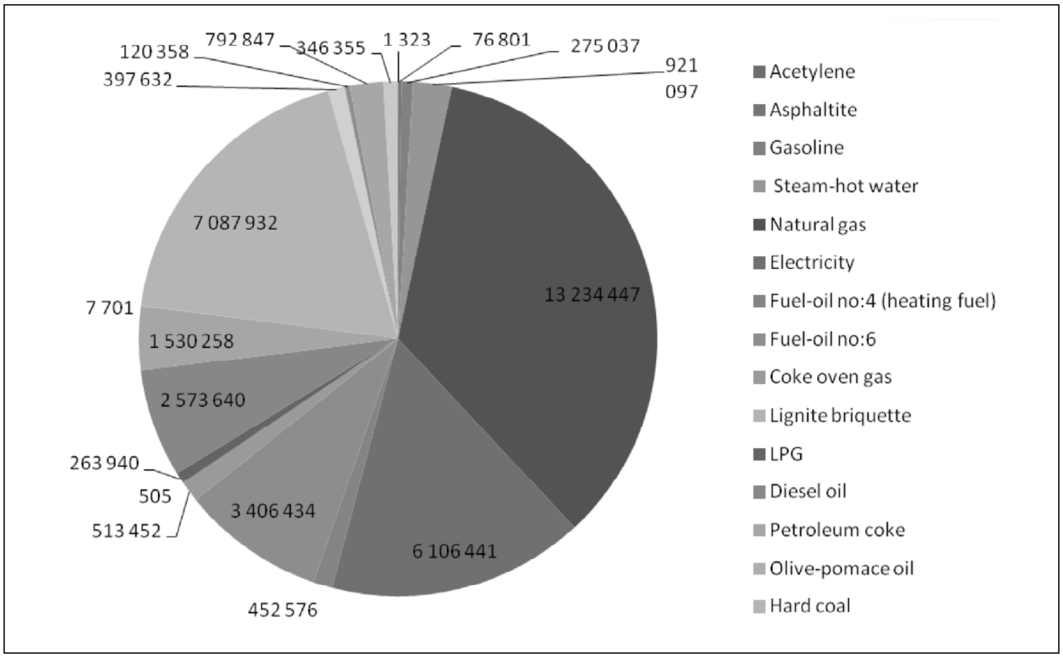
Turkey is dependent on primary energy sources to meet the annual energy demand. Much of these sources are imported. The below chart indicates total energy consumption of Turkey (as tons of oil equilavelent) by energy sources. Natural gas constitutes roughly 35% of energy consumed in Turkey.

Figure 1: Seasonality adjusted Current Account Balance (US$)



Source: Central Bank of Turkey

Figure 2 : Total energy consumption of Turkey, energy sources breakdown



Source: Turkish Statistical Institute Data

The reminder of the paper is as follows: Section 2 explains the literature review, Section 3 explains the data and methodology used and Section 4 describes the model and results. The outcomes of the study and suggestions are discussed in Section 5.

2. REVIEW OF LITERATURE

Cabalu and Manathu (2008) study vulnerability of Asia to the natural gas market. This is mainly due to gas supply interruptions, increasing gas prices, transportation and distribution bottlenecks, and a growing reliance on imports over longer distances. The vulnerability of eight countries is examined for the year 2006 using four market risk indicators (ratio of value of gas imports to GDP; ratio of gas consumed to GDP; ratio of gas consumed in an economy to population; and ratio of gas consumption to total primary energy consumption) and two supply risk indicators (ratio of domestic gas production to total domestic gas consumption and geopolitical risk). This is done through a linear regression analysis and is inspired by Shannon diversity index. The formula of the index is given below.

S = - Σ (hi mi h m)

where:

S = Shannon index of import flows of gas, adjusted for political stability in exporting country i;

hi = extent of political stability in country i (the exporting country), ranging from 0 (extremely unstable) and 1 (extremely stable); and

mi = share of gas imports from country i in total gas imports.

Using principal component analysis, a composite index of gas vulnerability is estimated by combining the individual indicators. The results demonstrate that there are significant differences in the values of individual and overall indicators of gas vulnerability among countries.

Payne *et al.* (2011) estimates the demand for residential natural gas in the state of Illinois, U.S.A, using an autoregressive distributed lag (ARDL) bounds testing – error ecorrection approach based on annual data from 1970 to 2007. The ARDL bounds testing approach reveals a long-run equilibrium relationship between natural gas consumption per capita and real residential natural gas prices, real personal disposable income per capita, real residential electricity prices, real fuel oil prices, and heating degree days. Long-run elasticity estimates show that only real residential natural gas prices, real residential electricity prices, and heating degree days are statistically significant. The results from the corresponding error correction model indicate that only real residential natural gas prices and heating degree days are statistically significant. While the long-run elasticity estimates are larger than the short-run elasticity estimates, both the short-run and long-run elasticity estimates are less than one in absolute terms. Furthermore, the speed of adjustment towards long-run equilibrium is approximately 1.42 years. This study shows that the economic variables other than natural gas prices, fail to explain natural gas demand Illinois.

Radev (2012) presents empirical analysis of demand of natural gas in 12 countries from European Union (EU), for the period 1989-2008. The ultimate goal is to assess the short-term and long-term elasticities of demand in different countries and in EU as a whole. These elasticities have to give a plausible picture of changing consumption of natural gas by the households and to allow determination and interpretation of the key indicator of the organization of gas sector – the relative price elasticity.

As independent variables in the dynamic log-linear model are involved the lagged demand of natural gas from previous periods, the duration of heating season (with the Heat Degree Days indexes), the (real) price of natural gas, the prices of substitutes of natural gas – fuel oil and electricity, and the income. The results received prove the existence of common characteristics, but also of structural differences, in consumption of gas by the households in different countries. They underline the advantages of shrinkage heterogeneous estimators as well as of the methods of fixed effects in the processing of Time Series-Cross Section (TSCS) data and in the assessment of elasticities of demand. The assessments of elasticities of demand to the price of gas and the income in short-term perspective present inelasticity, which further (in long-term) changes toward explicit expression of elasticity. The lower values of own-price elasticity and cross-price elasticity, as well as the slow pace of adjustment, are logical outcomes of restricted technological opportunities for substitution of natural gas with other energy sources in short-term. The empirical results confirm the expectations for a value of the relative price elasticity of about 4-5.

Ibarzabal (2011) studies conditions that have attracted private financial-capital investment in natural gas infrastructure from 2000 to 2011. A strong GDP in conjunction with stable macroeconomic conditions in Australia should ideally have a positive impact on investment in infrastructure. As is well known, the global financial crisis (GFC) generated unstable global macroeconomic conditions that had a negative impact on natural gas usage, price and exploring projects in countries such as the United States. But a series of government policies associated with a large stimulus package, together with a well-established and sound system of banking regulation, ensured that Australia suffered far less from the GFC than many other comparable countries. In two parts, the stimulus package included a program (of around A$30 billion) for constructing infrastructure, but none of it went into natural gas infrastructure. The global downturn in energy demand impacted on the capacity of the Australian oil and gas companies to fund new developments without cancelling any projects under way.

Several recent studies establish that crude oil and natural gas prices are cointegrated. Yet at times in the past, and very powerfully in the last two years, many voices have noted that the two price series appear to have "decoupled". Ramberg and Parsons(2012) explore the apparent contradiction between these two views. The recognition of the statistical fact of cointegration needs to be tempered with two additional points. First, there is an enormous amount of unexplained volatility in natural gas prices at short horizons. Hence, any simple formulaic relationship between the prices will leave a large portion of the natural gas price unexplained. Second, the cointegrating relationship does not appear to be stable through time. The prices may be tied, but the relationship can shift dramatically over time. Therefore, although the two price series may be cointegrated, the confidence intervals for both short and long time horizons are large. This is exlained through error correction model, seasonality, and residual volatility. In other words, variables relating to other technological or economic forces were omitted from the model, and these may be responsible for movements in the natural gas price that the model could not account for. Therefore, the historical cointegrating relationship may not be a very reliable predictor of the future natural gas price, at least not at longer horizons over which shifts in the underlying forces are unpredictable.

Researchers have investigated the efficiency of retail pricing in the electricity and natural gas industries for decades. Historically, the challenge has been to set prices in a manner that ensures a regulated utility covers its investment and production costs while simultaneously providing consumers with optimal incentives to consume. A common theoretical solution is to use a two-part tariff that includes a fixed component along with a marginal usage price set equal to the marginal cost of provision. In practice, tariffs set via a regulatory process often deviate from theoretical prescriptions for optimal two part tariffs.

Although some jurisdictions continue to follow this regulated utility model, others are opening retail electricity and natural gas sectors to competition via "retail choice." Many areas in the United States and United Kingdom, for example, allow end-users including residential customers to choose their retail provider. In these jurisdictions, the form of tariff functions by entrant retailers is not an outcome of a regulatory process. Rather, these tariffs arise from the strategic interaction of firms that compete for customers, albeit in markets that are unlikely to be perfectly competitive. Thus, these new retail choice regimes replace imperfect regulation with imperfect competition as the process that creates retail tariffs.

Puller and West (2013) discuss the challenges in evaluating the efficiency of tariffs and present evidence that prices continue to diverge from marginal cost after retail choice is introduced.

The introduction of retail competition in electricity and natural gas markets is generating important new areas of research on retail pricing. Economists have focused attention on the marginal price as the relevant signal of scarcity.

The extent to which consumers respond to this signal depends upon the saliency of tariff information. In new retail markets, bills are designed by firms that compete for customers rather than by regulatory commissions. In settings with retail choice, it will be interesting to observe which types of information on price and usage are saliently displayed on bills.Ultimately, the welfare implications for retail choice will depend upon the competitiveness of the retail markets, the nature of the tariff functions, and the information about those tariff functions that is saliently conveyed to customers.

3. DATA AND METHODOLOGY

The data used in the research is GDP which obtained from Turkish Statistical Institute and Natural Gas Imports which is obtained from BOTAS. The research period is between 1987 and 2013.

BOTAŞ was established on August 15, 1974 by The Turkish Petroleum Corporation (TPAO) for the purpose of transporting Iraqi crude oil to the Ceyhan (Yumurtal1k) Marine Terminal, in accordance with the Iraq-Turkey Crude Oil

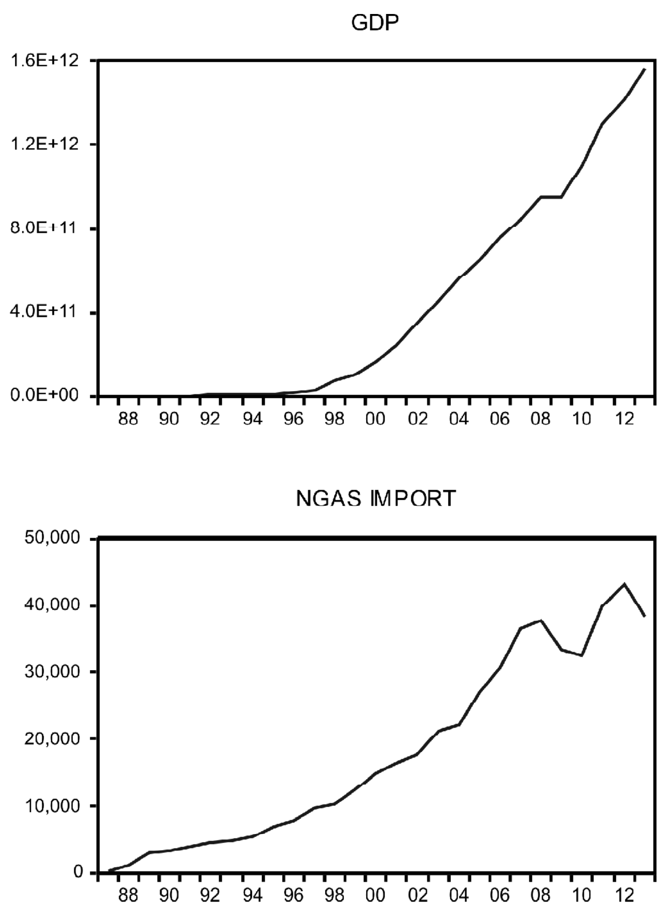
Pipeline Agreement signed on August 27, 1973 between the Governments of the Republic of Turkey and the Republic of Iraq.

Because of Turkey's increasing need for diversified energy sources, since 1987 BOTAŞ has expanded its original purpose of transporting crude oil through pipelines to cover natural gas transportation and trade activities, therefore becoming a trading company.

BOTAŞ's monopoly rights on natural gas import, distribution, sales and pricing by the Natural Gas Market Law. The Law covers import, transmission distribution, storage, marketing, trade and export of natural gas and the rights and obligations of all real and legal persons related to these activities. (Petroleum Pipeline Corporation)

The graphical presentation of data is shown in Figure 3. Similar trends can be observed visually for the variables GDP abd Natural gas import.

Figure 3 : Graphical Presentation of the data



Augmented Dickey Fuller technique (ADF) is used for testing whether the variables are staionary. The number of lags (p) is determined by the minimum Schwartz Bayesian information criterion or Akaike information criterion where it is statsitically significant.

$$\Delta z_t = \theta z_t - \alpha_1 \Delta z_{t-1} + \alpha_2 \Delta z_{t-2} + \ldots\ldots + \alpha_p \Delta_{t-p} + a_p$$

The test is often used for t-statistic associated with the ordinary least squares estimate of θ. This is called the Dickey-Fuller t- statistic. The Dickey-Fuller t-statistic does not follow a standard t-distribution as the sampling distribution of this test statistic is skewed to the left with a long, left-hand-tail. The correct critical values for the test, however is provided in the results. The null hypothesis of the Augmented Dickey-Fuller t-test is

H_0 $\theta = 0$ (i.e. the data needs to be differenced to make it stationary)

versus the alternative hypothesis of

H1 $\theta < 0$ (i.e. the data is stationary and doesn't need to be differenced) (Fomby)

Another technique used in this study for testing whether the variables are stationary is Phillips-Perron (PP). The Phillips–Perron test involves fitting (1), and the results are used to calculate the test statistics. They estimate not (1) but:

yt = πyt–1 + (constant, time trend) + ut

In (1) ut is I(0) and may be heteroskedastic. The PP tests correct for any serial correlation and heteroskedasticity in the errors ut non-parametrically by modifying the Dickey Fuller test statistics.

Phillips and Perron's test statistics can be viewed as Dickey–Fuller statistics that have been made robust to serial correlation by using the Newey–West (1987) heteroskedasticity- and autocorrelation-consistent covariance matrix estimator.

Under the null hypothesis that $\rho = 0$, the PP Zt and Zπ statistics have the same asymptotic distributions as the ADF t-statistic and normalized bias statistics. One advantage of the PP tests over the ADF tests is that the PP tests are robust to general forms of heteroskedasticity in the error term ut. Another advantage is that the user does not have to specify a lag length for the test regression. (Hudson).

The vector autoregression (VAR) model is one of the most applicable models in multivariate time series. It is a natural extension of the univariate autoregressive model to dynamic multivariate time series. The VAR model has proven to be especially useful for describing the dynamic behavior of economic and financial time series and for forecasting. It often provides superior forecasts to those from univariate time series models and elaborate theory-based simultaneous equations models. Forecasts from VAR models are quite flexible because they can be made conditional on the potential future paths of specified variables in the model.

In addition to data description and forecasting, the VAR model is also used for structural inference and policy analysis. In structural analysis, certain assumptions about the causal structure of the data under investigation are imposed, and the resulting causal impacts of unexpected shocks or innovations to specified variables on the variables in the model are summarized. These causal impacts can also be used with impulse response functions and forecast error variance decompositions.

Let Yt = (y1t, y2t, . . . , ynt) denote an (n×1) vector of time series variables. The basic p-lag vector autoregressive (VAR(p)) model has the form

$$Yt = c + \Pi 1Yt{-}1 + \Pi 2Yt{-}2 + \cdot\cdot\cdot + \Pi pYt{-}p + \varepsilon t,\ t = 1, \ldots, T$$ (Zivot, 2006)

If cointegration has been detected between series, it's known that there exists a long-term equilibrium relationship between them so VECM is applied in order to evaluate the short run properties of the cointegrated series. In case of no cointegration VECM is no longer required and Granger causality tests is used to establish causal links between variables. The regression equation form for VECM is as follows:

$$\Delta Yt = \alpha_1 + p_1\, e_1 + \Sigma\ \beta i\ \Delta Yt\text{-}i + \Sigma\ \delta i\ \Delta Xt\text{-}i + \Sigma\ \gamma\ i\ Zt\text{-}i$$

$$\Delta Xt = \alpha_2 + p_2\ e\ i\text{-}1 + \Sigma\ \beta i\ \Delta Yt\text{-}i + \Sigma\ \delta i\ \Delta Yt\text{-}i + \Sigma\ \gamma\ i\ Zt\text{-}i$$

In VECM the cointegration rank shows the number of cointegrating vectors. For instance a rank of two indicates that two linearly independent combinations of the non-stationary variables will be stationary. A negative and significant coefficient of the ECM indicates that any short-term fluctuations between the independent variables and the dependant variable will give rise to a stable long run relationship between the variables.

The major tool to determine the relationship between natural gas imports and GDP is Granger Causality. Granger causality test in a bivariate (X, Y) context can be expressed as:

$$Yt = \alpha_0 + \alpha_1 Y_{t-1} + \ldots\ldots + \alpha iYt\text{-}i + \beta 1X_{t-1} + \ldots\ldots\ldots\ \beta iX_{t-i} + \mu$$

$$Xt = \alpha_0 + \alpha_1 X_{t-1} + \ldots\ldots + \alpha\ iXt\text{-}i + \beta 1X_{t-1} + \ldots\ldots\ldots\ \beta iX_{t-i} + \mu$$

In the model, the subscripts denote time periods and μ is a white noise error. The constant parameter α 0 represents the constant growth rate of Y and X as a dependent variable, and thus the trend in these variables can be interpreted as general movements of cointegration between X and Y that follows the unit root process. Two tests can be obtained from this analysis: the first examines the null hypothesis that the X does not Granger-cause Y and the second test examines the null hypothesis that the Y does not Granger-cause X. If the test fails to reject the former null hypothesis and reject the latter, then conclusion is X changes are Granger-caused by a change in Y. Unidirectional causality will occur between two variables if either null hypothesis of either equation is rejected. Bidirectional causality exists if both null hypotheses are rejected and no causalityexists if neither null hypothesis of neither equation is rejected. (Asari *et al.,* 2011).

4. RESULTS

The variables are first checked with Augmented Dickey Fuller (ADF) and Phillips Perron unit root tests. According to the table below, the variables GDP and Natural Gas are not stationary in their levels; however they are stationary with their differences, I (1). This is because their unit root test statistics are higher than the critical values only for the I(1), for both ADF and Phillips Perron tests. The table 1 summarizes the results for the unit root tests.

Table 1
Unit root tests for the Model Data

	ADF Test Statistic	*Critical Value*	*PP Test Statistic*	*Critical Value*
GDP	-0,009	1,955	-0,043	-3,595
NATURAL GAS	0,514	-2,991	-0,080	-2,981
D(GDP)*	-4,697	-3,674	-4,347	-3,603
D(NATURAL GAS)*	-5,296	-2,991	-2,990	-1,955

*: The variable is stationary at 5% level of significance.

The variables GDP and Natural Gas are used as differenced , I(1) in the model. Vector auto regression model is used where the dependent variable is natural gas import with differenced values and independent variable is GDP with differenced values.

Lag length selection criteria is indicated in below table. Akaike information criterionsuggests the use of 5 lags where the others suggest 2 lags. For the principle of parsimony VAR(2) is used. Table 2 summarizes the lag selection criteria.

Table 2
Lag length selection criteria

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	-744.4464	NA	2.57e+28	71.09013	71.18961	71.11172
1	-736.6037	13.44449	1.79e+28	70.72417	71.02260	70.78893
2	-723.4703	20.01294*	7.59e+27*	69.85431	70.35170*	69.96226*
3	-720.0928	4.503313	8.34e+27	69.91360	70.60995	70.06472
4	-715.3901	5.374518	8.33e+27	69.84667	70.74198	70.04098
5	-710.7260	4.441974	8.75e+27	69.78343*	70.87769	70.02091

*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

VAR model representation is given below.

DNGAS = 0.0707494767748*DNGAS(-1)- 0.429786587103*DNGAS(-2) + 2.95815435669e-08*DGDP(-1) - 2.11686542658e-08*DGDP(-2) + 1454.914453617

DGDP=-9484875.8898*DNGAS(-1)-10854529.9007*DNGAS(-2)+.446372063603*DGDP(-1)+ 0.761978271566*DGDP(-2) + 31857112847.1

VECM (2) model is also studied to be able to analyze short term causality.

DNGAS= 0.0707494767748*DNGAS(-1) - 0.429786587103*DNGAS(-2) + 2.95815435669e-08*DGDP(-1) - 2.11686542658e-08*DGDP(-2) + 1454.91445361

DGDP=-9484875.8898*DNGAS(-1)-10854529.9007*DNGAS(-2)+0.446372063603*DGDP(-1)+ 0.761978271566*DGDP(-2) + 31857112847.1

Granger causality is studied for the VECM(2) model as well as VAR(2) model. According to VECM granger causality which is a short term causality indicator, GDP does not Granger cause Natural Gas imports (only 16,26% probability) , and also Natural Gas imports does not Granger cause GDP imports. Some causality is detected however with 6% , where this could be significant with 10% level of significance. According to VAR granger causality which is a long term causality indicator, GDP does Granger cause Natural Gas imports , and also Natural Gas does Granger cause GDP. The level of significance for the test is 5%.

Table 3
Granger Causality Probability Table for VECM(2) and VAR(2) models

	D(NGAS)	*D(GDP)*
VECM(2)	0,1626	0,0600
VAR(2)	0,0008	0,0002

5. CONCLUSION

The paper provides models – VAR and VECM to analyse long term and short term causality between natural gas imports and GDP. According to VECM , no causality is detected at 5% level of significance. In other words, Natural gas imports and GDP does not Granger cause each other. This is to say , there is no significant relationship between natural gas imports and GDP in the short run. In the long run, according to VAR model, it is found that Natural gas imports and GDP does Granger cause each other in both directions. That is to say, an icrease in GDP would increase Natural Gas Imports and an increase in Natural Gas Imports would increase GDP.

To achieve high growth expectation to get out of middle income trap, Turkey needs to be able to meet the energy demand , which is obtained by natural gas imports and natural gas imports' increase would increase GDP positively. This is mostly due to Turkey's high dependence of natural gas for energy.

This dependence can be reduced by switching to alternative sources of energy, such as coal, nuclear, shale gas and renewables. There can be also benefits by increasing number of source countries that natural gas is imported. Storage and reserves are also required to increase stability of the economy.

Another important aspect is that, Turkey's increasing natural gas imports would increase the current account deficit of Turkey and this also increases the risk for Turkey's private industry. The increased current account deficit contributes to Turkey's political risk, which is priced in foreign direct and portfolio investment. This also means higher cost of funding for the private industry. The private firms are therefore encoruaged to work with less debt in their capital structure, especially that of foreign currency, as a precaution for possible increased international risk perception of Turkey.

References

Asari, F.F. Abu H., Baharuddin, N.S., Jusoh, N., Mohamad, Z., Shamsudin, N., Jusoff, K. (2011), A Vector Error Correction Model (VECM) Approach in Explaining the Relationship Between Interest Rate and Inflation Towards Exchange Rate Volatility in Malaysia, World Applied Sciences Journal 12 (Special Issue on Bolstering Economic Sustainability), pp. 51-52.

Cabalu, H., Manuhutu, C., (2009), *Vulnerability of Natural Gas Supply in the Asian Gas Market,* Economic Analysis & Policy, Vol. 39 No. 2, , pp. 255-52.

Callen,Tim (2012), Gross Domestic Product: An Economy's All, *https://www.imf.org/external/pubs/ft/fandd/basics/gdp.htm*

Enironmental Protection Agency, United States, *http://www.epa.gov/cleanenergy/energy-and-you/affect/natural-gas.html*

Fomby, Thomas B. *http://faculty.smu.edu/tfomby/eco6375/BJ%20Notes/ADF%20Notes.pdf*

Hudson, John, *http://staff.bath.ac.uk/hssjrh/Phillips%20Perron.pdf*

Ibarzabal, J. A. H. (2011), *Natural gas infrastructure investment, regulation and ownership: the Australian case*, Policy Studies Vol. 32, No. 3, p. 235.

Payne, J.E., Loomis, D.G., Wilson R. , (2011), *Residential Natural Gas Demand in Illinois: Evidence from the ARDL Bounds Testing Approach,* Journal of Regional Analysis and Policy, p. 138.

Petroleum Pipeline Corporation, *http://www.botas.gov.tr/index.asp*

Petroleum Platform Association, *http://www.petform.org.tr/?lang=en&a=3&s=1*

Puller ,S.L., West J. (2013), *Efficient Retail Pricing in Electricity and Natural Gas Markets,* American Economic Review, p. 355.

Radev, Y. (2012), *Empirical Analysis of Demand of Natural Gas by Households in Europe, Economic Studies,p. 154*.

Ramberg, D.J. and Parsons J.E(2012).; *The Weak Tie Between Natural Gas and Oil Prices*, The Energy Journal, Vol. 33, No. 2. , p. 34.

Zivot, Eric (2006), *http://faculty.washington.edu/ezivot/econ584/notes/varModels.pdf*