The Relationship between Industrial Production, GDP, Inflation and Oil Price: The Case of Turkey

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Abstract

After the oil shock in 1973, the number of studies on causal relationship between oil price and macroeconomic variables has dramatically increased. This paper investigates the relationship among the oil price, inflation, GDP and industrial production for 1961 to 2012 period in the case of Turkey. Data used in the study was extracted from World Bank Development Indicators and the OPEC. Three different tests, namely unit root, co-integration and causality tests, have been employed to investigate the relationship among the variables. The results of Phillips-Perron (PP) as a unit root test suggests that all the variables under investigation are integrated of order one; I(1). Johansen co-integration results confirm a long-run relationship among these variables and Granger causality test illustrates the unidirectional relationship from oil price to industrial production.

Keywords: Oil price; Inflation; GDP; Causality.

1. Introduction

Since energy is essential to almost all economic sectors, oil has become one of the most strategic commodities for the global economy. Sharp increase in oil market has become one of the biggest economist's concerns since Hamilton (1983) who concludes the impact of oil price on the U.S economy after the 2nd World War. Moreover, crude oil has been playing a key role in all economic activities although the nature of this relationship may have changed over time (Arouri and Rault, 2011). So, changes in oil price can lead to a change in macroeconomic policies as well as microeconomic decisions.

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Given the importance of the oil, many studies have been conducted to investigate the relationship between oil price and different macroeconomic variables including: GDP, inflation, unemployment rate, industrial production, interest rate, stock price, government expenditure and etc. The results of the related studies might vary because of the different study assumptions like; different methodologies and variables, data frequency, structural breaks in the time span of the study and so on.

This article investigates the relationship between oil price, GDP, inflation and industrial production in the case of Turkey as an oil importing country for 1961-2012 period. For this purpose, Phillips-Perron (PP) is applied to check whether the data is stationary. Then, Johansen co-integration test is used to investigate any possible long-run relationship among the variables and finally Granger causality test is employed to estimate the direction of the founded long-run relationship. This article is unique since there is no previous related study of Turkey considering all the four variables. Hence, only a few studies include industrial production into their econometric models although it might be an important parameter in such economic analysis.

The article's structure will be as follows; the next section covers the empirical literature on highlighting the existence of relationship among oil price and each of the other three variables; inflation, GDP and industrial production. Section 3 includes two subsections, data and methodology part. Empirical result of the study is discussed in section 4 and the final section is the conclusion.

2. Literature Review

According to the literature, oil price is considered as an important input factor in variety of econometric models. Moreover, it has been always an attractive topic since Hamilton (1983) who argues that oil price changes has considerable impact in almost every U.S recession after the 2nd World War. However, there is no consensus in the literature on the causal relationship between oil price and several macroeconomic variables because of the mentioned assumption differences. For instance, Barsky and Kilian (2004) find a unidirectional relationship from macroeconomic variables to oil prices while the others like Kim and Willet (2000), Trehan (2005) and Ewing and Thompson (2007) believe that oil price affects the macroeconomic variables. Brown and Yucel (2002) aim to answer the question of why oil price affects the economic activities. They highlight their result into four general categories; 1. Reduction in supply of the input will result in decreasing the output. 2. Income transfer effect from oil importer country to the oil exporter one. 3. Real balance effect. 4. Monetary policy effect. However, they suggest that the best explanation is the supply side effect. Some of the previous studies focusing on the relationship between oil price and the rest of the variables (inflation, GDP and industrial production) are briefly discussed in the rest of this section.

In order to investigate the relationship between oil price and inflation, Hooker (2002) divides his study period (1962-2000) into two sub-periods because of the structural break occurred at the end of 1980. He finds a significant impact of oil price on inflation in the first period (1962-1980) but not in the second one (1981-2000). In 2005, Trehan supports Hooker's findings by studying the same topic and concluding the similar results. Roger (2005) analyzes some European countries and finds a short-run tradeoff between GDP and inflation which highlighted the importance of oil price for the European region at least in the short-run. Furthermore, Bermingham (2008) studies the small open economy of Ireland and finds the impact of increasing oil price on inflation. Jacquinot et al. (2009) focus on the same topic for the Euro area and find that oil price changes is a vital factor for estimating inflation in the short-run although this impact is much more complex in the long-run. Additionally, Castillo et al. (2010) also find that an increase in oil price volatility may lead to a higher inflation level.

Gross domestic product (GDP) is another common macroeconomic variable appears in the literature when the impact of oil price is concerned. Jimenez-Rodriguez and Sanchez (2005) investigate the relationship between oil price and GDP and find a nonlinear one among them. They realize that this impact would be larger in case of increasing the oil price rather than decreasing it. Their result also suggests that an increase in oil price will negatively affect the GDP for the oil importing countries except Japan; while it has a positive effect on the oil exporter countries' GDP. Furthermore, Kim and Willet (2000) apply the panel analysis on the same topic for OECD countries and find a strong negative relationship between GDP and oil price. In case of North Korea, Glasure and Lee (1997) find the same relationship between oil price and GDP.
Regarding to the relationship between oil price and industrial production, there are fewer studies. Cunado and Perez de Gracia (2003) find the significant effect of industrial production on oil price change. In contrast, Serletis and Shahmoradi (2005) and Ewing and Thompson (2007) support the notion of the oil price sensitivity to industrial production.

Turkey is a developing country whose economic performance has drew attention for the last decade. Berument and Tasci (2002) investigate the impact of oil price on inflation in Turkey and they find a significant effect of oil price on inflation when the general price level is adjusted. Çatık and Önder (2013) suggest a nonlinear relationship between oil price and Turkey's macroeconomic activities. They find that if the change in oil price exceeds certain level, it has a significant impact on GDP and inflation. However, among the various related studies of Turkey, there is no similar one focusing on the relationship between oil price, inflation, GDP and industrial production.

3. Data and Methodology

3.1. Data

This study covers 1961-2012 period and uses annual data for GDP, oil price, inflation and industrial production of Turkey. Oil price data has been collected from the OPEC at 2013 constant US$ and GDP, inflation and industrial production indexes are attained from the World Bank Development Indicators. GDP data is at 2005 constant US$, inflation data is consumer price basis and industrial production data is in percentage of the GDP.

3.2. Methodology

In order to investigate the relationship between oil price, GDP, inflation and industrial production, three types of tests are employed. First of all, the most widely used unit-root test; Philips-Perron (PP) (Philips and Perron, 1988) were employed to check the integration orders of the variables. Then, Johansen (1988) co-integration approach was applied to investigate the long-run relationship among these variables. Finally, once co-integrating vectors (equations) were found, Granger causality test is carried out to estimate the direction of the long-run relationships.

3.2.1 Unit Root Tests

Stationarity is one of the most important properties of a variable and it affects the behavior of the variable considerably. The variance and mean of a nonstationary variable are not constant and the covariance depends on the actual times variables are observed. If a variable is stationary the effect of a shock will be transitory or permanent. Before conducting any econometric analysis, unit root properties of the data needs to be verified. The purpose of the unit root test is to examine whether a variable is stationary or not.

There are several unit root tests to examine the integration property of a variable. Phillips- Perron (1988), one of the most widely used unit root tests, has been carried out in this study. Phillips-Perron unit root test is similar to Dickey- Fuller (1981) test; however PP deals with serial correlation and heteroskedasticity in the errors in a different way. The PP test is a non-parametric procedure so to solve the autocorrelation problem there is no need to specify a lag length. This property is considered as the main advantage of the test over Dickey Fuller procedure. PP is robust to heteroscedasticity in the error term as well.

The null hypothesis of the test is unit root in the series. If the result is statistically significant, the null hypothesis can be rejected which means that data is stationary at level, I(0) or to be integrated of order zero.

\[ H_0 : \delta = 0, \quad H_1 : \delta = 0 \]

3.2.2 Co-Integration Test

Co-integration test is used to investigate the long-run relationship among the variables. Co-integration aims to figure out whether two or more series are converging to form a long-run relationship even though each series has unit root. Johansen (1988) co-integration test assumes that all the variables are in the same order.
The null hypothesis for this test is as follows:

\[ H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0 \]

Rejection of the null hypothesis happens when trace statistic is greater than critical values at 1% or 5% and it means that at least one of the coefficient is statistically significant (not equal to zero). Once a co-integrating vector is estimated, there is a long-run relationship among the variables. In order to find the number of co-integrating vectors, Johansen applies maximal eigenvalue method. The maximal eigenvalue is based on a likelihood ratio test and its null hypothesis for (r) co-integrating vector against the alternative one for (r+1) co-integrating vector states as follows:

\[ \lambda_{\text{max}}(r, r + 1) = -T \ln(1 - \lambda_{r+1}) \]  

(1)

3.2.3 Granger Causality Test

Having at least one co-integrating vector confirms the long-run relationship and in order to investigate the direction of the relationship, Granger causality test needs to be employed. Granger causality test concluded that X is Granger cause Y, if Y can be predicted by the past and present value of X. This study applies the Granger causality test to investigate causal relationship among the variables investigated. The four main Granger model are described as follows;

\[ \Delta \text{GDP}_t = \sum_{j=1}^{p} \eta_j (\Delta \text{GDP})_{t-j} + \sum_{j=1}^{p} \theta_j (\Delta \text{IP})_{t-j} + \sum_{j=1}^{p} \phi_j (\Delta \text{OP})_{t-j} + \sum_{j=1}^{p} \psi_j (\Delta \text{INF})_{t-j} + \lambda_1 \Delta t_{t-1} + u_{1t} \]  

(2)

\[ \Delta \text{IP}_t = \sum_{j=1}^{p} \nu_j (\Delta \text{GDP})_{t-j} + \sum_{j=1}^{p} \xi_j (\Delta \text{IP})_{t-j} + \sum_{j=1}^{p} \sigma_j (\Delta \text{OP})_{t-j} + \sum_{j=1}^{p} \tau_j (\Delta \text{INF})_{t-j} + \lambda_2 \Delta t_{t-1} + u_{2t} \]  

(3)

\[ \Delta \text{OP}_t = \sum_{j=1}^{p} \zeta_j (\Delta \text{GDP})_{t-j} + \sum_{j=1}^{p} \sigma_j (\Delta \text{IP})_{t-j} + \sum_{j=1}^{p} \tau_j (\Delta \text{OP})_{t-j} + \sum_{j=1}^{p} \omega_j (\Delta \text{INF})_{t-j} + \lambda_3 \Delta t_{t-1} + u_{3t} \]  

(4)

\[ \Delta \text{INF}_t = \sum_{j=1}^{p} \varphi_j (\Delta \text{GDP})_{t-j} + \sum_{j=1}^{p} \psi_j (\Delta \text{IP})_{t-j} + \sum_{j=1}^{p} \omega_j (\Delta \text{OP})_{t-j} + \sum_{j=1}^{p} \zeta_j (\Delta \text{INF})_{t-j} + \lambda_4 \Delta t_{t-1} + u_{4t} \]  

(5)

4. Empirical Result

Table 1 represents the descriptive statistic for each variable. As table 2 shows, according to PP test, all of the variables has a unit root, in other words variables are not stationary at their level. However, they all become stationary at their first differences. Therefore, GDP, inflation, industrial production and oil price are all integrated of order one, I(1).

|                  | LNDGP  | LNINF  | LNOP   | LNIP   |
|------------------|--------|--------|--------|--------|
| Observation      | 52     | 52     | 52     | 52     |
| Mean             | 26.11519 | -1.047341 | 3.557829 | -1.326285 |
| Median           | 26.16440 | -1.072141 | 3.533029 | -1.303165 |
| Maximum          | 27.16540 | 0.141685  | 4.746855 | -1.040066 |
| Minimum          | 24.90344 | -2.226239 | 2.378931 | -1.754046 |
| Std. Dev.        | 0.644433 | 0.720149  | 0.720149 | 0.187355  |
| Skewness         | -0.145729 | -0.071165 | -0.071165 | -0.620353 |
| Kurtosis         | 1.932642 | 1.844563  | 1.844563 | 2.673853  |
| Jarque-Bera      | 2.652433 | 2.936466  | 2.936466 | 3.565738  |
| Probability      | 0.265480 | 0.230332  | 0.230332 | 0.168155  |
| Sum              | 1357.990  | -54.46175 | 185.0071 | -68.96680 |
| Sum Sq. Dev.     | 21.18000  | 26.44933  | 26.44933 | 1.790198  |

Note: INF, IP and OP represent Inflation, Industrial Production and Oil Price, respectively.
Table 2. PP Test for Unit Root

| Statistics (Level) | ln GDP Lag | ln INF Lag | ln IP Lag | ln OP Lag |
|--------------------|------------|------------|-----------|-----------|
| $\tau_1$          | -3.15 (1)  | -2.62 (5)  | -1.03 (3) | -1.75 (3) |
| $\tau_u$          | -1.46 (4)  | -3.14 (4)  | -2.38 (2) | 1.19 (2)  |
| $\tau$            | 8.10 (1)   | -2.37 (10) | -1.46 (0) | 0.84 (2)  |

| Statistics (First Difference) | Δln GDP Lag | Δln INF Lag | Δln IP Lag | Δln OP Lag |
|-------------------------------|------------|------------|-----------|-----------|
| $\tau_1$                      | -7.20* (3) | -38.92* (49) | -8.67* (6) | -6.96* (2) |
| $\tau_u$                      | -7.12* (2) | -11.62* (8)  | -7.40* (2) | -7.03* (2) |
| $\tau$                        | -3.81* (4) | -11.65* (8)  | -7.24* (2) | -6.94* (2) |

Note: INF, IP and OP represent Inflation, Industrial Production and Oil Price, respectively. $\tau_1$ represents the trend and intercept; $\tau_u$ considers only the intercept; $\tau$ stands for no trend and no intercept (None). * shows the rejection of the null hypothesis at the 1% level.

Having all the variables stationary at their first difference I(1), there is a possibility that they have a long run relationship. Johansen co-integration test has been applied for this purpose and as the results suggest (Table 3) that there is at least one co-integrating vector, meaning that there is a long run relationship between industrial production, GDP, inflation and oil price.

Table 3. Johansen Co-Integration Results at lag 4

| Hypothesis       | Eigenvalue | Trace Statistic | Critical Value (5%) | Critical Value (1%) |
|------------------|------------|----------------|---------------------|---------------------|
| None*            | 0.404426   | 51.60764       | 47.21               | 54.46               |
| At most 1        | 0.353654   | 27.25080       | 29.68               | 35.65               |
| At most 2        | 0.133571   | 6.739024       | 15.41               | 20.04               |
| At most 3        | 7.97E-06   | 0.000374       | 3.76                | 6.65                |

Note: * shows the rejection of the null hypothesis at the 5% level.

In order to find the direction of this relationship, Granger Causality test has been applied. The results illustrate that only one out of twelve null hypotheses can be rejected. In other words, there is only one unidirectional relationship at lag seven as follow; industrial production will be affected by the change in oil prices. Furthermore, there is no causality relationship until lag ten rather than the mentioned one (Table 4).

Table 4. Granger Causality Test at lag 7

| Null Hypothesis     | Observation | F-Statistic | Prob.    |
|---------------------|-------------|-------------|----------|
| LNOP does not Granger Cause LNIP | 45          | 3.60166     | 0.0062   |
| LNIP does not Granger Cause LNOP | 45          | 0.77268     | 0.6147   |
| LNINF does not Granger Cause LNIP | 45          | 0.78341     | 0.6064   |
| LNIP does not Granger Cause LNINF | 45          | 0.48200     | 0.8399   |
| LNGDP does not Granger Cause LNIP | 45          | 0.52077     | 0.8117   |
| LNIP does not Granger Cause LNGDP | 45          | 0.34365     | 0.9270   |
| LNINF does not Granger Cause LNGDP | 45          | 2.13744     | 0.0699   |
| LNOP does not Granger Cause LNINF | 45          | 0.41747     | 0.8837   |
| LNGDP does not Granger Cause LNOP | 45          | 0.57466     | 0.7707   |
5. Conclusion

The purpose of this study is to test any possible long-run relationship among the industrial production, oil prices, inflation and the GDP of Turkey and find the direction of any possible causal relationship among these variables for the 1961-2012 period. The result of the study reveals that there is a long-run relationship among the variables under investigation and Granger causality test confirms that oil price changes affect the industrial production of Turkey, which is a net oil importer country. The findings of our study are consistent with Serletis and Shahmoradi (2005) and Ewing and Thompson (2007).

Turkey does not have enough fossil fuel resources and its industry heavily relies on importing the crude oil for which there is no substitute yet. The dependency of the industrial sector to imported crude oil makes the country vulnerable to the oil price changes. Given the relationship between oil price and industrial production, it can be argued that to hedge against the oil price uncertainty is a vital factor for Turkey to have a sustainable and stable industrial production at least in the short and medium term. Dynamic consumption might be another option for a developing imported-oil-dependent country that confronts oil price shocks. Future studies should elaborate the main advantages and disadvantages of these strategies for the case of Turkey and also provide other possible solutions. The long run solutions, such as finding substitutes for oil, to decrease the dependency of industrial sector to fossil fuels needs to be elaborated by the prospective studies. Another motivation for the future research might be to investigate the relationship among these variables by taking into account of any possible structural break(s) and/or nonlinear relationship.

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