



LUND
UNIVERSITY

**School of Economics and Management
Department of Economics**

**OIL PRICES AND MACROECONOMIC VARIABLES IN A
VAR MODEL: THE CASE OF TURKEY**

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Selin DÜZ

Supervisor: Fredrik NG ANDERSSON

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ABSTRACT

This study analyzes the effects of real crude oil prices on the macroeconomic variables in Turkey by discussing the effects in the short run (3-6 months) and more persistent effects (2-5 years) on business cycles using Hodrick-Prescott filter method. There is an investigation about the relationship between world crude oil prices and real aggregate output, inflation, monetary aggregate, short term interest rate and nominal exchange rate of a small, open, oil importing economy, Turkey. The effects of real crude oil price on macroeconomic variables change for short run-mid run and oil price shocks have more persistent effect on business cycles. The analysis results reveal a negative relationship between oil price shocks and changes in real gross domestic product during 1987-2001. Further, the analysis shows that there is a positive relationship between changes in real crude oil price and changes in consumer price index, especially during 2002-2009. Even though Central Bank of the Republic of Turkey uses inflation targeting within these years, with significant increases in world oil prices after 2002, it seems plausible to observe that consumer price index responds to crude oil price increases.

Keywords: Oil price shock, Vector Autoregressive Model, Impulse Response, Turkey.

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LIST OF ABBREVIATIONS AND ACRONYMS

ADF Augmented Dickey-Fuller

AIC Akaike's information criterion

CPI Consumer Price Index

DF Dickey Fuller

GDP Gross Domestic Product

HP Filter Hodrick-Prescott Filter

HQIC Hannan-Quinn information criterion

IMF International Monetary Fund

KPSS Kwiatkowski-Phillips-Schmidt-Shin

PP Phillips Perron

RSS Residual Sum of Square

SIC Schwarz's Bayesian information criterion

TRL Turkish Lira

TRY New Turkish Lira

U.S. United States

UK United Kingdom

USD United States Dollar

VAR Vector Autoregression

1 INTRODUCTION

The effects of oil prices on oil importing countries have been one of the major economic research topics since the global oil crisis in 1970s. Especially, in the last decade, coexisting with the global slowdown, high and sharp fluctuating world oil prices received considerable attention. Oil importing small open economy countries, which usually have negligible effect on the world oil demand, supply or price, are also sensitive to the oil price shocks. Therefore, the analysis of the impact of the world oil price shocks on the macroeconomic variables is crucial in oil dependent, middle income or developing countries. One of such countries is Turkey, where the oil price fluctuations play a strategic role.

Turkey is a middle income, small, open and oil importing country. The country does not have considerable oil reserves, and according to Torul et al. (2008), its production process is strongly related to oil. The price level in Turkey is based on oil price as a subsection of consumer and producer price index. Moreover, there is no previous literature which analyses short run or persistent effects of oil price on monetary policy or important macroeconomic variables for the economy of Turkey. It is indisputable to expect that the empirical conclusions for Turkey will be different. All these facts render Turkey a suitable country to analyze the effects of oil price.

Oil price fluctuations affect many macroeconomic variables. It is obvious that inflation is highly depended on increase in oil price in middle income or oil importing countries, like Turkey. Oil price has an important effect on aggregate price level because oil is a crucial imported input in production process and increase in world oil prices has been one of the major factors in high and persistent inflation since the late 1970s (Kibritcioglu, 2002). Oil price shocks may affect another macroeconomic variable, aggregate output level, through investment and consumption. Volatility in oil prices may increase investment uncertainty by delaying investment (Guo et al., 2005). Disposable income and consumption level is lowered by positive oil price shocks, which cause increase in cost of production for oil importing countries like Turkey (Berument et al., 2010). Both of these impacts decrease the aggregate output level. The impact of oil price shocks on exchange rate has not been investigated in detail in the literature. However, Balcilar et al. (2009), showed that exchange rate mechanism in an oil importing country, Turkey, is affected by the external oil price shocks. As another

macroeconomic variable, interest rate is a vital tool for monetary policy. Central Banks may increase interest rates in order to prevent inflation because of high oil prices or oil price shocks. Alper et al. (2008) claims that households in Turkey borrow funds in order to smooth consumption with the expectation that shocks may be temporary. Interest rates increases as households borrow funds. That is to say, interest rate in Turkey may increase by oil price shocks.

Studies in the literature on the effects of oil price fluctuations are mainly based on developed or oil exporter countries. For example, Hamilton (1983) explains the relationship between oil price and macroeconomic variables in the U.S. and concludes that increase in oil prices leads to recessions in the U.S. Although many studies exist for developed or oil exporting countries, the studies for oil importing countries, such as Turkey, are limited.

The aim of this study is to investigate the response of macroeconomic variables to oil price shocks in Turkey. The Vector Auto Regressive (VAR) model is used to analyze the short run and business cycle effects, from which the economy of Turkey is affected the most. In order to focus on a recent period and to avoid the impacts of 1973 oil crisis, which may cause structural breaks, the data is chosen to be between 1987Q1 and 2009Q4.

The study is organized as follows. Section 2 reviews the relevant empirical studies on oil price and its impacts on economies. Section 3 discusses important macroeconomic events and monetary policy mechanism in Turkey between the years 1987 and 2009. In Section 4, features of data and the way how they are extracted is explained. In Section 5, empirical methodology, VAR model, impulse response functions, lag length determination and Hodrick- Prescott filter method are presented and short theoretical descriptions are given. Thereafter, in Section 6, empirical results are presented analyzing impulse response functions. In Section 7, conclusion and final remarks are given.

2 LITERATURE REVIEW

Several studies analyzed the relationship between oil prices and macroeconomic variables using vector autoregressive models. Generally, it is concluded that the effects of oil prices on the economy are different among countries. Especially, it is observed that the impacts of oil

price are different in oil exporter and oil importing countries. In addition, it is obvious that there are differences between developing, middle income countries and developed countries.

Oil price shocks are the leading factors besides monetary policy in postwar recessions in the U.S. as explained by Hamilton (1993). According to Hamilton, increases in oil prices caused the recessions in real gross domestic product in the U.S. between years 1973-1975, 1980-1982 and 1990-1991. The study also emphasizes that dramatic increase in crude oil prices had caused seven of the eight postwar recessions in the U.S. In addition, Oladosu (2009) examines the principal relationship between oil prices and the GDP for closer period, 1947-2008. In this study, it is stated that oil prices and the GDP are negatively correlated by using the general interpretation of changes in oil price as an input price shock. These studies in the literature show that changes in oil price and GDP is negatively related in developed countries like the U.S.

The long run and short run relationships between output, money demand, oil prices, inflation, exchange rates and interest rates are modeled by Cologni et al. (2006) in a structural cointegrated VAR model for the G-7 countries. The direct effects of oil price shocks on output and prices are emphasized and the estimated coefficients of the structural part of the model are investigated. The effect of oil prices on the inflation rate for all countries except Japan and U.K are shown.

The output fluctuations in oil exporting countries like Iran and Saudi Arabia are related to the oil price shocks as shown by Mehrara et al. (2006) using a structural VAR approach. This study shows the stylized facts that in mostly oil dependent countries like Iran and Saudi Arabia which do not have the institutional mechanisms, oil shocks dominate output fluctuations. Farzanegan et al. (2009) investigates the dynamic relationship between oil price shocks and major macroeconomic variables in oil exporter country, Iran. The full sample is divided into two parts as 1975-1988 and 1989-2006 for quarterly data in order to compare the results for postwar period and the rolling bivariate VAR model for inflation, output, and real effective exchange rates are estimated. It is shown that there is an asymmetric effect of oil price shocks for inflation side. It means both negative and positive oil price shocks increase inflation. Since Iran is an oil exporter country and its economy is highly depended upon oil, a strong positive relationship between positive oil price shocks and output growth is emphasized. The empirical results in this study show that positive oil price shocks increase

the real effective exchange rate. That means domestic currency appreciates in the midterm and he calls this effect as one of the syndromes of a “Dutch disease”.

According to Gausden (2010), oil prices do not have a direct effect on the UK economy, the exchange rate, the real wage or the short-term interest rate over the period of floating exchange rates without substantial alterations. But whenever Gausden uses augmented VAR model in order to catch structural shifts, the oil price has a greater prominence on the economy.

One of few studies on developing economies is the study which Rafiq et al. (2008) had examined for Thai economy during 1993-2006. This study shows the impact of oil price volatility on key macroeconomic variables. In the study, it is confirmed that oil price volatility explains an important portion of fluctuations in investment which is a component of GDP and other important macroeconomic variable, unemployment rate.

Increase in oil prices leads to real gross domestic product losses in economic theory and empirical results according to Brown et al. (2002). This study explains the economic theory that tells the negative relationship between economic activity and oil prices. One of the reason why rising oil price inversely affects production is that oil is a basic input to production and supply side shocks which increase oil price may reduce this input. Other reasons are listed as shifting demand, monetary policy and adjustment costs. However, the authors also emphasizes that a classic supply side effect explains both decrease in output growth and increase in inflation mostly.

The relationship between macroeconomic variables is modeled by Ayadi et al. (2000) including financial sector and energy sector during 1975-1994 by using VAR model in oil dependent, emerging economy, Nigeria. The paper demonstrates that energy sector has a significant effect on the economy. Nigeria is not able to control the price of exports and imports; so according to the study, behaviors of macroeconomic managers are useless in order to prevent the effects of oil booms.

The oil prices and macroeconomics relation for six Asian countries over the period 1975Q1–2002Q2 is studied by Cunado et al. (2005). The study shows that there are significant effects on both economic activity and price indexes but it is limited for the short run and the effects are more significant when oil price is converted to local currency. In addition, the study

concludes that there are some differences among response of Asian countries to changes in oil price.

The long run relationship between the real price of oil and real effective exchange rates for developed countries such as Germany, Japan and the United States is discussed by Amano et al. (1996). The study develops the terms of trade model and it predicts real oil prices have effects on exchange rates on industrialized countries such as U.S., Germany and Japan.

The way oil price shocks affect output growth for some oil exporter and oil importer countries, basically oil price taking characterized MENA (Middle East and North Africa) countries, is provided by Berument et al. (2010). According to this study, increase in oil price has a significant and positive effect on the outputs of Algeria, Iran, Iraq, Kuwait, Libya, Oman, Qatar, Syria, and the United Arab Emirates.

The study by Alper et al. (2008) shows that Turkey has a negative response of real output to increase in oil prices, such as in developed countries, and this response has diminished after early 2000s. The study contains variables to take into account for global liquidity and this fact differentiates this study from others in the literature. In addition, Alper et al. (2009) reports that Turkish retail gasoline prices are positively related to increasing world crude oil prices using structural VAR methodology.

Using theoretical framework, Unalmis et al. (2008) discusses the origins and macroeconomic consequences of oil price shocks. This study works on the literature that real oil price is endogenously determined in the model and develops this model by modeling small open economy like Turkey to see the impact of oil price shocks which are caused by rest of the world. In this sense, the study concludes that “an unexpected decrease in oil supply and an expected reduction in oil supply which lead to a precautionary oil demand” are the reasons which makes oil price higher. This study also emphasizes the importance of monetary policy in order to deal with oil price shocks problem for a small open country. Because inflation and output gaps are the variables which are in the objective function of Central Banks and these variables change dynamically with various oil price shocks. According to the study, choosing an appropriate inflation target is an important issue for a small and open country such as Turkey in the sense of oil price shocks that are driven by rest of the world.

3 OVERVIEW OF IMPORTANT MACROECONOMIC EVENTS IN TURKEY DURING 1987-2009

The Turkish economy is a volatile economy that may be severely impacted by an important global crisis. The initiation of open market operations of Central Bank in 1987 is followed by the initiation of foreign-effective currency market in 1988. In 1989, the restrictions on capital flow or movements were completely abolished. Turkey has two major crises in the past two decades. The first crisis occurred in a managed floating rate regime at the beginning of 1994. The Turkish real gross domestic product contracted 6% which is the greatest loss recorded. During the crisis, the Turkish Lira was devalued more than 50% against the U.S. dollar in the first quarter of 1994, the Central Bank spent half of its reserves, interest rates rose sharply, and the inflation rate increased to three digit levels. The second crisis which was preceded by the financial fragility that began in the second part of November 2000 and the interest rate became more than five times higher than the preannounced value in the stabilization program.

3.1 The 1994 crisis

In the early 1994, Turkey encountered the highest current account deficit and public deficit which show the macroeconomic instability in its history. This unsustainable structural instability in the mid-long run and inaccurate policies were the main reasons of the economic crisis in 1994. According to Celasun (1998), the main reason behind the 1994 crisis was a growing domestic debt stock which could not be controlled. Disadvantages of fast capital account liberalization, which began in 1989 without any fiscal adjustment, had been observed in the financial liberalization process of Turkey.

Unlike other developing economies, where speculative attacks had caused macroeconomic instability, Turkish economy did not respond to economic decisions. On the contrary, these policies and decisions made Turkish economy worse. In the middle of the year 1993, the government announced that interest rate for domestic debt was too high and the short run policy of the government would be based on decreasing interest rates. In this sense, the government began to increase money supply. However, high liquidity and expectations about low interest rate increased the demand for foreign currency. The government thought that it was possible to restrict the demand for dollar by selling or decreasing the dollar reserves of the Central Bank. In this case, the main assumption was that the circulating money would be directed to the Istanbul Stock Exchange Market. However, this assumption did not hold

because commercial banks acted based on the information about a possible devaluation, and moreover, Istanbul Stock Exchange Market had a low transaction volume unable to handle the speculative capital. Hence, the exchange rate doubled (19.000 TRL/USD to 38.000 TRL/USD) and international reserves of the Central Bank decreased (7 billion dollars to 3 billion dollars) from January 1994 to April 1994. Because of the sharp increases in TRL/USD exchange rate and inflation expectations, and the inability of taking a debt domestically and the inability of finding a foreign credit after credit rating institutions had decreased the rating of Turkey, the government established an economic and financial stability program and made a standby agreement with IMF for 14 months.

On 5 April 1994, the government announced the new economic stability decision agreement. In order to decrease the demand for foreign currency and to pay short term domestic debt, the government was obliged to issue treasury bills with 400% interest rates. This effort to reduce interest rates made interest rates jump, on the contrary. The results were high unemployment, inflation over 100%, deterioration in balance of payments and devaluation. Following the devaluation of Turkish lira, exports level started to increase, imports level started to decrease, trade deficit became smaller and current account balance became positive in a short while. High interest rates were encouraged in order to regulate the system. In this period, the government followed only fiscal policy. Since no appropriate monetary policy was utilized, real gross domestic product contracted 6% at the end of the year. In 1995, Turkish economy started to recover these effects. However, the price level had a trend which was greater than before. At the end of the year 1994, whole price index increased to %150, and in 1995 increases in price level became 70%. Thus, the stabilization program after the crisis caused an increase in real gross domestic product, and surprisingly, an increase in inflation.

The sensitivity of political system and short-lived governments increased the uncertainty between the years 1996-1998 and the precautions were limited to regulating short run problems. Because of these reasons, mid run and lung run financial stability programs could not be successful in Turkey. Fast growth trend in Turkish economy, which had started in 1995, continued until the second part of the year 1998. However, both instability in political system and the crisis, which were directed by foreign conjuncture, ended this growth trend period.

Asian financial crisis, which started in 1997, affected the entire world including the Turkish economy, which is one of the emerging markets. During this crisis, capital outflows from

emerging markets, due to the decrease in global demand, had important impacts on Turkish economy.

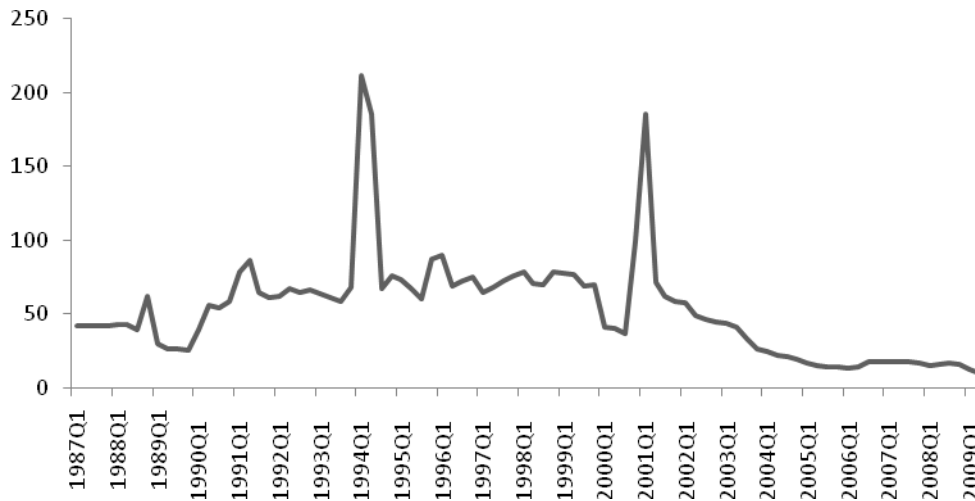


Figure 1: Weighted Average Interbank Overnight Rate, Quarterly Data, 1987–2009

3.2 The 2000-2001 Crisis

The second crisis which was preceded by the financial fragility that began in the second part of November 2000 during the exchange rate stabilization program. At the end of 2000, average overnight interest rates and secondary market bond rates were four times higher than the levels at the beginning of November (see Figure 1). Also, the interest rate was more than five times higher than the preannounced value in the stabilization program depreciation. On February 19, 2001 Prime Minister announced a severe political crisis between the government and the President. Immediately, the announcement was followed by a critical economic crisis in the already highly volatile markets. On the same day, overnight rates jumped to previous levels of 6.2%, and then, the exchange rate system collapsed. After this problem, Turkey declared that it was going to implement a floating exchange rate system.

The market was severely impacted by the crisis which arose after the lack of liquidity in November 2000. The stress on the markets was further increased by the rumors about banks and the arrests of some bank owners and businessmen. Under the impact of sell outs, the stock market fell to 1999 levels and the overnight interest rates increased to all time record values. In a short while, the foreign currency outflow reached to 7 billion dollars. The

precautions against the crisis did not do any help. However, the additional support of 10.4 billion dollars acquired from IMF, alleviated the stress in the markets for a while.

The main purpose of the new stand-by economical program settled with IMF in the early 2000 was to reduce the inflation rate. The program aimed a parallel increase in the foreign exchange rate and the inflation rate, while promoting investment in TRL. After the program was initiated, the Government was more relaxed in domestic debt, reduced interest rates increased the demand, and imports boomed. However, day by day, the banking system was going wrong, and delayed reforms were concerning the markets. Consequently, foreign investors started to fear about these circumstances.

According to Ozatay et al. (2003), the high current account deficit and real appreciation of Turkish lira are not only reasons which triggered the crisis. The reason behind the crisis was risk accumulation in the banking system before crisis caused by the increase in currency and maturity mismatches and the rise in nonperforming loans.

In November 2000, the concerns in the markets were too high, and the rumors about the banks were blocking the system more and more. In early November, the arrest of some of the bank owners created a panic in the market. These circumstances caused the investors to escape from the bond market, resulting in a sharp increase in the overnight interest rates on November 16th. On the following day, November 17th, 109 million dollars flew out of the markets of Turkey. The Central Bank of Turkey increased the money supply as an attempt to resolve the liquidity problem. On November 20th, after the panicked foreign investors started to cash out their bonds and leave the Turkish markets, Istanbul Stock Exchange sharply fell by 7.1%, while the bond interest rates stayed at 50%, the overnight interest rates rose above 100%. The rumors about one of the major banks, Demirbank, spread more, and, the crisis grew. Following these events, the prime minister of Turkey warned the markets to ignore these rumors. However, the markets could not ignore the rumors, and the stock exchange fell by 9% on November 28th. The overnight interest rate suddenly increased to 240%, although it had been reduced to 90% since November 20th. Some banks refused to supply money to the markets, and the Central Bank's foreign currency reserves were depleted in a short while. The heads of the Banking Regulation and Supervision Agency and the Central Bank held a meeting with the agents of all banks in Turkey. The next day, prime minister of Turkey held a meeting with economics staff, and, negotiations with IMF on a new stabilization program was initiated. Meanwhile, the amount of money that flew out from Turkey approached to 6

billion dollars. On November 30th, after the Central Bank announced that it will supply money in return of foreign exchange, the overnight interest rate increased to 400%, and the stock exchange fell by 8%.

Following these events, IMF held an urgent meeting to help Turkey. As IMF suggested, the Council of Ministers announced a package of measures, which included the privatization of 33.5% of Turk Telekom and significant increases on the taxes related to automobiles. Moreover, a restructuring board for the privatization of the banks was formed.

Ozatay et al. (2003) emphasizes that budget deficits were primarily financed with the help of government securities but this mechanism is sustainable when there is a demand for government securities. In this sense, a decrease in demand forced authorities to monetize and this caused a jump in both the exchange rate and the inflation rate.

After these crises in 2001, Central Bank of The Republic of Turkey became totally independent with the change in legislative law on 25 April 2001. Moreover the main aim was determined as achieving price stability with this law. In addition, in February 2001 crisis, the exchange rate regime became floating. All of these important events may affect the direction of this study. It is obvious that there are improvements and differences in behaviors and tactics of Central Banks in these years. The preliminary target becomes inflation and directing monetary policy by using short term interest rate tool becomes important in the role of Central Banks. There are many reasons behind it such as easy compatible of interest rate in the short run, flexible exchange rate system is used and increase in the role of Central Banks. Short term interest rates especially overnight rates are important targets because changes in short term interest rates determine mid run and long run interest rates with expectations mechanism.

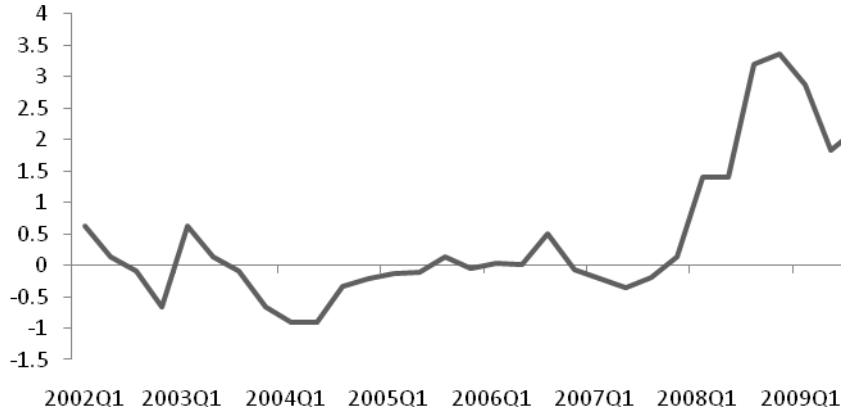


Figure 2: Consumer Price Index (Only Energy) in Turkey, 2002-2009

The effects of increases in oil price on Turkish economy during 1987-2009 can be summarized as follows. Since Turkey is a net oil importer country, even though the country reduces the level of import as a result of increase in oil prices, Turkey still pays the high amount of money for this import. In this sense, balance of payments deteriorates. Mostly, oil prices affect inflation with taxes as an indirect way. The main reason why oil prices increase inflation is that it increases costs of production when the price of imported crude oil price increases. Figure 2 shows the increase in energy subtitle of consumer price index in Turkey and there is a significant increase in 2008 when world crude oil price has the highest level. In addition, it is obvious that the increase in imports of Turkey does not depend on level of imported oil; it depends on the increase in oil prices all over the world.

4 METHODOLOGY

4.1 The Basic Framework of Vector Autoregressive Model (VAR Model)

VAR model is defined as a model that analyzes dynamic effect of random disturbances on the variables. Each variable is equal to both its own lagged values and the lag values of all the other variables in the model. A first order VAR model is given in Verbeek (2008, p. 322) as

$$\begin{aligned} Y_t &= \delta_1 + \theta_{11}Y_{t-1} + \theta_{12}X_{t-1} + \varepsilon_{1t} \\ X_t &= \delta_2 + \theta_{21}Y_{t-1} + \theta_{22}X_{t-1} + \varepsilon_{2t} \end{aligned} \quad (1)$$

where ε_{1t} and ε_{2t} are white noise (independent of lags of Y_t and X_t). If the coefficients are not equal to zero, it means that they show the history or X_t will explain Y_t . The linear system can be written as matrices system:

$$\begin{pmatrix} Y_t \\ X_t \end{pmatrix} = \begin{pmatrix} \delta_1 \\ \delta_2 \end{pmatrix} + \begin{pmatrix} \theta_{11} & \theta_{12} \\ \theta_{21} & \theta_{22} \end{pmatrix} \begin{pmatrix} Y_{t-1} \\ X_{t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix}. \quad (2)$$

VAR (p) model is a higher dimensional case of AR model and it can be written as

$$\vec{Y}_t = \delta + \Theta_1 \vec{Y}_{t-1} + \dots + \Theta_p \vec{Y}_{t-p} + \vec{\varepsilon}_t, \quad (3)$$

where \vec{Y}_t is a vector of endogenous variables, each Θ_j is a $k \times k$ matrix and $\vec{\varepsilon}_t$ is a k -dimensional vector of white noise terms with covariance matrix Σ (Verbeek, 2008).

Also the VAR model may include exogenous X_t variables and the model is given as

$$\vec{Y}_t = \delta + \Theta_1 \vec{Y}_{t-1} + \dots + B X_t + \dots + \Theta_p \vec{Y}_{t-p} + \vec{\varepsilon}_t. \quad (4)$$

In (4), \vec{Y}_t is a vector of endogenous variables, \vec{X}_t is a vector of exogenous variables, ε_t is an innovation or error vector and A and B are coefficient matrices which will be estimated. It is possible to add constant, deterministic trend or dummy variables into VAR model.

VAR model was firstly discussed by Sims (1980) as an approach which disregards the theoretical restrictions of simultaneous equation systems. The main importance of this new methodology is that the zero restrictions are not used. Therefore, there are no restrictions which are based on economic theory in this model. That means the model is formed by using characteristics of our data. This statement may be thought that economic theory is not important for VAR modeling at first sight. However, selection of variables for VAR model in the sense of economic theory shows that VAR model and economic theory are related.

There are several advantages of the VAR Model. One of them is that lagged components of endogenous variables are known at time t so this model does not have a simultaneity problem and OLS is usable for estimation. Another advantage is that the model is easily utilizable by changing number of variables. According to Verbeek (2008), one of advantages using VAR

model is that the model may be more parsimonious and this makes the forecasting more precise because the variables are modeled simultaneously and the lagged components of variables make the model more informative. Vector Error Correction Model (VECM) is an advanced version of VAR model which contains restrictions. However, according to Sims (1980), all modeled variables may have an influence on all other variables in the system. He states that distinction of exogenous and endogenous variables is not an issue and this distinction is a complicated. That means all variables may be defined as endogenous. In this sense, VAR is better than structural simultaneous models which have restrictions.

There are several disadvantages of VAR model. One of disadvantages of using VAR model is that the series have to be stationary in the model only for inference. Since data contains unit root mostly, the data have to be differenced in order to make them stationary. However, there is an argument about differencing data changes the structure of data and that causes of losing long run information. In this study, there will be an alternative approach, HP filter approach which is used without differencing data and this approach will analyze more persistent and relatively longer run effects. Another disadvantage is that VAR model may contain degrees of freedom problem. Kennedy (2008, p.306) states that there is a compulsion about taking small set of variables in VAR model because number of variables is an important issue that may cause degrees of freedom problem since there is no exogenous variable in the model.

4.2 The Basic Framework of Lag Length Selection, Impulse Response Functions and Hodrick-Prescott Filter Method

4.2.1 Lag Length Selection

Lag length selection is a debate which information criteria are used in order to choose the optimum length for unrestricted VAR model. Since the model which is used in this study does not have an exogenous variables, number of lag starts from one. According to Verbeek (2008, p. 324), it is not easy to determine lag length in VAR model and lag length selection strategies may be based on the basis of Akaike or Schwarz Information criteria or basis of statistical significance.

According to Brooks (2008, p. 293), there are two common approaches in selection of lag length. One of them is cross-equation restrictions for lag length selection. In the VAR

modeling, the correct procedure is to test the coefficients on a set of lags on all variables for all equations in the VAR at the same time. With the aim of VAR modeling, VAR models should be formed as unrestricted as possible. In the case which equations have different lag lengths, the VAR model becomes restricted VAR and some coefficients are equalized to zero.

Another approach in order to determine lag length selection is to look at information criteria. According to Brooks (2008, p. 294), distribution of disturbance terms are not assumed as normal and this approach focuses on the residual sum of squares (RSS) and the penalty the loss of degrees of freedom when extra parameters are added. When the extra variable is added to model or the additional lag is added, RSS decreases and the penalty value increases. The common information criteria are Akaike's information criterion (AIC), Schwarz's Bayesian information criterion (SIC) and the Hannan-Quinn information criterion (HQIC).

The purpose of this approach is to choose number of lags which minimizes the value of the information criterion. However, there is a debate in which criterion is the best one. These criteria may be compared in order to choose an appropriate lag length. If there is a comparison between these criteria, SIC may be seen as the most consistent one but it is inefficient one and AIC is not stable but usually more efficient one (Brooks (2008, p. 294)).

4.2.2 Impulse Response Functions

Impulse responses show the responsiveness of the dependent variables to shocks and to each of the variables in VAR model. A unit shock is applied to the error to each equation separately and the effects on the system may be traced out on output. Number of G^2 impulse responses can be seen if there are G variables (Brooks (2008, p. 299)).

VAR model can be given in vector moving average to see impulse responses in the case shocks should die away in the system practically (Brooks (2008, p. 299)).

According to Verbeek (2008, p. 324), the effect on \vec{Y}_{t+s} ($s > 0$) is given by

$$R_s = \frac{\partial \vec{Y}_{t+s}}{\partial \vec{\varepsilon}_t}. \quad (5)$$

This matrix in (7) can be described as its (i, j) -element shows the effect of a one-unit increase in ε_{jt} upon $Y_{i,t+s}$. After one unit increase, the dynamic effects upon the j -th variable

are seen by the elements in the first column and j -th row of I_k, R_1, R_2, \dots . A representation or graph of these elements is called the impulse response function. The response of $Y_{j,t+s}$ to an impulse in Y_{1t} is given, keeping all other variables constant for t and before. The accumulated response function is shown as

$$AR_s = \sum_{i=1}^s R_i . \quad (6)$$

4.2.3 Hodrick-Prescott Filter Method

The Hodrick-Prescott filter is a method used in economics such as in real business cycle theory in order to eliminate the cyclical part of a time series from original data. This method was first used by Hodrick and Prescott in order to analyze postwar U.S. business cycles. (Hodrick, 1997) Theoretically, as it is mentioned in E-views 6 user's guide, the HP filter minimizes the function

$$\sum_{t=1}^T (y_t - s_t)^2 + \lambda \sum_{t=2}^{T-1} ((s_{t+1} - s_t) - (s_t - s_{t-1}))^2 \quad (7)$$

and chooses s , where λ is a penalty parameter and it shows the smoothness of the series. In this study, λ is determined as 1600 because the data set is quarterly.

5 DATA

The data set consists of quarterly data between 1987Q1-2009Q4. The data set begins with 1987 to capture the effects of transition to liberalization period in Turkey. The availability of more accurate statistics in Turkey after 1987 is another important reason why 1987 is chosen as the initial year in the data set. However, this period is divided into subsamples in order to explore effects of oil price on macroeconomic variables properly because Central Bank of The Republic of Turkey became independent with the change in legislative law on 25 April 2001. Moreover the main aim was determined as achieving price stability with this law. In addition, in February 2001 crisis, the exchange rate regime became floating. If we consider the effects of these structural changes take up to two quarters that seems plausible to divide

subsample from 2002Q1. In this sense, the analyses are taken into account for two sub periods, 1987Q1-2001Q4 and 2002Q1-2009Q4.

Crude oil price data (USD/barrel) are extracted from U.S. Energy Information Administration, Independent Statistics and Analysis. Then in order to find real crude oil price, the data is deflated by using U.S. consumer price index (U.S. city average) which are taken from United States Bureau of Labor Statistics and its base period is 1982-84=100. Inflation deflated crude oil price is taken into account because crude oil price may be volatile because of U.S. inflation and the important issue is that pure effect of crude oil prices on Turkish economy, not effect of U.S. inflation on Turkish economy.

Real gross domestic product, consumer price index, monetary aggregate (M2), nominal exchange rate (TRY/USD), nominal interest rates data are extracted from Electronic Data Delivery system of Central Bank of the Republic of Turkey (CBRT). The 1987-2006 period is taken by using kind of activity and in producers' value at 1987 prices (Million TRL) for real gross domestic product data and 2006-2009 period data is generated by using overlapping data of value at 1998 prices, Million TRL. Since Turkey is a high inflationary country, it is preferred to take into account gross domestic product in constant prices because the focus of analysis should be the effect of real crude oil price on real gross domestic product, not the effect on inflation since effects on inflation is analyzed as an another case. Consumer price index data are generated for 1987-2004 periods that are based on 1987=100 price index and 2005-2009 period data is generated by using overlapping data of price index based on 2003. Monetary aggregate variable (Temporary Data, TRY Thousand) data are determined as “Beginning from 2005, with the addition of participation banks, investment and development banks all money supply definitions was rearranged. New definitions became $M2 = M1 + \text{Time deposits (TRY, FX)}$ ”¹ Central Banks may change monetary base by using open market operations, buying or selling bonds in exchange for currency and this causes a change in monetary base. Nominal exchange rate data are calculated as an average of buying and selling data. CBRT makes the data before 01.01.2005 are divided to million to avoid breaks in the graphs and to provide integrity. Finally, nominal interest rates data as a percentage are represented by interbank weighted overnight simple interest rate. “The interbank transactions rate is calculated as daily average rates weighted by the volume of transactions. The monthly average interest rate is calculated from the daily weighted rates for

¹ OECD definition

the month, weighted by monthly transaction amounts. Annual and quarterly data refer to the final month of the period.”²

6 EMPIRICAL RESULTS AND DISCUSSIONS

In this section, empirical results of all tests and VAR estimation are discussed and their macroeconomic interpretations are accounted for this analysis using econometric software program E-views. The variables are seasonally adjusted using Census X12 multiplicative method following the built information in E-views and then logarithm of the series are taken to observe the relative size effects. The analysis includes six macroeconomic series after differencing the series:

dcpi: First difference of consumer price index

di: First difference of interbank overnight interest rate

dm2: First difference of money supply (m2)

dexc: First difference of nominal exchange rate

dgdpc: First difference of real gross domestic product

doil: First difference of real world oil price

Generally, the amount of the output growth effect and inflation rate effect of an oil shock is related to many factors: the size of an oil price shock that can be described as increases in oil prices and the real oil price, the persistence of the shock, how much the economy of the country depends on oil and the monetary and fiscal policy responses of the country.

6.1 Effects of Oil Prices in the Short Run

In this part, there is an analysis on the first differenced data and quarterly dataset are used to explore the effects of real crude oil prices on macroeconomic variables for short run such as 3-6 months. In the following parts, unit roots tests are obtained, VAR estimation results are shown and accumulated impulse response graphs are interpreted.

² OECD definition

6.1.1 Unit Root Tests

The variables should be stationary for inference in order to apply unrestricted VAR model. Graphs of the series, as we can see in Figure A.1 in appendix, show that the series are non stationary. In order to be sure, three unit root tests, Augmented Dickey Fuller (ADF), Phillips Perron (PP) and Dickey Fuller (DF), are done. In addition, a stationary test Kwiatkowski-Phillips-Schmidt-Shin (KPSS) is done. All of the series seem non stationary or they have unit roots since their test statistics are in the non rejection area at 5% level except KPSS test. Because KPSS test has null hypotheses which claims the series is stationary.

Logarithms of all series are taken because relative changes are better to be analyzed. Since it can be seen in Figure A.1 in appendix, they are mostly positively sloped and that means the series have unit roots. Also the unit root tests show that the series are non stationary. Therefore, all of the series are taken as firstly differenced. Even if financial and macroeconomic series are mostly stationary after differencing the data, in order to be sure, unit root and stationary tests are done. Three unit root tests, ADF, PP and DF are performed in order to check whether series have unit root. In addition, KPSS test which has a null hypothesis that claims series are stationary is done.

As it can be seen in Table 1 below, we can reject the null hypotheses for the series at 5% level when we apply unit root ADF and PP tests since t statistics of all the series are greater than the critical value and it means test statistics are in the rejection area. In addition, KPSS test shows that series are stationary.

Table 1: Unit root test results

Variables	ADF test	DF test	PP test	KPSS test*
dcpi	-3.866	-1.705	-6.240	0.279
di	-9.322	-9.373	-13.527	0.117
dm2	-5.218	-2.570	-5.123	0.253
dexc	-6.687	-6.185	-6.763	0.221
dgdg	-9.067	-8.145	-9.067	0.034
doil	-7.569	-7.542	-7.569	0.027
%5 level critical value	-3.461	-3.068	-3.460	0.146

*KPSS test is based on LM statistics and it has a null hypothesis which claims the series is stationary.

**All tests are done with trend and intercept.

6.1.2 VAR Estimation Results

In this part, VAR estimation results are discussed and the significant effects of real oil price are interpreted. Firstly, in order to select the best lag length for VAR model, information criteria approach is used. Since constant variable (c) is determined as exogenous in the model, the lag starts at zero. E-views does the lag length selection tests automatically and gives an optimum result. E-views gives that LR is a sequential modified LR test statistic (each test at 5% level), FPE is a final prediction error, AIC is Akaike information criterion, SC is Schwarz information criterion and HQ is Hannan-Quinn information criterion.

For subsample 1, both AIC and HQ information criterion show that the fourth lag length is optimum since they are the lowest values. Even if second lag is selected by considering LR and FPE, as it is mentioned in the methodology part of this study, Brooks (2008, p. 293) states that the disadvantage of cross equation restrictions as X^2 test is valid asymptotically if and only if the disturbance terms in each equations are normally distributed. This disadvantage of these criteria causes to determine optimum lag length as 4. Also AIC and HQ are most common information criteria so AIC and HQ are considered in order to decide which lag length is optimum. For subsample 2, all information criteria show that the fourth lag length is optimum since they are the lowest values. The lag length criteria test in E-views can be done until fourth lag because E-views cannot take a logarithm of non positive numbers in data and cannot analyzes another lags.

Impulse response analysis is affected by the order of the variables. Because of this reason, the variables should be ordered from exogenous to endogenous before estimation. With this aim, Granger causality tests may be applied but Granger causality tests are sensitive to lag length so they may give problematic and misleading results. Since oil price is determined in the rest of the world or world market and it is thought as exogenous to Turkish economy, real oil price comes first in this analysis.

Since the focus of this thesis is to analyze the effects of oil price shocks on Turkish economy, the study investigates only effects of real world crude oil prices on macroeconomic variables so only the related part which shows the equations of oil price with lagged variables is shown in the estimation output of E-views. Since each column shows an equation in the system in estimation results, there are six equations. In the estimation output, the estimated coefficient, the standard error in parentheses and t statistic in square brace are reported.

6.1.2.1 Subsample 1: 1987Q1-2001Q4

According to Table 2, there is no significant effect of real oil price on macroeconomic variables for subsample 1 in the short run since their absolute t values are less than approximately 2. Since Central Bank of the Republic of Turkey follows a monetary policy which focuses on growth, especially before the crisis in 1994, it is expected that the response of real gross domestic product should be negative. Even if it is mentioned in the previous literature that real output has negative response to oil price shocks, it is hard to say that relative real oil price (differenced logarithm of the series) affects real gross domestic product. For further analysis, it is better to look at impulse response graphs in following parts.

Table 2: VAR Estimates for 1987Q1-2001Q4

	Real Oil Price	CPI	Exchange Rate	Interest Rate	M2	Real GDP
Real Oil Price (-1)	0.429 (0.176) [2.435]	0.011 (0.049) [0.234]	-0.056 (0.102) [-0.548]	-0.033 (0.432) [-0.077]	0.069 (0.039) [1.760]	0.050 (0.029) [1.729]
Real Oil Price (-2)	-0.541 (0.202) [-2.682]	-0.027 (0.056) [-0.487]	-0.015 (0.117) [-0.130]	-0.297 (0.495) [-0.599]	-0.035 (0.044) [-0.794]	-0.045 (0.033) [-1.366]
Real Oil Price (-3)	0.536 (0.215) [2.486]	-0.020 (0.060) [-0.345]	0.040 (0.125) [0.323]	0.008 (0.529) [0.016]	-0.016 (0.048) [-0.346]	0.048 (0.035) [1.358]
Real Oil Price (-4)	-0.339 (0.209) [-1.617]	-0.054 (0.059) [-0.920]	-0.145 (0.122) [-1.194]	-0.172 (0.514) [-0.335]	-0.016 (0.046) [-0.348]	0.016 (0.034) [0.462]

R squares of estimations are 0.515 for first subsample and 0.843 for second subsample. These values are quite high and the explanatory variables, lag variables of real oil price can explain macroeconomic variables in this case.

Several residual tests are done for VAR estimation of all two subsamples and two approaches in this thesis to check whether there is a serial correlation or heteroskedasticity problem. The results show that VAR residual serial correlation LM test for 5 lags does not reject the null hypothesis which claims there are no serial correlations for all estimation results. In addition, white heteroskedasticity tests (no cross terms) which show the test regression is run by

regressing each product of residuals by using only levels and squares of components. These tests show there are no heteroskedasticity problem with the null hypothesis of no heteroskedasticity the non-constant regressors should not be jointly significant with built results in E-views.

6.1.2.2 Subsample 2: 2002Q1-2009Q4

Table 3 shows that first lag of real oil price affects consumer price index and also the first and second lag affect real GDP in the short run since absolute t value is greater than approximately 2. The response of changes in consumer price index to changes in real oil price is positive and that seems meaningful because Turkey is oil importing and small open economy and positive oil price shocks which come from rest of the world affect main subtitle of consumer price index such as retail gasoline prices and transportation in Turkey. Especially, significant increase in real oil prices in 2008 may be a reason for this positive effect on consumer price index in this period.

Table 3: VAR Estimates for 2002Q1-2009Q4

	Real Oil Price	CPI	Exchange Rate	Interest Rate	M2	Real GDP
Real Oil Price (-1)	-0.095 (0.546) [-0.174]	0.056 (0.017) [3.163]	-0.152 (0.283) [-0.538]	0.032 (0.342) [0.094]	-0.010 (0.095) [-0.109]	0.182 (0.073) [2.500]
Real Oil Price (-2)	-0.028 (0.680) [-0.041]	0.004 (0.022) [0.225]	-0.487 (0.352) [-1.385]	-0.257 (0.426) [-0.604]	0.099 (0.119) [0.834]	0.207 (0.090) [2.280]
Real Oil Price (-3)	-0.903 (0.625) [-1.443]	-0.008 (0.020) [-0.424]	0.124 (0.324) [0.383]	-0.485 (0.392) [-1.237]	0.155 (0.109) [1.420]	-0.028 (0.083) [-0.337]
Real Oil Price (-4)	-0.446 (0.327) [-1.365]	-0.015 (0.010) [-1.467]	0.110 (0.169) [0.649]	0.134 (0.205) [0.654]	0.043 (0.057) [0.758]	-0.039 (0.043) [-0.901]

6.1.3 Impulse Response Results

It is possible to determine the direction and amount of how much variables in the VAR model respond to shocks in error terms using impulse response analysis. In this study, accumulated

impulse response graphs are used in order to interpret the effects of real oil price consistent with previous literature studies. Because Turkish macroeconomic time series data are very volatile and accumulated impulse response functions that represent the integral of impulse responses may show more persistent effects than impulse response functions which show the effect of one time shock. In the analysis, 10 periods are selected in order to see responses for 3-6 months. This time interval is 2.5 years since this study uses quarterly data. The graphs show the time path of accumulated impulse responses of each macroeconomic variable to changes in real world crude oil price. The graphs also include one standard error interval on the accumulated impulse responses.

6.1.3.1 Subsample 1: 1987Q1-2001Q4

Figure 3 shows accumulated responses for 10 periods. To examine the accumulated responses for 10 periods seems plausible because 10 periods is equivalent to 2.5 years and this part focuses on short run effects (3-6 months). The figures are ordered as first left to right and then top to bottom. As it can be seen from the second graph of Figure 3, accumulated response of inflation rate to real oil price changes is decreasing between 6 and 18 months. However, there is an increasing response after 2 years. The third graph demonstrates the accumulated response of change in nominal exchange rate to change in real oil price. This graph shows there is an appreciation of Turkish lira between period 15 months and 2.5 years. The fourth graph depicts there is a positive response of short term interest rate to real oil price changes between 1 and 2 years. The fifth graph shows the decreasing accumulated response of money supply (m2) to real oil price changes between 6 months and 2 years. The last graph shows decreasing accumulated impulse response of changes in real GDP to changes in real oil price between 15 months and 2.5 years. The main question here is whether the responses of real GDP continue to decrease after period 10. However, the response becomes stable. The only result about the effects of real oil price on real GDP may be that oil price shocks make real GDP volatile in the short run. The general impacts of real oil price shocks are observed on growth and inflation rate so the interpretation of accumulated impulse responses focuses on real GDP and consumer price index. Since impulse responses for relatively shorter periods (3-6 months) are analyzed in this section, these results direct the research in order to look at the effects on business cycles or more persistent effects of oil price.

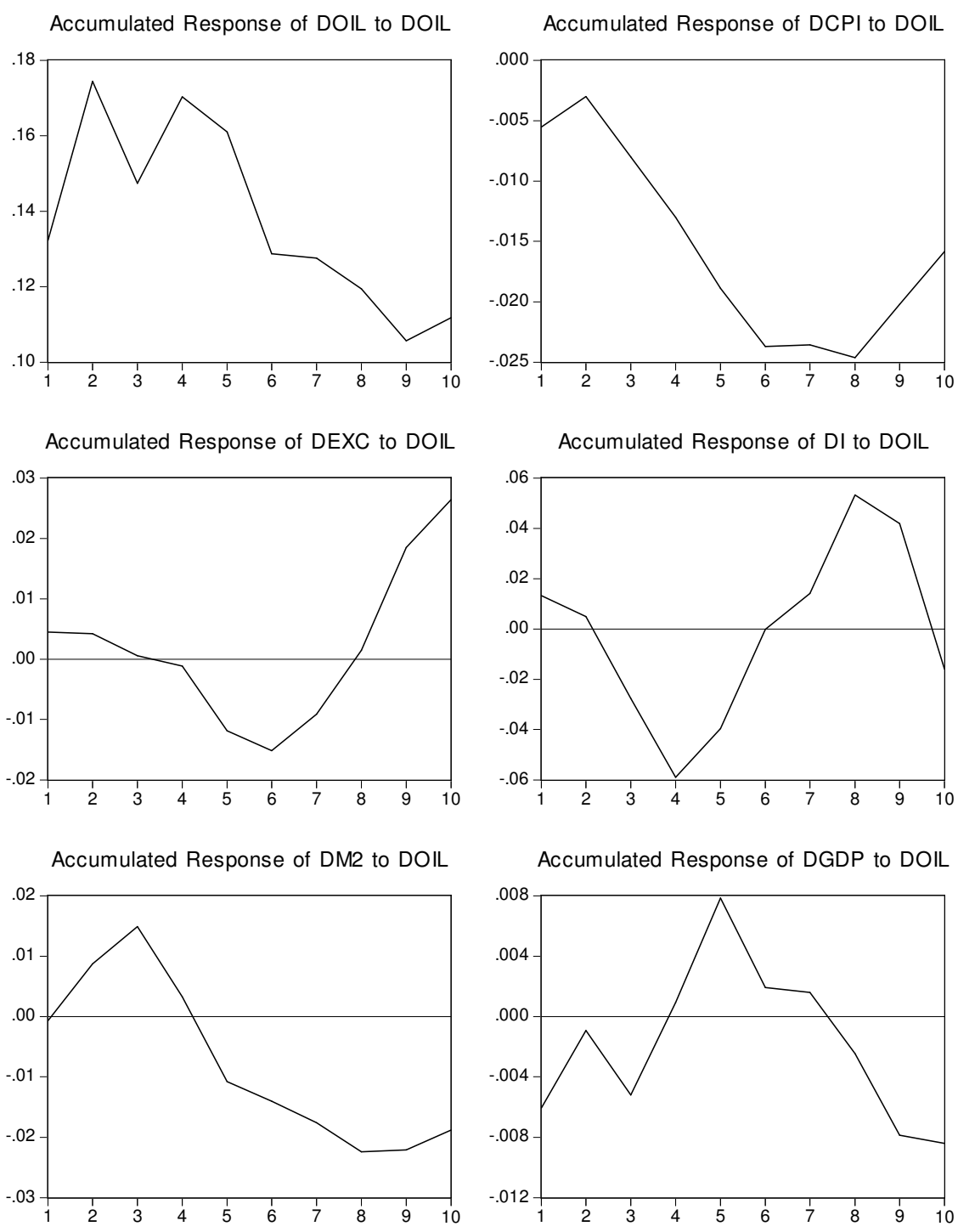


Figure 3: Accumulated Impulse Responses for 1987Q1-2001Q4

6.1.3.2 Subsample 2: 2002Q1-2009Q4

In this section, accumulated responses of macroeconomic variables to changes in real oil price in the short run for years 2002-2009 is given. Figure 4 shows there is a positive response of inflation rate to real oil price until 9 months and there is a decreasing response between 15 months and 27 months as we can see from graph 2. Turkey is a developing country which has inflation responds to changes in world crude oil prices quickly relative to other developing countries (Zola, 2009). The author emphasizes that Turkey responds to international oil price shocks in six months and this time is shorter than other 17 developing countries. The third graph shows there is a decreasing response of exchange rate which means that Turkish lira depreciates between 18 and 27 months. The fourth graph depicts that there is an increasing response of short term interest rate change to real oil price after 6 months. This conclusion seems plausible because Central Bank implements inflation targeting rule in this period and increases in interest rate is meaningful with an increase in inflation rate. The fifth graph shows that there is also increasing response of m2 to real oil price shocks after 6 months. The last graph demonstrates that there is an increasing accumulated response of real GDP to real oil price shock between 15 and 27 months. Since impulse responses for relatively shorter periods (3-6 months) are analyzed in this section, these results direct the research in order to look at the effects on business cycles or more persistent effects of oil price.

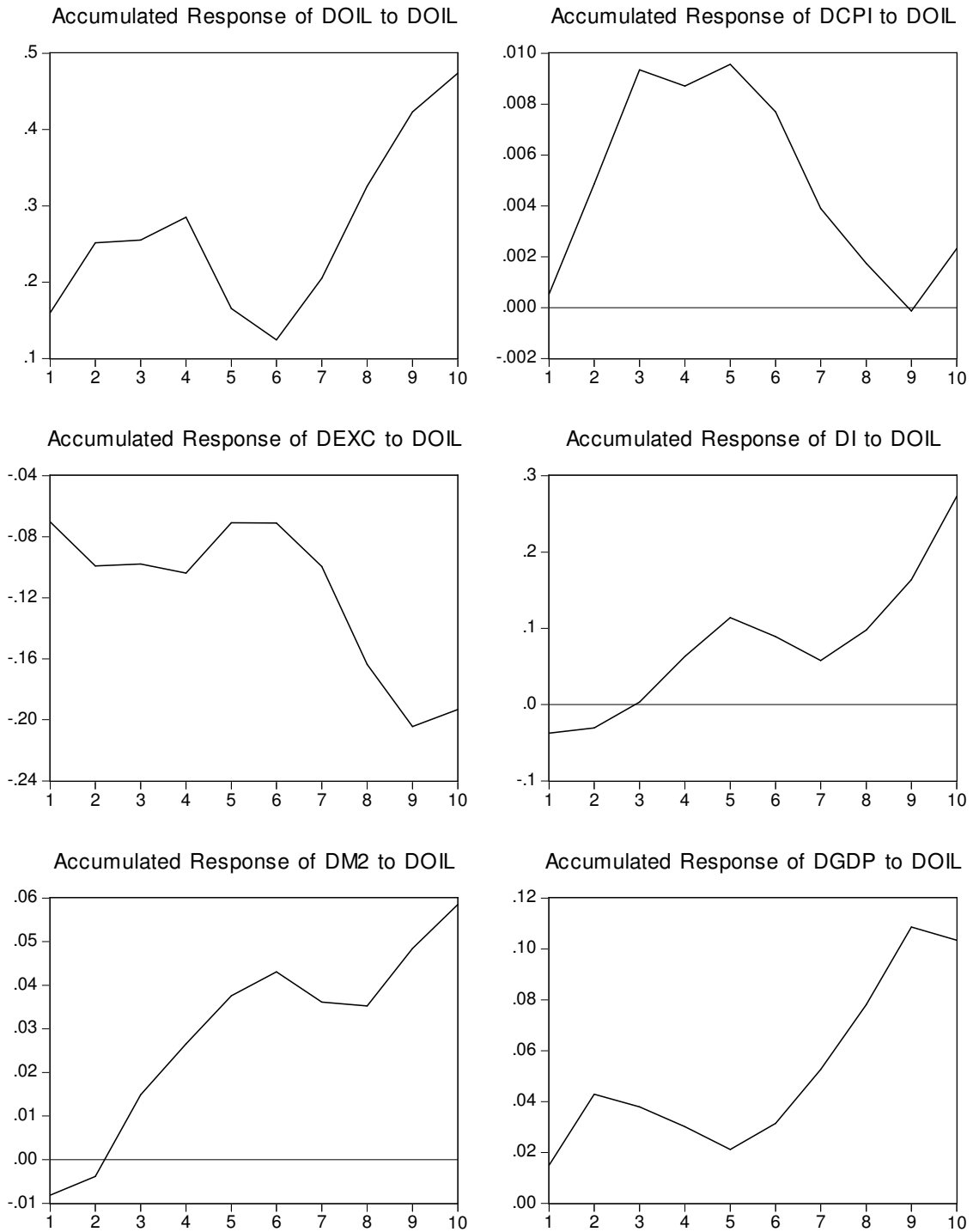


Figure 4: Accumulated Impulse Responses for 2002Q1-2009Q4

6.2 Effects of Oil Prices on Business Cycles

In this part, more persistent effect of real crude oil prices on macroeconomic variables on business cycles (mid run effect such as 2-5 years) is discussed.

6.2.1 HP Filter Approach

All data set except interest rate are seasonality adjusted using Census X12 multiplicative method. Then logarithm series of all data are generated before using HP filter cycle approach. Finally, HP filtered new cycle series are generated as roilpgap, intgap, rgdpgap, m2gap, excgap and cpigap.

Since the HP filter method is applied, there is no unit root problem for series and next step is VAR estimation in order to see effects of oil prices on macroeconomic variables.

The general form of VAR model can be given as:

$$\text{VAR} = F(\text{roilpgap}, \text{rgdpgap}, \text{intgap}, \text{excgap}, \text{m2gap}, \text{cpigap})$$

6.2.2 VAR Estimation Results

In this part, VAR estimation results are discussed and the significant effects of real oil price gap are interpreted. For subsample 1, LR, FPE and AIC information criteria show that the fourth lag length is optimum since they are the lowest values. For subsample 2, all information criteria show that the fourth lag length is optimum since they are the lowest values. This result is consistent with the result in another approach in Section 6.1.2.

In this section, unrestricted VAR model is used for six HP filtered macroeconomic variables. This section investigates only effects of real world crude oil price gap on gaps of macroeconomic variables so only the related part which shows the equations of real oil price gap with lagged variables is shown in the estimation output of E-views. Since each column shows an equation in the system in estimation results, there are six equations. In the estimation output, the estimated coefficient, the standard error in parentheses and t statistic in square brace are reported.

6.2.2.1 Subsample 1: 1987Q1-2001Q4

Table 4 shows that response of five macroeconomic variables gaps to real oil price gap and its lagged variables and this section investigates more persistent effects of real crude oil price on variables. Second and third lag of real oil price gap have significant effect on real gross domestic product gap since their t values are greater than approximately 2. In addition,

second lag has more significant effect than other lag because its t value is greater than t value in other lag. This estimation output emphasizes that real gross domestic product has a response to real crude oil price both on business cycles and negative response of real GDP is more significant than positive response. Other absolute t values are less than approximately 2 so that means real oil price gap has no significant effect on consumer price index, exchange rate, interest rate and money supply (m2) in this subsample. This result shows the effects of real oil price on real GDP is more significant in the mid run.

Table 4: VAR Estimates for 1987Q1-2001Q4

	Real Oil Price Gap	CPI Gap	Exchange Rate Gap	Interest Rate Gap	Real GDP Gap	M2 Gap
Real Oil Price Gap (-1)	0.930 (0.162) [5.733]	-0.002 (0.046) [-0.053]	-0.025 (0.103) [-0.251]	0.077 (0.422) [0.183]	0.038 (0.030) [1.273]	0.066 (0.037) [1.767]
Real Oil Price Gap (-2)	-0.566 (0.221) [-2.553]	0.002 (0.063) [0.041]	0.148 (0.140) [1.056]	0.065 (0.577) [0.113]	-0.099 (0.041) [-2.417]	-0.084 (0.051) [-1.646]
Real Oil Price Gap (-3)	0.646 (0.245) [2.634]	-0.040 (0.069) [-0.580]	-0.085 (0.155) [-0.551]	-0.100 (0.639) [-0.157]	0.093 (0.045) [2.053]	0.023 (0.056) [0.413]
Real Oil Price Gap (-4)	-0.458 (0.167) [-2.736]	-0.008 (0.047) [-0.174]	0.007 (0.106) [0.067]	0.327 (0.436) [0.749]	-0.030 (0.031) [-0.993]	-0.003 (0.038) [-0.081]

R squares of estimations are 0.864 for first subsample and 0.938 for second subsample. These values are quite high and the explanatory variables, lag variables of real oil price gap can explain macroeconomic variables gap in this case.

6.2.2.2 Subsample 2: 2002Q1-2009Q4

Table 5 shows that first lag of real oil price gap affects consumer price index since absolute t value is greater than approximately 2. The response of changes in consumer price index to changes in real oil price is positive and that seems meaningful because Turkey is oil importing and small open economy and positive oil price shocks which come from rest of the world affect main subtitle of consumer price index such as retail gasoline prices, transportation in Turkey. Especially significant increase in real oil prices in 2008 may be a

reason for this positive effect on consumer price index in this period. This result shows that changes in real oil price have impacts on consumer price index both in relatively short term which it is discussed in previous section and on business cycles or these changes also have persistent effects on inflation.

Table 5: VAR Estimates for 2002Q1-2009Q4

	Real Oil Price Gap	CPI Gap	Exchange Rate Gap	Interest Rate Gap	M2 Gap	Real GDP Gap
Real Oil Price Gap(-1)	0.674 (0.452) [1.491]	0.087 (0.013) [6.289]	0.252 (0.264) [0.957]	0.358 (0.194) [1.843]	0.005 (0.079) [0.073]	0.035 (0.074) [0.478]
Real Oil Price Gap (-2)	0.748 (0.726) [1.029]	0.032 (0.022) [1.441]	-0.108 (0.424) [-0.256]	0.133 (0.312) [0.427]	0.119 (0.127) [0.937]	0.062 (0.120) [0.516]
Real Oil Price Gap (-3)	-0.186 (0.587) [-0.316]	0.008 (0.018) [0.452]	0.331 (0.343) [0.966]	-0.316 (0.252) [-1.253]	0.075 (0.103) [0.729]	-0.134 (0.097) [-1.383]
Real Oil Price Gap (-4)	-0.466 (0.459) [-1.015]	-0.016 (0.014) [-1.151]	0.144 (0.268) [0.539]	0.025 (0.197) [0.128]	0.028 (0.080) [0.351]	-0.047 (0.075) [-0.622]

6.2.3 Impulse Response Results

In the analysis, twenty periods are selected in order to see responses for 2-5 years. This time interval is 5 years since this study uses quarterly data. The graphs show the time path of impulse responses of each macroeconomic variable gap to real world crude oil price gap. The graphs also include two standard error intervals on the impulse responses.

6.2.3.1 Subsample 1: 1987Q1-2001Q4

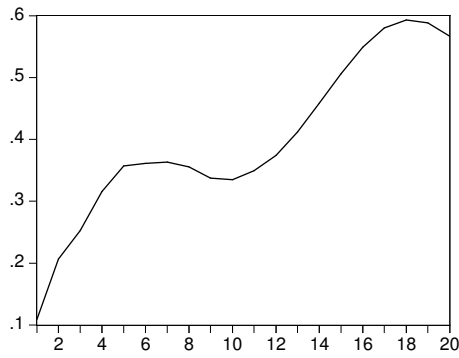
Figure 5, second graph depicts that there is an increasing response of consumer price to real oil price gap after 6 months and this positive response continue until 2.5 years. The third graph shows that the response of exchange rate is positive and Turkish lira depreciates in this period until 2.5 years. Also this conclusion seems plausible in the sense the history of Turkish economy which is mentioned in Section 3 in this period. The fourth graph shows the interest rate gap has a volatile response to real oil price gap since Turkey has two major crises in this

period. The fifth graph depicts the positive response of money supply after 3 months and this seems plausible since Central Banks increases money supply in this period as we mentioned in Section 3. The final graph shows the negative response of real GDP gap to real oil price gap until three years and this result supports the significance of the effect in VAR estimation output. Hence, it is obvious that the responses of real GDP gap on business cycles are more significant than responses in relatively short run which is discussed in the previous section. This result is consistent with previous literature. According to Hamilton, increases in oil prices caused the recessions or decrease in real gross domestic product in the U.S.

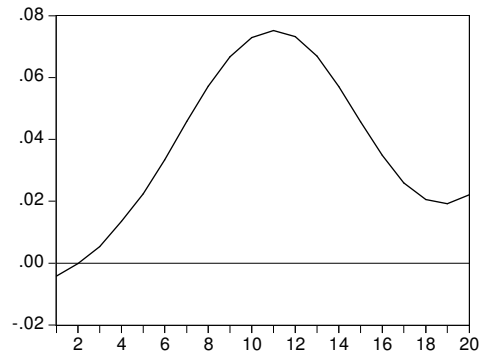
6.2.3.2 Subsample 2: 2002Q1-2009Q4

Figure 6 emphasizes more persistent effects of real oil price on macroeconomic variables in 2002-2009. The second graph shows positive and immediate accumulated response of consumer price index to real oil price gap until 2.5 years. The third graph shows the depreciation of Turkish lira between 6 months and 2 years. The fourth graph depicts a decreasing response of interest rate gap to real oil price gap after 2.5 years. Similarly, money supply gap responds to real oil price gap and it has a negative response after 2.5 years as it can be seen in fifth graph. The final graph demonstrates the negative response of real GDP gap to real oil price gap between 6 and 21 months and between 3.5-4 years. Since Central Bank implements an inflation targeting rule in this period, the movements of CPI and interest rate between 6 and 15 months seem plausible. Unalmis et al. (2008) emphasizes that a direct monetary policy focuses on inflation targeting response to price of oil is not a good idea. Because if there are uncertainties about origin of oil price shocks, for example if the reason behind oil price shock is increase in foreign productivity, real gross domestic product will contract when Central Bank follows a rule which raises interest rates.

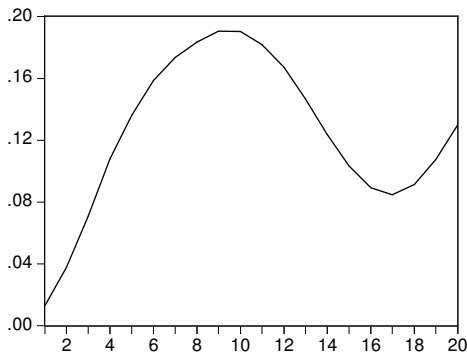
Accumulated Response of ROILPGAP to ROILPGAP



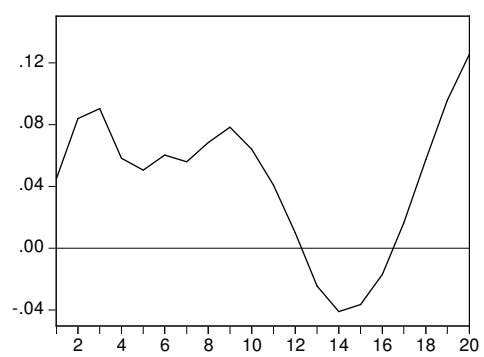
Accumulated Response of CPIGAP to ROILPGAP



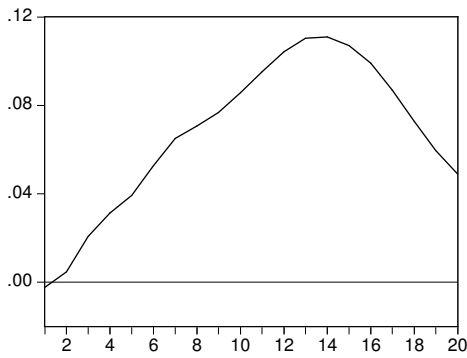
Accumulated Response of EXCGAP to ROILPGAP



Accumulated Response of INTGAP to ROILPGAP



Accumulated Response of M2GAP to ROILPGAP



Accumulated Response of RGDPGAP to ROILPGAP

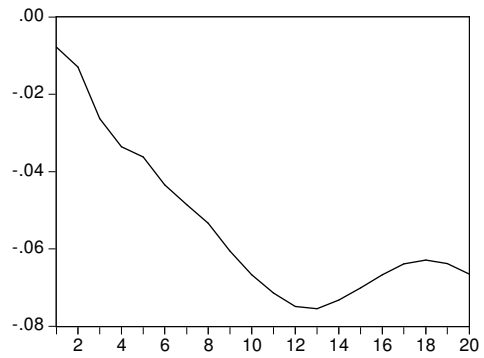
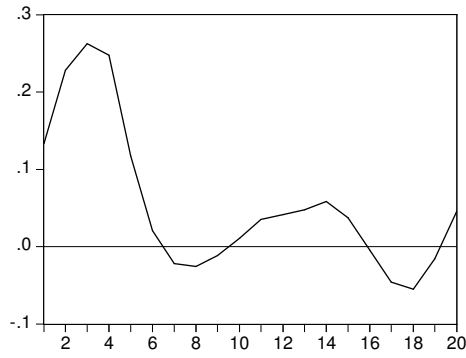
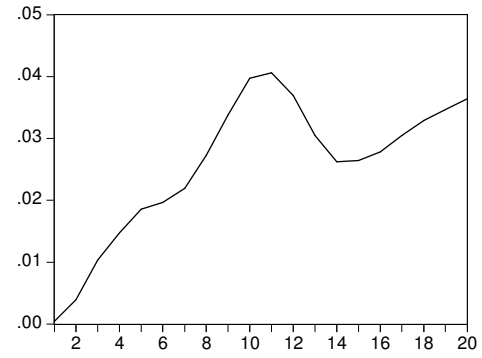


Figure 5: Accumulated Impulse Responses for 1987Q1-2001Q4

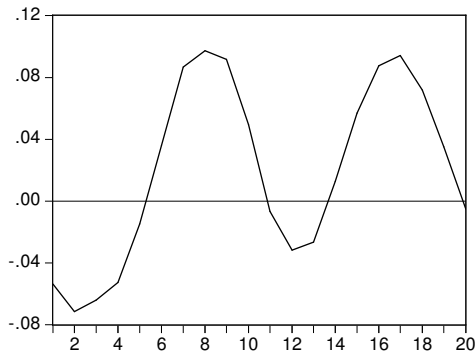
Accumulated Response of ROILPGAP to ROILPGAP



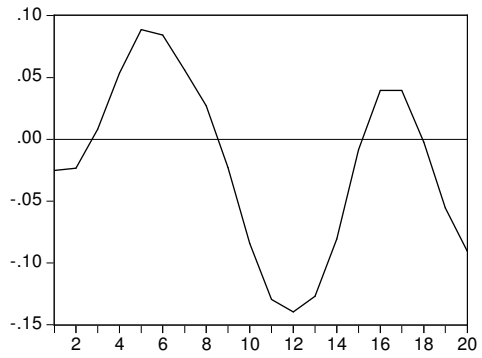
Accumulated Response of CPIGAP to ROILPGAP



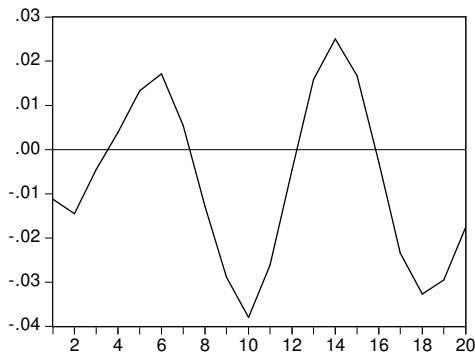
Accumulated Response of EXCGAP to ROILPGAP



Accumulated Response of INTGAP to ROILPGAP



Accumulated Response of M2GAP to ROILPGAP



Accumulated Response of RGDPGAP to ROILPGAP

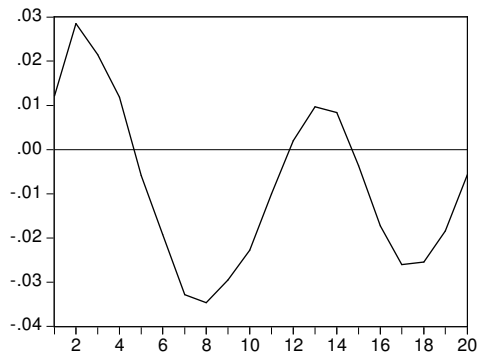


Figure 6: Accumulated Impulse Responses for 2002Q1-2009Q4

7 CONCLUSIONS

In this study, we investigated the effects of real world crude oil price shocks on Turkish economy. The study emphasizes the impact of oil price shocks both in short run (3-6 months) and more persistent effects on business cycles (2-5 years) in mid run for two subsamples. In the short run, VAR estimation results show that there are no significant effects on all of the variables in the period 1987-2001. However, there are significant effects of real oil price shocks on inflation rate and relative change in real gross domestic product in the period 2002-2009. The analysis reports that real oil price shocks cannot explain macroeconomic variables in Turkey for first subsample in the short run, even if the real oil price shocks can explain inflation rate and growth rate for second subsample. Accumulated impulse response graphs of the first subsample shows that real oil price shocks make real gross domestic product volatile, but it is unclear that the real gross domestic product has a negative response to oil price shocks. In addition, for the second subsample, these graphs demonstrate inflation rate has an immediate positive response to oil price shocks only for 9 months and real gross domestic product has a negative response between 6 and 15 months. To sum up, the short run conclusions does not show meaningful results how oil price shocks affect variables in Turkey, especially inflation and growth rates, even if these results demonstrate that oil price shocks make inflation and growth rates volatile. In the mid run, the effects of real oil price shocks are more significant. VAR estimation results, obtained using HP filter, show that real gross domestic product gap is significantly affected negatively by oil price shocks for first subsample, and consumer price index gap is significantly affected positively by oil price shocks for second subsample. Accumulated impulse response figures depict that consumer price index gap has a positive response to oil price shocks up to 2.5 years and real gross domestic product gap has a negative response to these shocks 2 years for both of subsamples. This concludes that oil price shocks have more persistent effects on macroeconomic variable cycles in Turkey.

REFERENCES

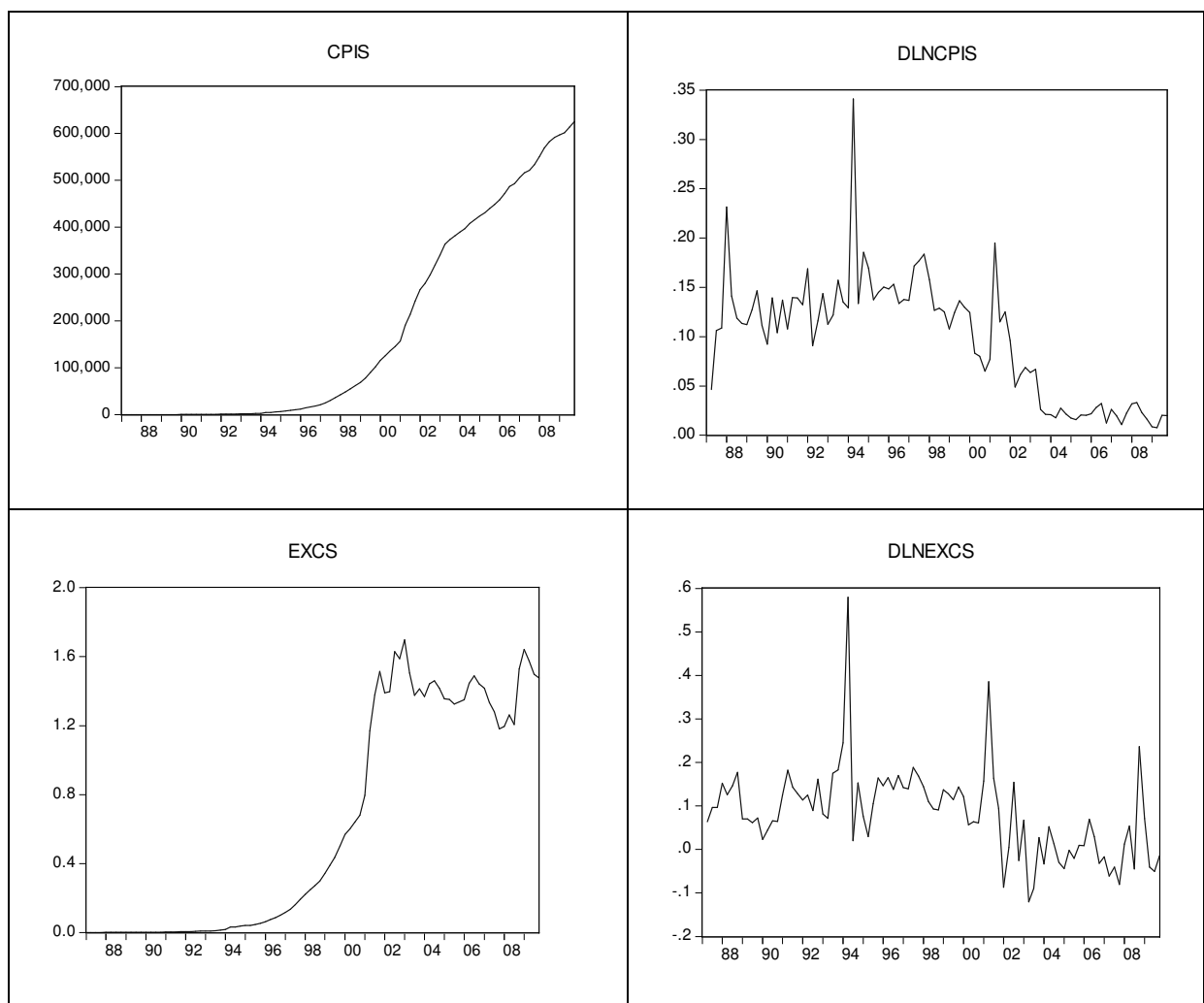
- Alper C. Emre, Torul O., (2009), *Asymmetric Adjustment of Retail Gasoline Prices in Turkey to World Crude Oil Price Changes: The Role of Taxes*, Economics Bulletin Vol. 29, No. 2, pp. 775-787.
- Alper C. Emre, Torul O., (2008) *Oil Prices, Aggregate Economic Activity and Global Liquidity Conditions: Evidence from Turkey*. Economics Bulletin, Vol. 17, No. 4 pp. 1-8.
- Amano R., van Norden S., (1996), *Exchange Rates and Oil Prices*, Working Paper 95-8, Bank of Canada, Ottawa.
- Ayadi O.F., Chatterjee A., Obi C.P., (2000), *A Vector Autoregressive Analysis of an Oil-Dependent Emerging Economy – Nigeria*, OPEC Review, Vol. 24, No. 4, pp. 329-349.
- Balcilar M., Tuna G., (2009), *Sources of Macroeconomic Fluctuations in a Volatile Small Open Economy*, Turkish Studies, Vol. 10, No. 4, pp. 613–629.
- Berument H., Ceylan N.B., Dogan, N., (2010), *The Impact of Oil Price Shocks on the Economic Growth of Selected MENA Countries*, The Energy Journal, Vol. 31, No. 1 , pp. 149-176.
- Blanchard O. J., Gali J., (2007), *The Macroeconomic Effects of Oil Price Shocks: Why Are the 2000s So Different from the 1970s?*, NBER Working Paper.
- Brooks C., (2008), *Introductory Econometrics for Finance*, 2nd Edition, Cambridge University Press, United Kingdom.
- Brown S., Yücel M.K., (2002), *Energy Prices and Aggregate Economic Activity: An Interpretative Survey*, The Quarterly Review of Economics and Finance, Vol. 42, No. 2. pp. 183-208.
- Cognigni A., Manera M., (2006), *Oil Prices, Inflation and Interest Rates in a Structural Cointegrated VAR Model for the G-7 Countries*, Energy Economics, Vol. 30, No. 3, pp. 856-888.
- Cunado J., Perez de Gracia F., (2005), *Oil Prices, Economic Activity and Inflation: Evidence for Some Asian Countries*, The Quarterly Review of Economics and Finance, Vol. 45, No. 1, pp. 65-83.

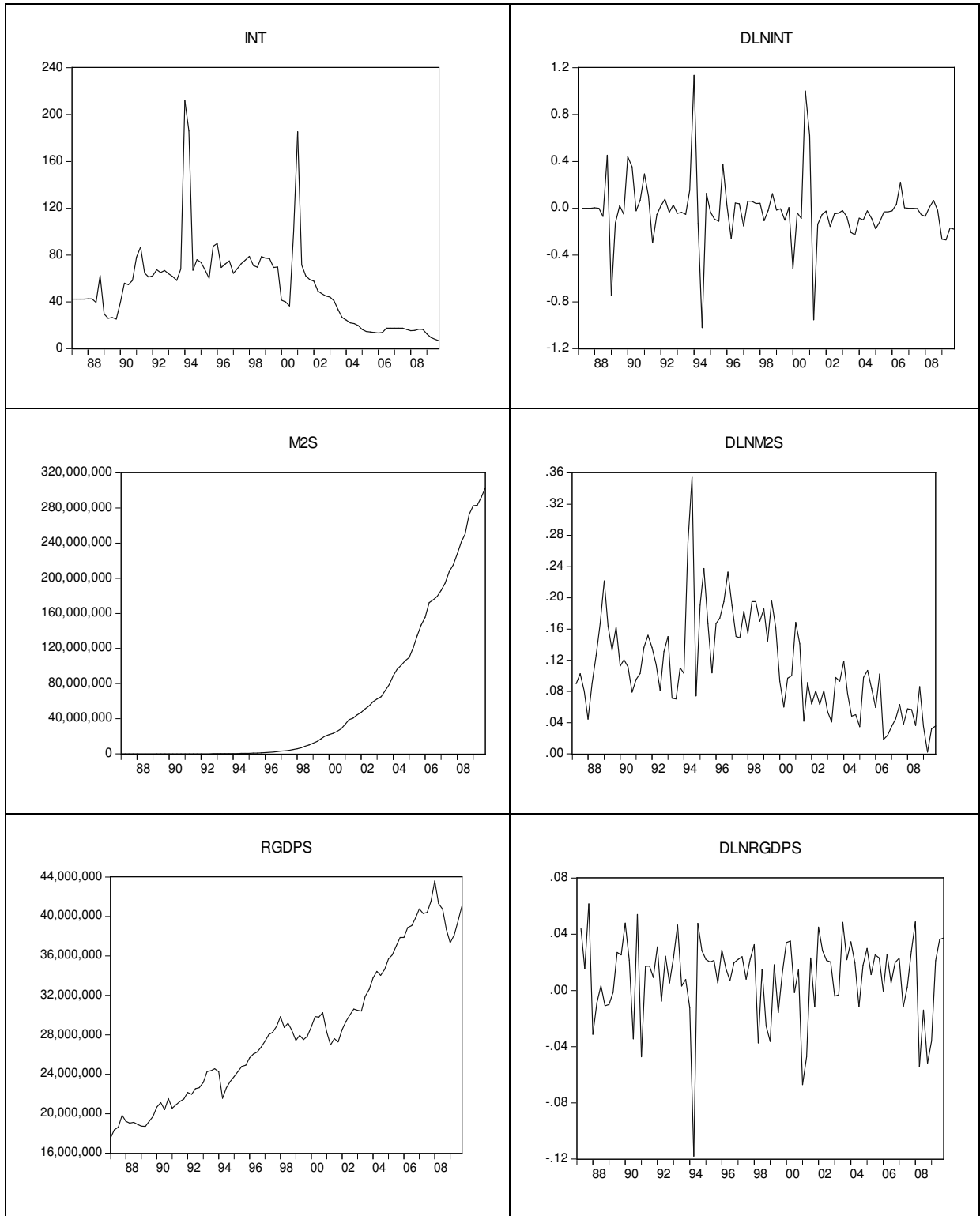
- Enders W., (1995), *Applied Econometric Time Series*, John Wiley & Sons Inc.
- Farzanegan M.R., Markwardt G., (2009), *The Effects of Oil Price Shocks on the Iranian Economy*, *Energy Economics*, Vol. 31, No.1 pp. 134-151.
- Gausden R., (2010), *The Relationship between the Price of Oil and Macroeconomic Performance: Empirical Evidence for the UK*, *Applied Economics Letters*, Vol. 17, pp. 273-278.
- Guo H., Kliesen K.L., (2005), *Oil Price Volatility and US Macroeconomic Activity*, *Review Federal Reserve Bank of St.Louis*, Vol. 87, No. 6, pp. 669–683.
- Hamilton J.D., (1983), *Oil and the Macroeconomy since World War II*, *The Journal of Political Economy*, Vol. 91, No. 2, pp. 228-248.
- Hodrick R.J., Prescott E.C., (1997), *Postwar U.S. Business Cycles: An Empirical Investigation*, *Journal of Money, Credit, and Banking*, Vol. 29, No. 1, pp. 1–16.
- Kennedy P., (2008), *A Guide to Econometrics*, 6th Edition, Blackwell Publishing.
- Kibritçioğlu A., (2002), *Causes of Inflation in Turkey: A Literature Survey with Special Reference to Theories of Inflation and Disinflation in Turkey*, ed. by Kibritçioğlu, A., L. Rittenberg, and F. Selçuk, Aldershot: Ashgate, pp. 43-76.
- Oladosu G., (2009), *Identifying the Oil Price–Macroeconomy Relationship: An Empirical Mode Decomposition Analysis of US Data*, *Energy Policy* Vol. 37, No.12, pp. 5417–5426.
- Ozatay F., Sak G., (2003), *Banking Sector Fragility and Turkey’s 2000–01 Financial Crisis*, *Research Department Discussion Paper*, The Central Bank of The Republic of Turkey.
- Rafiq S., Salim R., Bloch H., (2009), *Impact of Crude Oil Price Volatility on Economic Activities: An Empirical Investigation in the Thai Economy*, *Resources Policy*, Vol. 34, No. 3, pp. 121-132.
- Sims C.A., (1980), *Macroeconomics and Reality*, *Econometrica: Journal of the Econometric Society*, Vol. 48, No. 1, pp. 1-48.
- Ünalmiş D., Ünalmiş İ, Ünsal D.F., (2008), *Oil Price Shocks, Macroeconomic Stability and Welfare in a Small Open Economy*, *The Central Bank of Republic of Turkey, Research and Monetary Policy Department No. 08/02*.

Verbeek M., (2008), *A Guide to Modern Econometrics*, 3rd Edition, John Wiley & Sons Ltd., Erasmus University Rotterdam.

Zoli E., (2009), *Commodity Price Volatility, Cyclical Fluctuations, and Convergence: What is Ahead for Inflation in Emerging Europe?*, IMF Working Paper.

APPENDIX





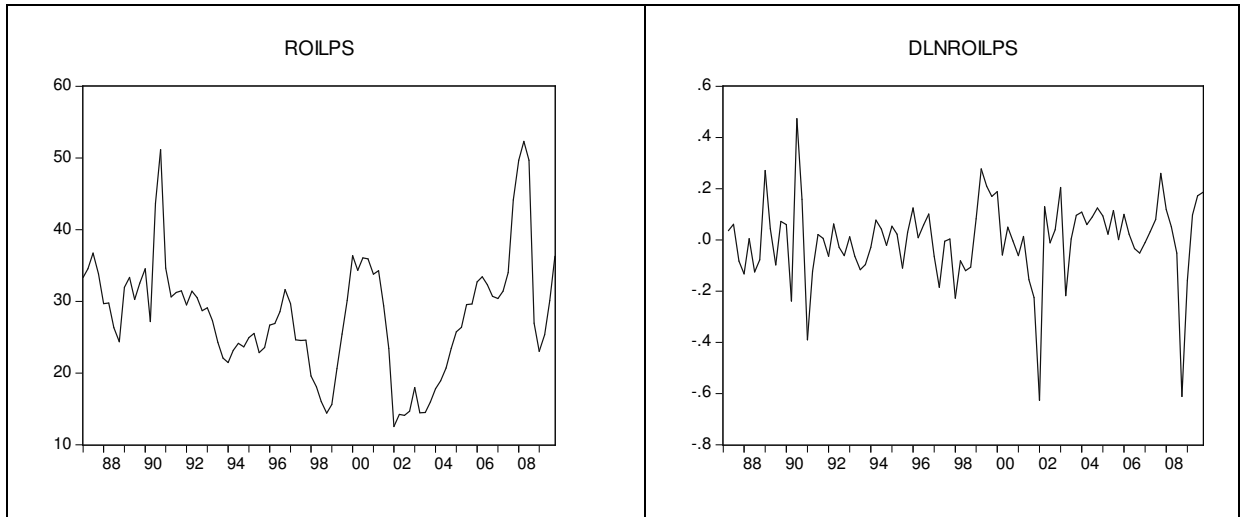
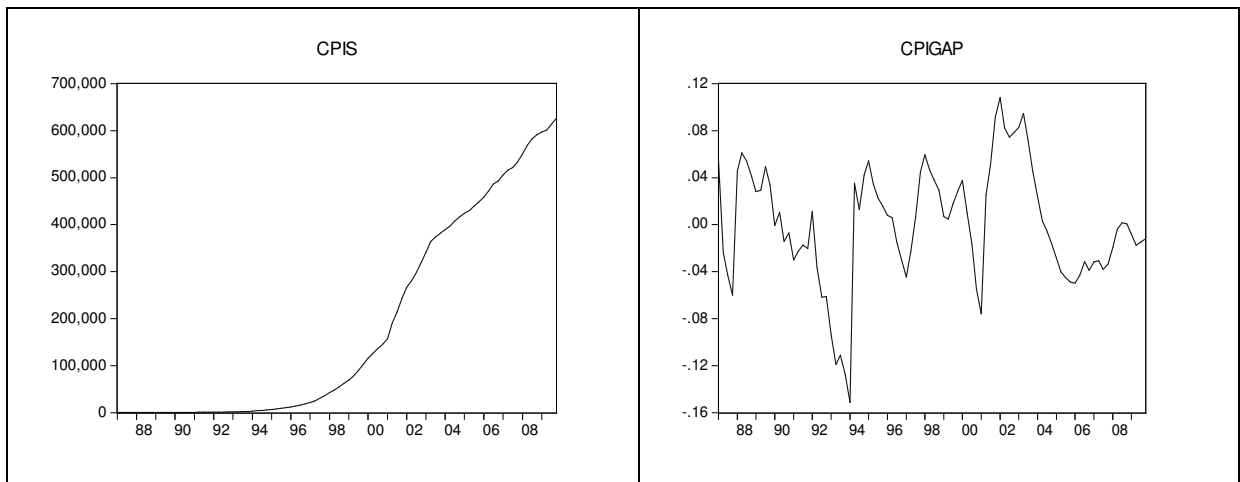
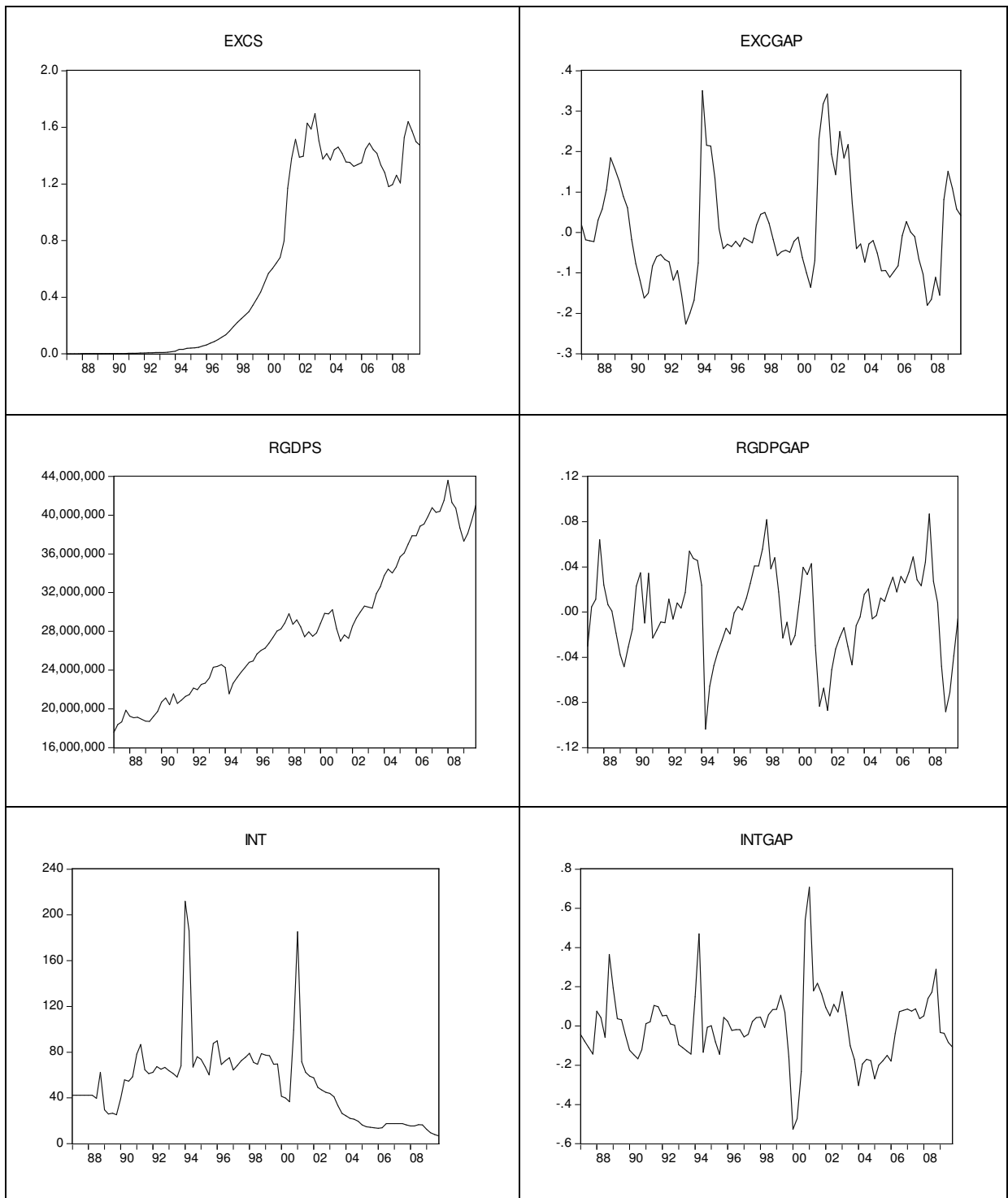


Figure A. 1: Seasonally adjusted original series (except interest rate) and graphs after taking logarithm and differencing the data





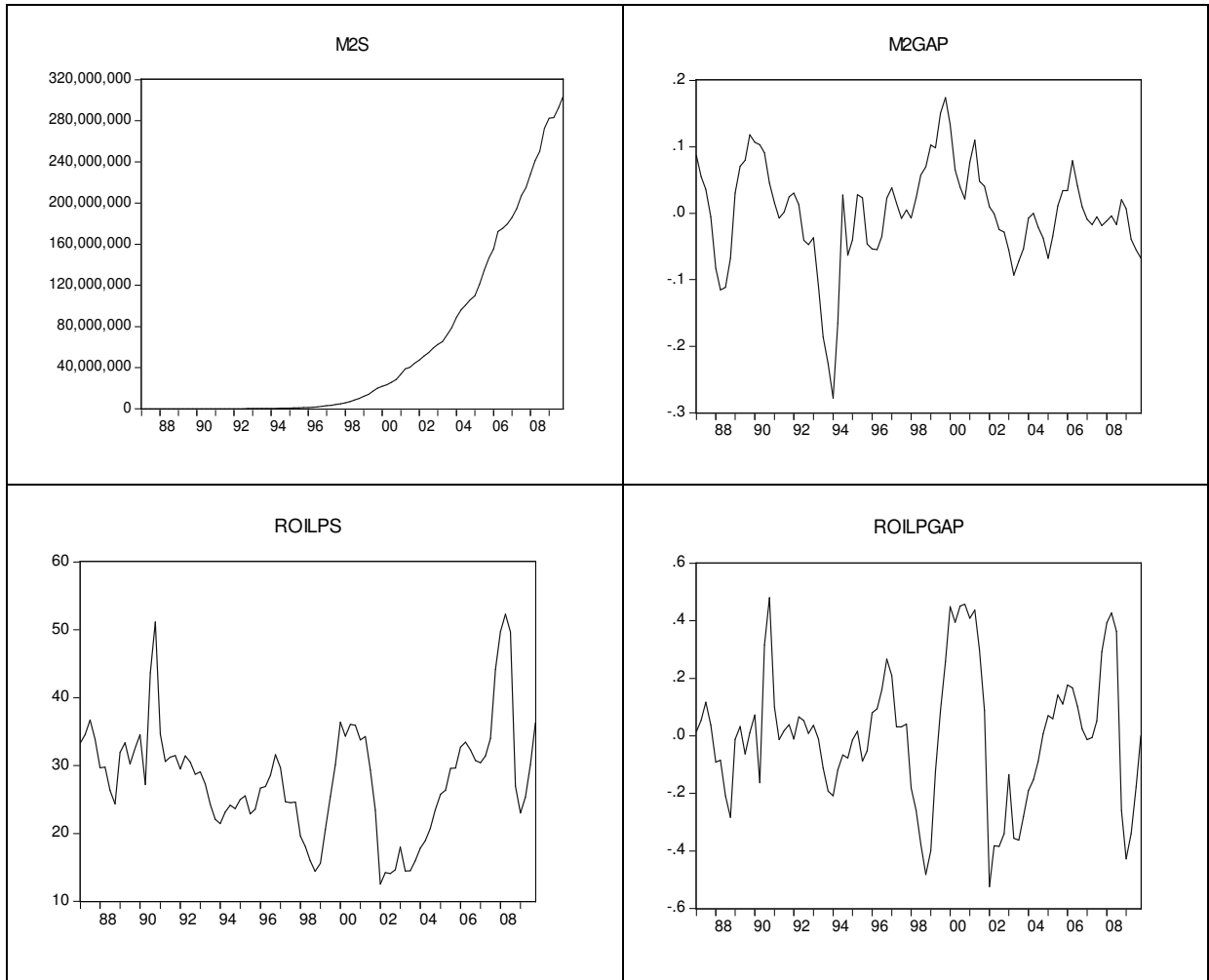


Figure A. 2: Seasonally adjusted (except interest rate) original series and graphs after using HP filter cycle method

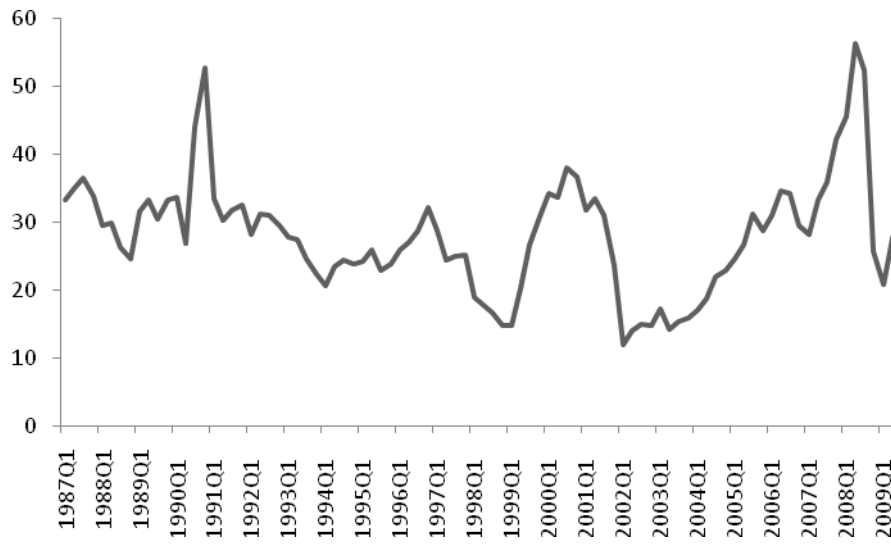


Figure A. 3: Real Crude Oil Price (USD/barrel)