Macroeconomic variables and oil price: evidence from Turkey

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Abstract

The focus of the paper is on the relationship between oil price and macroeconomic variables in the context of Turkey's economy. Macroeconomic variables used in this research are Gross Domestic Product (GDP), Consumer Price Index (CPI), Crude Oil (CROIL), FOREX and Foreign Reserves (FR). The standard time series techniques are applied for the analysis. Our findings based on the above techniques tend to suggest that the FOREX (USD/TL) is the most leading variable followed by GDP and oil price. and does have a significant impact on Turkey's economy. It appears that the oil price follows the exchange rate in that when the American dollar appreciates, the oil price in local currency would go up as the oil price is denominated in US$.

Keywords: oil price, Macroeconomic variables, VECM, VDC, Turkey

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1. Introduction

The impact of crude oil prices on the global economy has become an important issue. However, developments in crude oil prices are closely watched in the world market and they have a significant impact on the world economy. The fluctuations of the price have a potential effect in the level of input prices and the production process. The researchers have often focused on the effect of the oil price on developed and net oil importing countries, but there is not much research on the relations between oil price and macroeconomic variables, particularly for Turkey. We try to analyze and demonstrate the relations between oil price and macroeconomic variables in Turkish economy.

According to recently released data by the Turkish Statistical Institute (TurkStat), the Turkish economy has continued its strong growth trend in the 4th quarter of 2010, reaching 9.2 percent, well over market estimations. With the overall growth rate of 8.9 percent, Turkey has left Europe behind, becoming one of the fastest growing economies in the world in 2010. Oil is one of the most important import items in Turkish economy. Turkey is one of the big oil importing countries where 90% of its oil need is met through imports, mainly from Middle East and Russia.

The aim of the paper is to investigate the relations between oil price and macroeconomic variables in Turkish economy by employing the following macroeconomic variables; Gross Domestic Product (GDP), Consumer Price Index (CPI), Crude Oil (CROIL), FOREX(USD/TL) and Foreign Reserves (FR). The study will contribute to the literature of oil price and its relationships with the macroeconomic variables to the economy of Turkey by applying a time series technique in particular cointegration, error correction model, and the variance decomposition model in order to find the empirical evidence of the nature of the relations and significance between the variables.

The paper follows five sections. Section one represents the Introduction part. Literature review, the conceptual and different studies in existing literature is discussed in Section two. Description of Methodological issues and data sources is discussed in Section three. Section four demonstrates the analyses and findings regard to the application of the eight steps of time series. Finally, the last section, conclusion section summarizes the principal findings.

2. Literature Review

The effect of the oil price on a country's economy is one of the keen interest to many researchers particularly economists. Throughout the history oil has played a very important and very critical role to shape countries development. One of the earliest attempts to study the impact of oil price on economy was done by Darby (1982). Darby (1982), studied the US recession in 1973 to 1975 and found that oil shock effect was statistically significant that caused 2.5% decrease in US GNP.

Hamilton (1983) found a statistically meaningful relationship between GNP growth and fluctuations in oil prices in US economy for the periods of 1948-1972 and 1973-1980. He found that the negative correlation between oil price fluctuations and economic growth reflects a negative correlation from oil prices to aggregate economic activity.

Another research on impact of oil price shocks on several macroeconomic variables in seven OECD countries has been done by Burbidge and Harrison (1984). They founded that the oil embargoes explain a major part of economic activity. They also founded that the results showed little evidence that the changes in oil prices had an effect in industrial production.

IMF (2000) had researched on the impact of oil price increase on global economy. The study was done on the differential impact of an oil price increase of US$5 per barrel on developed and developing countries. The impact is found to be greater for developed countries than for developing countries as a group. The results obtained vary widely on the relative size of oil importing to exporting countries. The study also found that there are evidences that oil price changes tend to be positively correlated with the economic growth of the oil-producing countries.

Cunado and Gracia (2003) studied on oil price impact in 15 European countries. They could not find any cointegrating long-run relationship between oil prices and economic activity except for the United Kingdom and Ireland. They concluded that the impact of oil shocks on economic activity is limited to the short run.

Kibritçioğlu and Kibritçioğlu (1999) researched the topic of how fluctuations in the oil prices around the world affected sectoral and general price levels in Turkey's economy as a crude oil importing country. In this context, they studied the degree of impact caused by rises in imported crude oil prices on the inflation for the period 1986-1999 by using VAR analysis method. According to the results of their study, the indirect impact of crude oil import price rises on the inflation is very low.

The recent research by Erkan et al. (2010) studied the impact of fluctuations in oil price in Turkey's economy by covering the years from 1991 to 2008. Macroeconomic variables used in this study are GNP, inflation, unemployment and the ratio of exports and imports. They have used the VAR model in estimating the macroeconomic impact of oil prices. However it is observed that a rise in oil prices does not have any substantial impact on macroeconomic variables.

The paper tries to contribute to the literature of oil price and relationship with macroeconomic variables in Turkey economy by applying a time series technique in particular cointegration, error correction model, and the variance decomposition model in order to find the empirical evidence of the nature of the relations and significance between the variables. Here we are taking the case of Turkey and present the result from applying time series approaches by using the following macroeconomic variables GDP, CPI, FOREX, CROIL, Foreign Reserves, which makes the study different from other studies.

3. Methodology

This study adapted a time series technique, in particular, cointegration, error correction modelling and variance decomposition, in order to find empirical evidence. The time series method is favoured over the traditional regression for the main shortcomings of regression. The shortcoming is due to the non-stationary of the most finance variables. This means that performing ordinary regression on the variables will render the results misleading, as statistical tests like t-ratios and F statistics are not statistically valid when applied to non-stationary variables. If we test on the differenced form of these variables that it means the long term trend is effectively removed. In other words, the regression is not really testing long term (theoretical) relationships.

Another problem with traditional regression, the endogeneity and exogeneity of variables is pre-determined by the researcher, usually on the basis of prevailing or a priori theories. Cointegration techniques are advantageous in that it does not presume variable endogeneity and exogeneity. In the final analysis, the data will determine which variables are in fact exogenous, and which are exogenous. In other words, with traditional regression the causality is presumed whereas in cointegration, it is empirically proven with the data. In the below section we try to briefly describe the steps we follow in time series techniques.

The data used here are the quarterly data covering 13 years starting from January 1998, a total of 52 observations were obtained from the DataStream.

3.1. Cointegration Test

The first step in time series techniques is to determine the stationarity or non-stationarity of our variables under consideration. A variable is said to be integrated of order n, if it requires differencing n times to achieve stationary.

We apply the augmented Dickey-Fuller (ADF) to determine the variables' stationarity properties or integration order. We test for stationarity or non-stationarity of each variable in their original and differenced form. We want to make sure that the level variable form is non-stationary and the differenced variable is stationary before we can proceed to the second step (to test the lag order of the variables).

3.2. Long-Run Structural Modelling (LRSM)

When we have determined the number of lags and cointegrating relationships, than we apply the Long-Run Structural Modelling to estimate theoretically meaningful long-run (or cointegrating) relations among the variables based on the study. We impose identifying and over identifying restrictions to see the relations of the variables.

3.3. Vector Error-Correction Modelling (VECM)

The Vector Error Correction Model can indicate the direction of the Granger causality both in the short and the long run. If the error correction coefficient in any equation is insignificant, that implies that the corresponding dependent variable of that equation is "exogenous". But if the coefficient is significant, it implies that the corresponding dependent variable is "endogenous". The VECM, cannot tell us which variable is most exogenous or endogenous.

3.4. Variance Decompositions (VDCs)

The Variance Decomposition (VDC) is a test that shows how endogenous or exogenous the variables are relatively. The VDC decomposes the variance of the forecast error of a particular variable into proportions attributable to shocks in each variable in the system including its own. The relative endogeneity or exogeneity of a variable can be determined by the proportion of the variance explained by its own past shocks. The variable which is explained mostly by its own shocks is deemed to be the most exogenous of all variables. The variable that have a lot of decomposed proportions in other variables are said to be endogenous.

3.5. Impulse Response Functions (IRFs)

The Impulse response function is the graphical representation of information contained in the VDCs. The IRFs essentially map out the dynamic response of a variable owing to one period standard deviation shock to another variable.

3.6. Persistence Profiles

Persistence Profiles (PFs) maps out the dynamic response of the cointegrating vectors in the long run. The Persistent Profile trace out the effects of a system wide shock on the long run relations between the variables. From this test we can find out how many period does it takes for the equation to come back to equilibrium after the whole system has been shocked.

4. Empirical Analysis and Findings

In this section we are demonstrating our empirical results on the time series steps which we applied to our study on relations between oil price and macroeconomic variables in Turkey's economy. We have followed the eight steps, first by testing the stationary and non-stationarity of the variables, second determination of the order of the VAR model, third testing cointegration, fourth long run structural modeling, fifth Vector Error correction model and sixth variance decompositions seventh impulse response functions and eighth persistent profiles.

Step 1: Testing the stationarity/non-stationarity of each variable

We begin our empirical study by determining the stationarity of the variables. First we have take the log of each variables. The variables included for this test are; Gross Domestic Products (GDP) , Turkey to US Foreign Exchange (FOREX), Foreign Reserve (FR), Consumer Price Index, (CPI) and Crude Oil Price Spot (CROIL). The first action is to generate the "log" of the "level" form of the variables and then the "first difference" of the log of the variables.

After running Augmented Dickey-Fuller test to each log variable and to each log differenced variable, the calculated estimates were made against the critical statistic value. Only for the CPI we differenced two times in order to see the data non-stationary. In Table 1 we have summarized the result of the ADF Unit-Root Test.

Variable	**Description /Log**	**Result**
LGDP	Gross Domestic Products	non-stationary
DLGDP	1st. Diff. Gross Domestic Products	Stationary
LFOREX	Foreign Exchange	non-stationary
DLFOREX	1st. Diff. Foreign Exchange	Stationary

LFR	Foreign Reserve	non-stationary
DLFR	1st. Diff. Foreign Reserve	Stationary
LCROIL	Crude Oil Spot Price	non-stationary
DLCROIL	1st. Diff. Crude Oil Spot Price	Stationary
LCPI	Consumer price Index	non-stationary
DDLCPI	2st. Diff. Inflation	Stationary

Table 1.Stationary and Non-stationary of Variables

From the table above, we find that all the log level form variables are non-stationary and the first differenced log form are stationary, except DDLCPI. In order to proceed to the next step and since CPI is very important for our model (represents inflation) then we keep this variable in our model. Therefore we can move to the next step that is to determine the lag order.

Step 2: Determination of the order (or lags) of the VAR model

Before proceeding we need first to determine the order of lags for the VAR model. Based on the AIC the highest lag is 5. But this lag is too high for our case with only 44 observations since it will reduce the degree of freedom. Therefore we chose the SBC highest result which has the lag 2. The SBC criterion shows that var(2) with the highest value of 245.4552. In the light of these we choose VAR(2) model as our lag order model.

Step 3: Testing cointegration

The third step is to determine the value of cointegrating relationship of the current model. We use “multivariate” with VAR order 2 to get the results based on “eigen values” and the “trace” statistics to determine the value of r (cointegrating relationship).

We reject the null of no cointegration as well as the null of 1 cointegration. But we accept the null of 2 cointegrating groups.

Therefore we reject the null of r <= 0, r <= 1 and accept null of r = 2.

At null of r <=2, the statistical value 19.8 is less compared to 25.42 at 95%. We accept the null of r <= 2. So, r = 2 is accepted at 95% critical value and there is 2 co-integration present among the variables.

The variables are moving together and they are theoretically related and does not happen spuriously or by accident.

However, cointegration cannot tell us the direction of Granger-causation as to which variable is leading and which variable is lagging.

Step 4: Long Run Structural Modeling (LRSM)

The next step is to test the Long Run Structural Modeling. LRSM endeavours to estimate theoretically meaningful long-run (or cointegrating) relations by imposing on those long-run relations (and then testing) both exact identifying and over-identifying restrictions based on theories.

The result of exact identifying restriction to the co-integration equation or linear combination equation at this stage can be as follows by putting A5=1, A2=0, in first restriction and B5=1,B3=0 in second restriction.

vector 1

-9.2LGDP + 0.87LFR- 0.90LCPI+1LCROIL+0.0505t
(2.4017) (0.5769) (2.2263) (0.1838)

Where, vector 2

0.25LGDP + 3.28LFOREX – 4.98LCPI+1LCROIL+0.066t
(4.66) (2.45) (3.07) (0.0243)

where values in parenthesis are the standard deviation.
After calculating the t-ratios (value of coefficients / standard error), we found that the value of t-ratio of LFR is [1.51] < 2 insignificant and variable LCPI [0.404] < 2 insignificant. Therefore we proceed with further over identifying restrictions making value of LFR (A3=0) and LCPI (B4=0).

The co-integration equation or linear combination equation with the over identifying restrictions at this stage can be as follows:

vector 1

-6.63LGDP -1.02 LCPI +1 LCROIL +0.06t
(1.02) (0.19) (0.0158)

Where, vector 2

-8.4395LGDP -0.85FOREX +1 LCROIL+0.05903t
(1.54) (0.18) (0.01848)

The statistical result shows the10.6%, which is more than 10%.Meaning that we accept the null. The null is that our restriction that coefficient if LFR in group 1and LCPI in group 2 are equal to 0 is correct. So, we proceed with this model.

Step 5: Vector Error Correction Model (VECM)

Step 5 in the Time-Series techniques is the Vector Error Correction Model. In this test, if the error-correction coefficient is insignificant, the corresponding dependent variable is "exogenous". But if that coefficient is significant, that implies that the corresponding dependent variable is "endogenous".

In the result all of ECM 1 and 2, p-value are less than 10%. Thus, ECM are significant affecting DLGDP ➔ ECM (as a combination of all long term variables in the long run) is significant affecting DLGDP (GDP in the short run). In this result, GDP in the first group and the second group is follower (dependent variable).

FIRST GROUP:

GDP (follower) CPI (follower) OIL (follower)

As we see the result shows that all variables are follower, so the first group is not relevant and we more focus in the second group

SECOND GROUP:

GDP (follower) FOREX (leader) OIL (follower)

Turkey is oil importer. If US $ appreciates, Oil price will increase for local demand because oil is in US dollar.

Step 6: Variance Decompositions (VDCs)

The sixth step involves Variance Decomposition. This step partitions the variance of the forecast errors into proportions attributable to shocks in each variable in the model equation including itself. The relative Endogeneity and Exogeneity can be determined by the table below. Looking at the 10th horizon for each variable shocked, the percentage of the proportion can be realized

ORTHOGONALIZED

TAKING HORIZON = 10

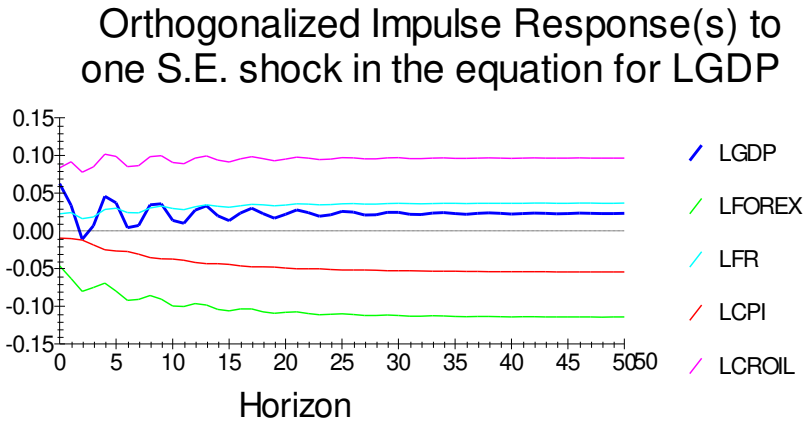
	LGDP	LFOREX	**LCROIL**
LGDP	**.48211**	.32071	.012930
LFOREX	.22698	**.63145**	.051289
LCROIL	.19237	.057452	**.14357**

Based on Step 5, we exclude this LFR and LCPI because they were not significant The strongest variable is the variable which depend most on its own path (LFOREX – 63% depends on its own path). Rank of the variables; 1. LFOREX, 2.LGDP, 3.CROIL. So, from our model in previous step FOREX is Leader. Here we know that, FOREX is strong leader depends 63% on its own path. In terms of follower CROIL is the weakest which is 14% depend on its own path. GDP is stronger which depend 48% on its own path.

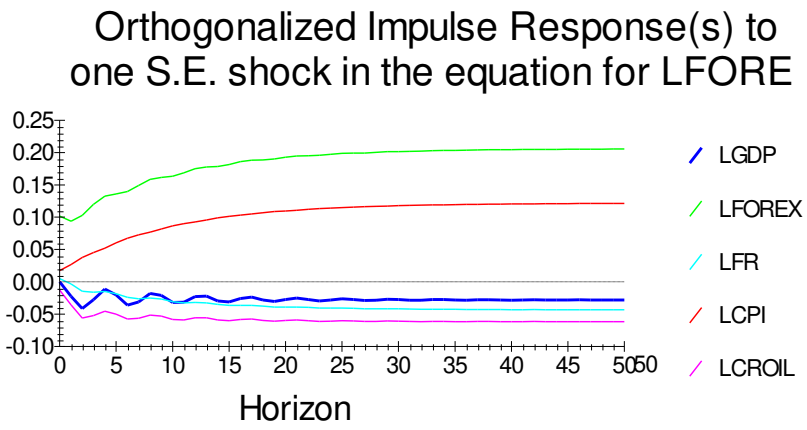
Step 7: Impulse Response Functions(IRFs)

IRFs will map the dynamic response path of a variable owing to a one-period standard deviation shock to another variable. The IRFs are normalized such that zero represents the steady-state value of the response variable. The graph of each variable are as follows, but we exclude the LFR and LCPI:

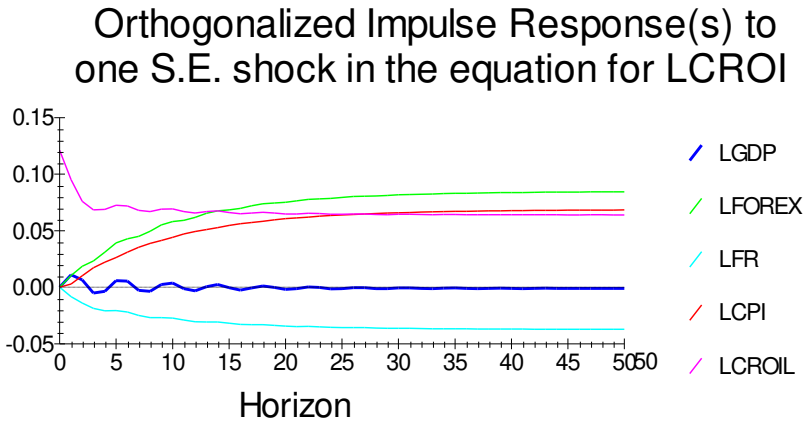
ORTHOGONALIZED:



This graph shows the orthogonalized impulse response of other variables when LGDP is shocked. The variable LFOREX responded quite substantially compared to other variables. This shows that the Gross Domestic Product variable is highly related to FOREX.



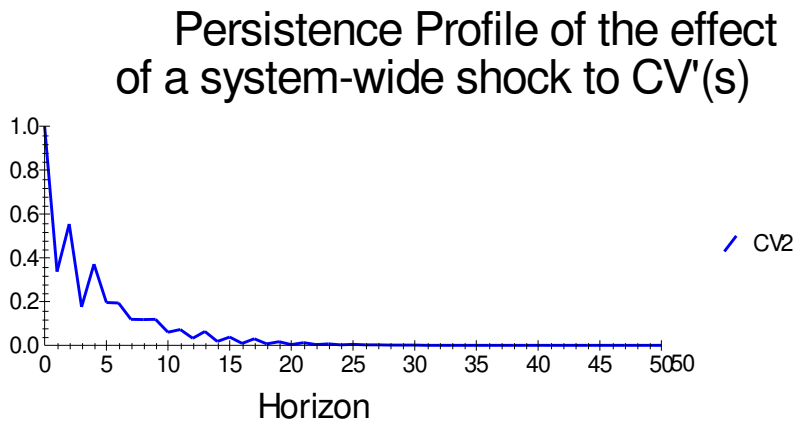
When you shock FOREX as a leader GDP is only deviates 0.02. This graph shows the orthogonalized impulse response of other variables when LFOREX is shocked. All other variables react negatively when shocked by the variable LFOREX.



This graph shows the orthogonalized impulse response of other variables when LCRO is shocked. The variable LFOREX responded quite substantially compared to other variables. This shows that the Crude Oil Prices variable is highly related to FOREX. All other variables does not react to the crude oil shocked variable. This is against the theory but there is possibility of Turkey government spend substantial amount of money in giving subsidy on petrol and diesel for domestic consumptions, and applying other alternatives especially directs their policy toward depending on the energy sector.

Step 8: Persistence Profiles (PF)

SECOND GROUP: We analyse only the second group because it is more relevant from the result in Step 5.



When there is a shock from external factors to the second cointegration group (GDP, FOREX, OIL), then they will deviate from equilibrium, but they will get back to equilibrium (cointegrated again) after 20 periods (quarters).

5. Conclusion

The objective of this study is to examine relationship between Crude Oil Prices and macroeconomic variables in Turkish Economy. However the study has its limitation on observations where the observations are short. According to the obtained results the cointegration test shows that there are two cointegrating relationship. But, we found from VECM that the first group is not relevant.

Hence, we focus more on the second cointegration group, which include GDP, FOREX and Oil. The FOREX coefficients appear to be highly significant and exogenous from the VECM test. Meanwhile, GDP and Oil are followers. It means that FOREX is a leader. The documented VDC shows that FOREX is a strongest leader because it depends 63% on its own path. In terms of follower, the GDP depends 48% on its own path whereas Oil depends 14% on its own path. It means that GDP is stronger than oil prices.

From our Impulse Response function result, when there is a shock to GDP, oil price deviates considerably 10% from equilibrium. Moreover, when there is a shock on FOREX, GDP is only deviating -2% whereas oil price deviates -5% from equilibrium. The persistence profile result shows that if there is a shock from external factor, then the second group variables (GDP, FOREX, and Oil) will deviate from equilibrium. But they will get back into equilibrium after 20

quarters. The overall findings lead us to conclude that, change in FOREX affects the GDP and Oil prices.

Based on the test results, the effect of FOREX does have significant impact on the Turkish economy. FOREX affects Oil Price because the currency fluctuation affects the oil price in local economy and FOREX also affects GDP because of international trade.

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