THREE ESSAYS ON OIL PRICES AND ECONOMIC ACTIVITY IN TURKEY

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2009

THREE ESSAYS ON OIL PRICES AND ECONOMIC ACTIVITY IN TURKEY

Thesis submitted to the

Institute for Graduate Studies in the Social Sciences

in partial fulfillment of the requirements for the degree of

Master of Arts

in

Economics

by

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2009

Three Essays on Oil Prices and Economic Activity in Turkey

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May 2009

Thesis Abstract

Orhan Torul, "Three Essays on Oil Prices and Economic Activity in Turkey"

This thesis consists of three essays analyzing the effects of oil prices on the Turkish economy. In the first essay, I investigate the relationship between oil prices and real aggregate output of a small open economy, Turkey. Parallel to the results for developed economies in the literature, I first report for Turkey that the negative response of real output to oil price increases have diminished since the early 2000s. Yet, when I incorporate global liquidity conditions, I unveil that the negative impact of oil price changes is significant even in the post-2000 period.

In the second essay, I empirically investigate the impact of shocks to world crude oil prices on retail gasoline prices in Turkey. First, I report that domestic prices respond significantly to increasing world crude oil prices, but not to decreases. I argue that the source of observed asymmetry is mainly attributable to government price setting policy. I also claim that rather than smoothing the impact of volatility in world crude oil prices on retail gasoline prices, the Turkish fiscal authorities attempt to maximize tax revenue from gasoline.

In the third essay, I investigate the relationship between oil prices and the manufacturing sector of Turkey. I take into account unique features of Turkey, and incorporate global liquidity and domestic finance conditions, along with real exchange rate dynamics in my model. I report that while oil price increases fail to impede aggregate manufacturing growth, they robustly impede production growth of some of the sub-sectors.

Tez Özeti

Orhan Torul, "Petrol Fiyatları ve Türkiye'deki Ekonomik Aktivite Üzerine Üç Deneme"

Bu tez, petrol fiyatlarının Türkiye ekonomisi üzerindeki etkisini analiz eden üç denemeden oluşmaktadır. İlk denemede, petrol fiyatları ile küçük ve açık bir ekonomi olan Türkiye'nin reel toplam çıktısı arasındaki ilişkiyi inceledim. Literatürde gelişmiş ekonomiler için olan bulgulara paralellik gösterir biçimde öncelikle Türkiye'nin reel çıktısının petrol fiyat artışlarına negatif tepkisinin 2000'lerin başından itibaren azaldığını bildirdim. Ancak, küresel likidite koşullarını yansıtan değişkenleri dikkate aldığımda, petrol fiyat artışlarının negatif etkisinin 2000 sonrası dönemde de kayda değer olduğunu ortaya çıkardım.

İkinci denemede, dünya ham petrol fiyatlarına gelen şoklarının Türkiye'deki perakende benzin fiyatlarına olan etkisini ampirik olarak araştırdım. Öncelikle yerli fiyatların dünya ham petrol fiyat artışlarına kayda değer tepki verirken azalışlarına tepki vermediğini bildirdim. Gözlenen asimetri kaynağının büyük ölçüde devletin fiyat tayin etme politikasından ileri geldiğini öne sürdüm. Ayrıca, Türkiye maliye yetkililerinin dünya ham petrol fiyat volalitesinin etkilerini pürüzsüzleştirmektense benzinden kaynaklanan vergi gelirini maksimize etmeye çalıştığını savundum.

Üçüncü denemede, petrol fiyatları ile imalat sektörü arasındaki ilişkiyi inceledim. Türkiye'nin özgün niteliklerini dikkate aldım ve modelime finans ve küresel likidite koşullarının yanı sıra reel kur dinamiklerini dahil ettim. Petrol fiyat artışlarının toplam imalat sektörü büyümesini engellemese de bazı alt sektör büyümelerini tutarlı bir biçimde sekte vurduğunu savundum.

ACKNOWLEDGEMENTS

First and foremost, I would like to thank my supervisor, Prof. C. Emre Alper for his support, guidance and encouragement during all stages of this thesis. I am also indebted to Assoc. Prof. Oya Pınar Ardıç, Prof. Burak Saltoğlu, and Prof. Ünal Zenginobuz for their most valuable comments and contributions throughout my study.

I would like to thank Assoc. Prof Ahmet Faruk Aysan, who has been geniunely supportive and encouraging during the program and afterwards.

I would like to acknowledge the Scientific and Technological Research Council of Turkey (TÜBİTAK) for granting me a generous graduate scholarship.

I dedicate this thesis to my family who have always supported and encouraged me my whole life.

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CHAPTER 1

OIL PRICES, AGGREGATE ECONOMIC ACTIVITY AND GLOBAL LIQUIDITY CONDITIONS: EVIDENCE FROM TURKEY

Introduction and Literature Review

There is vast empirical literature on the interaction between crude oil price changes and real economic activity. While the majority of the previous studies support the existence of the supply-side cost effects, recent findings question the validity of a negative impact of oil price increases on real output growth.

Hamilton (1983), in a seminal paper, finds a negative and significant relationship between real oil price changes and the U.S. GNP growth, using a multivariate vector autoregression (VAR) analysis. Mork (1989) argues for the presence of asymmetry and documents that, while oil price increases impede real GNP growth, oil price decreases do not have any statistically significant impact. Using a volatility-based specification, Lee *et al.* (1995) verify the presence of asymmetry, and find that the effects of oil price increases in an environment with stable prices are more drastic when compared to an environment where oil prices change frequently. Hamilton (1996), in order to better capture the asymmetry, introduces another specification of prices based on the increase over the previous year's maximum price. He argues that even after controlling for asymmetry, the unfavorable effects of oil price changes on aggregate output growth still persist.

Other developed economies have also been empirically investigated. For example, Jiménez-Rodríguez and Sánchez (2005) document that excluding Japan, the unfavorable effects of oil prices are statistically valid for the sample of net oil importers, as well as an oil exporter, the United Kingdom.

Blanchard and Galí (2007) argue that the negative effects of oil price changes for most of the developed economies ceased to exist in the early 2000s. They explain this phenomenon as being a consequence of more sound monetary policies of experienced central banks, more flexible wage contracts, a smaller share of petroleum in production, and smaller and less frequent unfavorable shocks to aggregate output other than oil prices.

This study investigates the effects of oil price changes on the real output for a net oil importing small open economy, Turkey.[1] In terms of econometric modeling, Turkey differs from the previously investigated developed economies in three aspects. First, being a small open economy, Turkey's real GDP is not expected to influence world crude oil prices. Second, as an emerging market economy, global liquidity conditions have become an increasingly important determinant of the growth prospects in Turkey.[2] Also, as stated previously, being a small open economy, Turkey cannot affect the global liquidity conditions. Third, the relationship between world oil prices and global liquidity conditions is ambiguous. As a result of rising oil prices, current account surpluses of OPEC and other major oil exporting countries could improve global liquidity conditions. On the other hand, the resultant current account deficits of oil importers will have the opposite effect. Accordingly, this study uses a structural VAR approach to model these econometric issues utilizing monthly data on Turkey from 1991 to 2007. I first follow the previous literature and ignore the potential effects of global liquidity conditions. My findings are parallel to the results of Blanchard and Galí (2007) for developed economies, and I report for Turkey that the negative response of the real output to oil price increases have diminished since the early 2000s. Other than using different specifications for oil price changes and the real output growth, which

[1] According to Energy Information Administration (EIA) Online Database, in terms of oil endowments, Turkey is not as fortunate as many other Middle Eastern countries. As of 2006, Turkey produces approximately 42,500 barrels of crude oil per day whereas the demand for consumption is around 619,000. Turkey's annual crude oil consumption constitutes 35% of her primary source of energy consumption, is slightly higher than 3% of her GDP and corresponds to 0.73% of total world crude oil consumption. Turkey's high degree of reliance on oil as a primary source of energy and high dependency on imports underlines the strategic importance of oil prices for the Turkish economy.

[2] Alper (2002) shows that for Turkey, capital inflows are strongly procyclical and lead the cycle by one quarter.

are the standard variables used in the empirical literature, in my next set of estimations I also include variables to account for global liquidity conditions. Once the global liquidity conditions are included, I unveil that the negative impact of oil price changes on the aggregate economic activity is still significant even after 2000.

Data and Variable Definitions

I first give data sources and the definitions of the variables used in the estimations. Monthly Brent crude oil prices are obtained from the IMF's International Financial Statistics database. I obtain the real oil price series through dividing the nominal oil prices by the deseasonalized U.S. consumer price index (CPI). The deseasonalized U.S. CPI excluding energy prices are obtained from the online database of the St. Louis Federal Reserve Bank. Data on the Turkish real GDP, Turkish industrial production index, and overnight interest rates are obtained from Central Bank of Turkey's online database. Turkey's quarterly real GDP data are converted into monthly frequency using the monthly industrial production index following Friedman's (1962) method. Monthly domestic interest variable is obtained by averaging the daily simple weighted interbank overnight interest rate. The two measures of global liquidity used are the Fed Funds Rate (FFR) and the implied volatility of the S&P 500 index options (VIX). The FFR data are obtained from St. Louis Fed, and the VIX data are from Chicago Board of Exchange online databases.

I first deseasonalize the real oil price and Turkish real GDP variables by Census X-12 method. Next, I take the natural logarithms and then first-difference the series. They are found to be stationarity. VIX and interest rate variables are also found to be stationary at levels.

I next turn to the issue of which variable would be best to use for proxying oil price changes. I use four different specifications: oil price increase variable due to Mork (1989), Scaled Oil Price Increase (SOPI) due to Lee *et al.* (1995), Net Oil Price

Increase (NOPI) based on the previous three years due to Hamilton (1996) and the simple log difference.[3]

Oil price increase variable due to Mork (1989) is defined as:

$$o_t^+ = \begin{cases} o_t & \text{if } o_t > 0 \\ 0 & \text{else.} \end{cases} \tag{1}$$

where o_t denotes log-difference of oil price.

Converting the proposed specification of Lee *et al.* (1995) AR(4)-GARCH(1,1) for quarterly into AR(12)-GARCH(1,1) for monthly data, SOPI is defined as:

$$o_t = \alpha_0 + \alpha_1 o_{t-1} + \alpha_2 o_{t-2} + \ldots + \alpha_{12} o_{t-12} + u_t \tag{2}$$

where

$$(u_t | u_{t-1}) \sim N(0, \sigma_t^2) \qquad \sigma_t^2 = \gamma_0 + \gamma_1 \sigma_{t-1}^2 + u_{t-1}^2 \tag{3}$$

$$SOPI_t = \max\{0, (\hat{u}_t / \hat{\sigma}_t)\} \tag{4}$$

Following Hamilton (1996), NOPI based on maximum price over 36 months is defined as:

$$NOPI_t^{36} = \max\{0, p_t - max(p_{t-1}, p_{t-2}, \ldots, p_{t-36})\} \tag{5}$$

where p_t denotes the natural logarithm of nominal oil price.

In order to estimate the effects of oil price changes, I first employ a standard bivariate VAR with one of the real oil price variable specifications and the real Turkish GDP. Next, I also incorporate global liquidity conditions and estimate multivariate structural vector autoregressions (SVARs) with one of the real oil price specifications, FFR, VIX, domestic interest rate, and real GDP, respectively.

[3] Hamilton (2003) argues that SOPI and NOPI perform better than the rest of the asymmetric price specifications in capturing the effects of oil price shocks. For a different volatility-based specification, see Ferderer (1996).

Here the FFR and VIX variables, so called the "push factors", are used to proxy global liquidity, the domestic interest rate variable serves as a "pull factor", and also captures the impact of central bank reactions to significant oil price changes.

In the estimations, other than the endogenous variables, I include a constant and a dummy variable which takes the value of 1 for Turkey's 1994 and 2001 crises, and 0 otherwise. I determine the lag-length of the bivariate VAR and SVAR models by log-likelihood criterion. After estimating the reduced form, I obtain the structural form solutions using the pre-imposed restrictions on the system. Finally, I conduct impulse-response analyses.

Methodology and Estimation Results

I start by estimating a standard bivariate VAR with one of the oil price specifications and the real GDP growth for Turkey for the 1991:2-2007:10 period[4]. Estimation results I present for my initial set of estimations are for the log-differenced real oil price specification.[5] Figure 1 depicts the accumulated response of Turkish real output to Brent oil price change impulses.[6] Aggregate output responds negatively albeit insignificantly to oil price shocks. Blanchard and Galí (2007) report insignificant response of real output to oil price shocks since the 2000s. In order to see whether the response of the Turkish real output to oil price shocks is different or not in the 2000s, I next separate the sample period into two subperiods with respect to the year 2000 in an *ad hoc* manner and estimate the bivariate VARs for the two sub-periods.

[4] Even though data span of oil price and real output variables are larger, because domestic interest rate variable and VIX variable are available since 1990, my estimation is constrained to the 1991:2-2007:10 period. The log-likelihood criterion based lag length is 13 months, which is in accordance with the 4 quarterly lags of Hamilton (1983, 1996, 2001), Hooker (1996), Mork (1989), Jiménez-Rodríguez and Sánchez (2005), among others.

[5] Estimation results for the bivariate VAR model are robust to the choice of oil price specification.

[6] Following the empirical literature on oil prices, I use accumulated responses since the response of aggregate output exhibits an oscillating pattern.

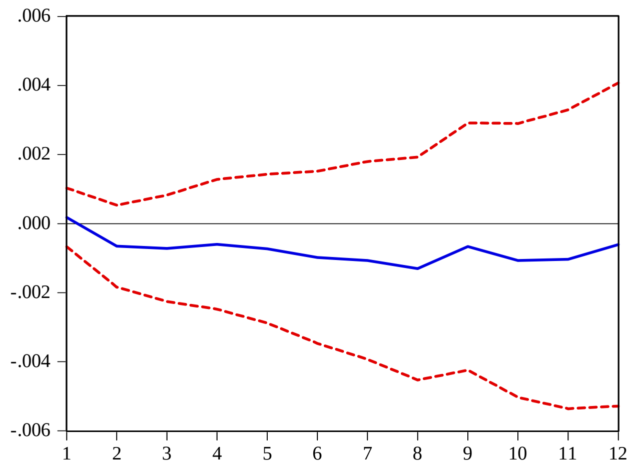


Figure 1 Accumulated response of real GDP in bivariate model (sample period: 1991-2007)

The accumulated response functions presented in Figures 2 and 3 reveal that the macroeconomic impact of oil price shocks are indeed different in the 2000s for Turkey. For the 1991:2-1999:12 period, as illustrated in Figure 2, the real output is negatively and significantly affected by rising crude oil prices. The significant and negative response of the real output to oil price increase is robust, except for the NOPI specification.[7]

[7] NOPI variable, by design, filters out gradual increases and is intended to capture only large changes in oil prices. Insignificant impact of NOPI variable is not surprising given the lack of abrupt oil price changes in my sample.

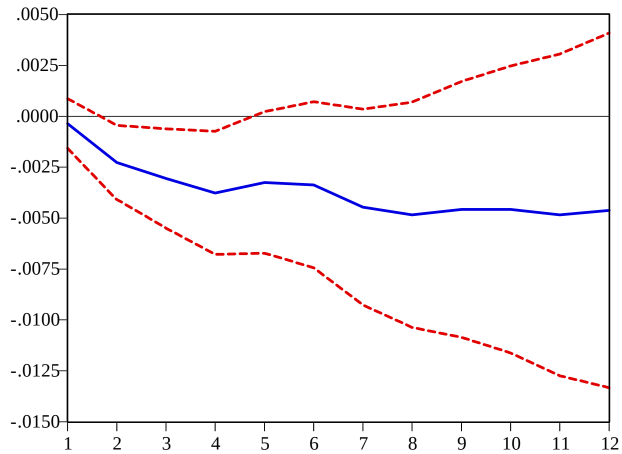


Figure 2 Accumulated response of real GDP in bivariate model (sample period: 1991-1999)

For the 2000:1-2007:10 period, as illustrated in Figure 3, the aggregate output does not respond significantly to oil price changes. Since I divide the sample into two in an *ad hoc* manner, I further investigate the time-varying behavior of the response of the real GDP to the real oil price. Using rolling bivariate VAR with a window length of 107 months, I derive the three-dimensional time-varying accumulated responses of real GDP, and display my findings in Figure 4.[8] The accumulated impulse-response graph verifies the gradually declining impact of oil prices on the real output across time, and confirms that my findings are not as a result of arbitrary sample separation, but as a result of structural alteration at the beginning of 2000.

[8]The initial 107 months cover the 1991:2 - 1999:12 period.

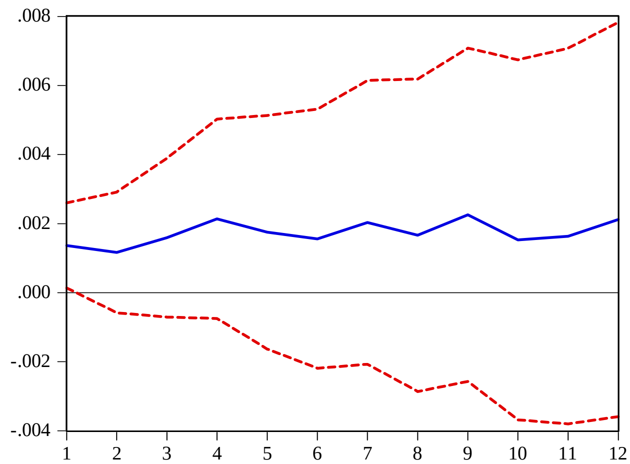


Figure 3 Accumulated response of real GDP in bivariate model (sample period: 2000-2007)

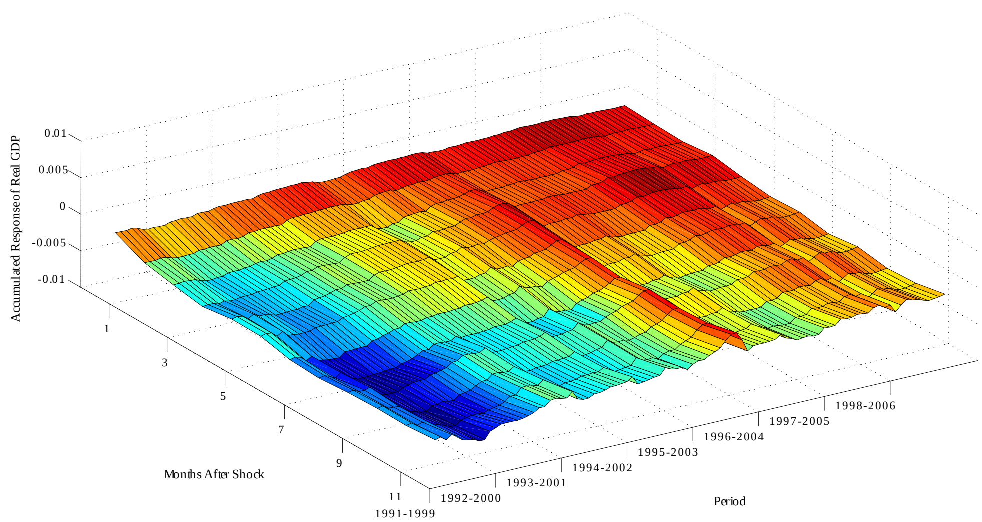


Figure 4 Time-varying accumulated response of real GDP in bivariate model (sample period: 1991-2007)

I next incorporate global liquidity conditions into the picture and analyze the impact of oil prices on real output given the global liquidity conditions for a small open economy using a SVAR model.

Suppose y_t denotes the vector of all endogenous variables in the model which are the real oil price, FFR, VIX, the domestic interest rate and the real output, respectively. α, δ, β_i and $\Gamma_i, (i = 0, 1, 2, ..., p)$ denote the coefficient matrices associated with the constant and the endogenous variables in the structural and reduced form VAR models, respectively. Finally, p denotes the lag length.

The structural form VAR(p) regression equation can be written as:

$$\beta_0 y_t = \alpha + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \ldots + \beta_p y_{t-p} + u_t \tag{6}$$

where $u_t \sim N(0, \Sigma_u)$ denote the structural form innovations.

The reduced form VAR(p) can then be written as:

$$y_t = \delta + \Gamma_1 y_{t-1} + \Gamma_2 y_{t-2} + \ldots + \Gamma_p y_{t-p} + \varepsilon_t \tag{7}$$

where $\Gamma_i = \beta_0^{-1}\beta_i$, $\delta = \beta_0^{-1}\alpha$ and $\varepsilon_t \sim N(0, \Sigma_e)$ denote the reduced from innovations and relate to the structural shocks through $\varepsilon_t = \beta_0^{-1} u_t$ so that $\Sigma_e = (\beta_0^{-1})\Sigma_u(\beta_0^{-1})'$.

Next I discuss how I impose short-term restrictions on β_0^{-1} and estimate the SVAR.

I first consider the real oil prices. Although there is an ongoing controversy about the source of oil price changes, the orthodox point of view regard oil price changes as a result of supply-side, rather than demand-side reasons. Accordingly, I assume that oil price is not influenced by other variables in the system contemporaneously. In other words, shocks on global liquidity conditions and Turkish interest rates and the real output do not affect oil prices in the same month. Since Turkey is a small open economy, the assumption that oil price changes are contemporaneously unaffected by Turkey's interest rate and real aggregate output can be considered as appropriate. Hence, the structural and the reduced form innovation terms are related as follows: $\epsilon_{ot} = b_{11}u_{ot}$.

As for the Federal Funds Rate variable, FFR, I assume that the Federal Open Market Committee responds to the real oil price changes contemporaneously in order to achieve price stability and not to the rest of the variables in the system. As before, it is safe to assume shocks to Turkey's domestic interest rate and the real output is not an important determinant of the unexpected changes to FFR. Hence the FFR innovations could be expressed as: $\epsilon_{ft} = b_{21}u_{ot} + b_{22}u_{ft}$.

The implied volatility index, VIX, is another important indicator of global liquidity conditions and is assumed to be affected by the real oil prices as well as the FFR but not from other variables in the system contemporaneously. Therefore innovations to the VIX is assumed to be represented as:
$\epsilon_{vt} = b_{31}u_{ot} + b_{32}u_{ft} + b_{33}u_{vt}$.

The domestic interest rate is assumed to respond to changes in real oil prices and global liquidity conditions contemporaneously. I assume that the Central Bank of Turkey, due to fear of price increases, would respond to an increase in the oil prices and a deterioration in the global liquidity conditions to the extent that it affects domestic prices through exchange rate. I also assume that since the real output is observed with a lag, Central Bank of Turkey and hence the policy rate is contemporaneously not affected by the real output shocks and may respond with a lag. Hence, the interest rate equation could be expressed as:
$\epsilon_{it} = b_{41}u_{ot} + b_{42}u_{ft} + b_{43}u_{vt} + b_{44}u_{it}$.

The final variable in the system, which is the real output of Turkey, is assumed to be contemporaneously related to Federal Funds Rate, implied volatility index, and domestic interest rate, but not the real oil price changes. The rationale for this assumption is that the actualization supply-side effects of oil price changes is a timely process, the production decision changes due to changing input costs does not take place contemporaneously but with a lag.[9] Therefore the innovation terms of the real output equation is assumed to take the form:

$\epsilon_{yt} = b_{52}u_{ft} + b_{53}u_{vt} + b_{54}u_{it} + b_{55}u_{yt}$.

Combining these 5 equations, the relationship between reduced and structural form innovations may be written as:

$$\begin{bmatrix} \epsilon_{ot} \\ \epsilon_{ft} \\ \epsilon_{vt} \\ \epsilon_{it} \\ \epsilon_{yt} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 & 0 \\ b_{21} & b_{22} & 0 & 0 & 0 \\ b_{31} & b_{32} & b_{33} & 0 & 0 \\ b_{41} & b_{42} & b_{43} & b_{44} & 0 \\ 0 & b_{52} & b_{53} & b_{54} & b_{55} \end{bmatrix} \begin{bmatrix} u_{ot} \\ u_{ft} \\ u_{vt} \\ u_{it} \\ u_{yt} \end{bmatrix} \tag{8}$$

where ε_{ot}, ε_{ft}, ε_{vt},ε_{it}, ε_{yt} are the reduced form, u_{ot}, u_{ft}, u_{vt}, u_{it}, u_{yt} are the structural form innovation terms of the real oil price, FFR, VIX, Turkey's domestic interest rate and real GDP, respectively.[10]

Similar to the bivariate VAR, log-likelihood criterion determine the optimal lag length to be 13 months. I present the accumulated response of the aggregate output from the SVAR model for the full sample in Figure 5. In contrast to the results obtained from the bivariate VARs, the accumulated response of the real GDP to the real oil price shocks is negative and significant and does not die off until 8 months after the shock. Other than the direct response of the real output to oil shocks, two other variables response are worth noting. The responses of both the Federal Funds Rate and the Turkey's overnight interbank rate to oil price impulses are positive and significant. This finding is similar to previously reported empirical results, and may be attributed to two major reasons: First, at macro

[9] Previous empirical studies using quarterly data assume a contemporaneous relation between output and oil prices. However, I use monthly data and such an assumption would be erroneous. Nevertheless, my results are robust to this specification.

[10] My findings are robust with respect to the use of other short-term restrictions, including Cholesky recursive factorization.

level, central banks respond to oil price shocks, and increase interest rates in order to suppress inflationary pressure. Second, at micro level, agents who believe that the shocks are temporary would be inclined to borrow funds to smooth their consumption, which cause a rise in interest rates.

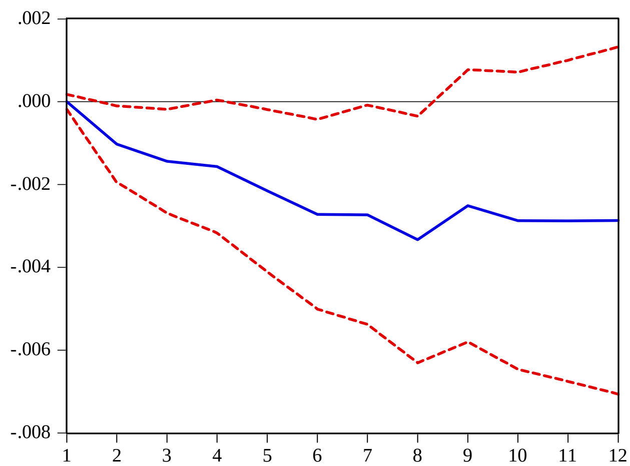


Figure 5 Accumulated response of real GDP in multivariate model (sample period: 1991-2007)

When the sample period is divided with respect to the year 2000, the accumulated responses of aggregate output to oil price shocks derived from SVAR are found to be negative and significant in both periods, as illustrated in Figures 6 and 7. While the significance and magnitude of the responses are more stable and powerful up to 2000, in contrast to Blanchard and Galí's (2007) findings, the real output responds negatively and significantly to real oil price increases even in the post-2000 period.

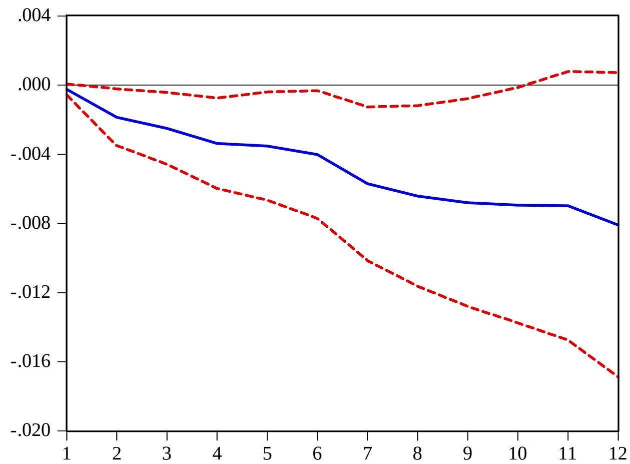


Figure 6 Accumulated response of real GDP in multivariate model (sample period: 1991-1999)

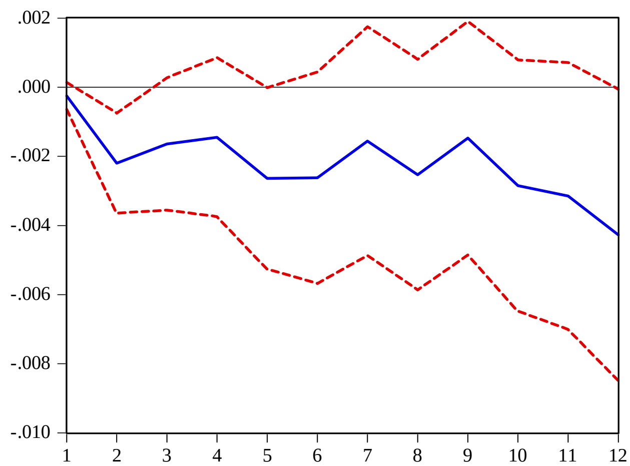


Figure 7 Accumulated response of real GDP in multivariate model (sample period: 2000-2007)

I also derive the time-varying accumulated response of the real GDP to an oil price shock for the multivariate SVAR framework, and present my results in Figure 8. I find that the behavior of the real output responses are relatively stable over time, with the exception of the financial crisis years of 1994 and 2001. Furthermore, in contrast to Blanchard and Galí's (2007) findings, the magnitude of the real output response to an oil price shock is found to be gradually increasing in absolute value. This essentially implies that when the global liquidity conditions and the domestic interest rates are accounted for, the negative and significant effects of oil prices on the real output persist even in the post 2000 period.

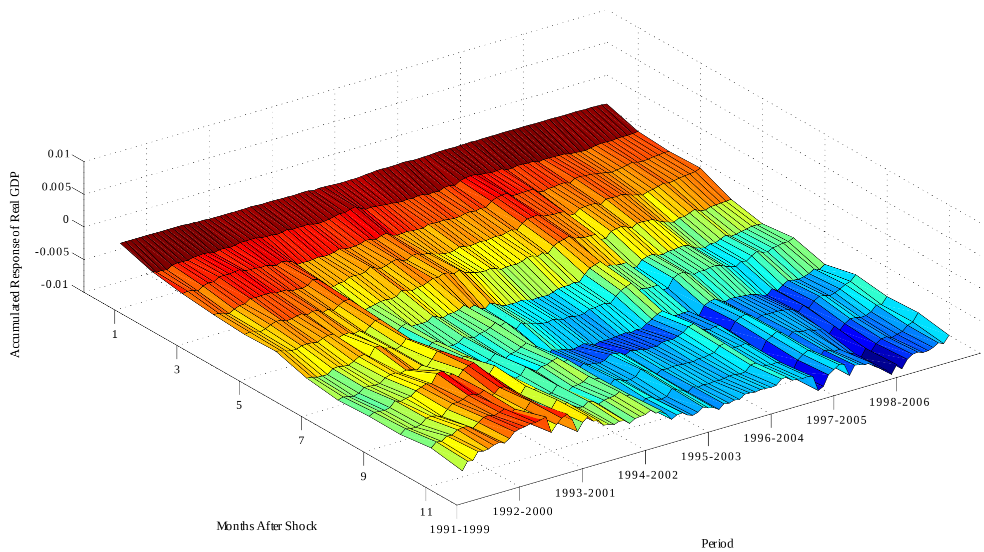


Figure 8 Time-varying accumulated response of real GDP in multivariate model (sample period: 1991-2007)

Conclusions

In this study, I investigate the effects of oil price changes on the aggregate economic activity of Turkey, empirically. Turkey, as a small open economy, differs from the previously empirically investigated countries since she cannot influence world oil demand and/or supply, and prices accordingly. Following the financial account liberalization of Turkey since end-1990s, I incorporate the financial and global liquidity conditions into my model. I report that when the global liquidity conditions are excluded, the accumulated response of the real output to oil price innovations are found to be statistically insignificant in the post-2000 period. However, with the global conditions, the negative and significant impact of oil price shocks persist. Further, I document that both the Fed funds rate and the Turkish overnight interest rate respond positively and significantly to oil price increases and there is no significant relationship between oil price changes and the implied volatility index. I conclude that the inclusion of the global liquidity conditions in the relation between aggregate economic activity and oil price changes is an important issue for a small open economy, Turkey.

CHAPTER 2

ASYMMETRIC ADJUSTMENT OF RETAIL GASOLINE PRICES IN TURKEY TO WORLD CRUDE OIL PRICES: THE ROLE OF TAXES

Introduction and Literature Review

Many consumers all around the world complain that retail gasoline prices respond quickly to world crude oil price increases but adjust more slowly to world crude oil price decreases.[11] While numerous theoretical explanations have been offered for the existence of the asymmetry, econometric evidence so far has been mixed.[12] Even though Borenstein *et al.* (1997), Balke *et al.* (1998), and Al-Gudhea *et al.* (2007) for the U.S., Bacon (1991) for the U.K. and Grasso and Manera (2007) for France, Germany, Italy, Spain and the U.K. find relatively favorable evidence for the existence of the asymmetry, Norman and Shin (1991), Bachmeier and Griffin (2003) for the U.S. and Godby *et al.* (2000) for Canada report symmetric response of retail gasoline prices to world crude oil price changes. The reasons for the mixed evidence include differences in data span, data frequency, market structure, as well as estimation techniques.

I empirically investigate the response of retail gasoline prices in Turkey to world crude oil price changes. This study contributes to the burgeoning literature on gasoline and crude oil price asymmetry in two fronts. First, to my knowledge, this study is the first to investigate this issue for an emerging market economy that is a net oil importer. The relation between domestic gasoline prices and world crude oil prices should be handled more delicately for an emerging market economy since even when world crude oil prices are constant, exchange rate movements due to a change in global liquidity conditions, for example, have implications for

[11] Bacon (1991) coins the phrase *rockets and feathers* to describe this asymmetry in response.

[12] Explanations of the phenomenon include market power and the collusive behavior of the refineries and supply stations, consumer search costs, variations in mark-ups over the business cycles and the asymmetric response of the consumers to changing retail prices. See Brown and Yucel (2000) for a detailed survey.

domestic retail gasoline prices.[13] Additionally, oil price increases may lead to a widening current account deficit in oil importing emerging market economies, which is an important indicator of vulnerability.[14] Second, retail gasoline price formation makes Turkey unique in the world. According to the International Energy Agency's Key World Energy Statistics 2007, Turkish consumers pay the highest retail prices for light fuel oil, automotive diesel oil and unleaded gasoline, and second highest retail price for heavy fuel oil in the world. Unlike in other countries where the response of retail gasoline prices to changes in the world crude oil price depends on many intermediate margins, in Turkey, retail gasoline prices are by and large determined by the government. Taxes on gasoline which have been subject to frequent changes by the council of ministers make up 70 to 80% of the retail gasoline prices during the 1991-2007 period.[15] Refinery prices (cost of world crude oil converted to domestic currency from the spot exchange rate plus refining costs and profits) on the other hand, make up only 15% of the retail price.[16] Given that the refineries were state-owned until the beginning of 2006, other than the world crude oil prices and the exchange rate changes, Turkish gasoline price formation can easily be argued to be government determined. Hence any evidence for asymmetry in Turkish retail gasoline price responses to world crude oil price changes is likely to be due to government policies.

The current gasoline price formation in Turkey can best be explained through the following example. On January 1, 2009, the refinery sale price of 95 Octane

[13] Alper and Torul (2008) stress the importance of controlling for the global liquidity conditions while estimating the impact of oil price changes on the real output for Turkey as an emerging market economy.

[14] The annualized current account deficit is slightly higher than 5% of Turkey's GDP in 2008 and oil imports account for almost 40% of this ratio alone.

[15] Based on Turkish Ministry of Finance Online Database, 2008 Statistics, taxes on oil products account for 14.2% of overall tax income, and 57.2% of special consumption taxes in 2008. They also correspond to 43.6% of income taxes, and 98% of domestic value-added taxes. Also see Yildirim (2003) on the high frequency of changes on Gasoline taxes in Turkey.

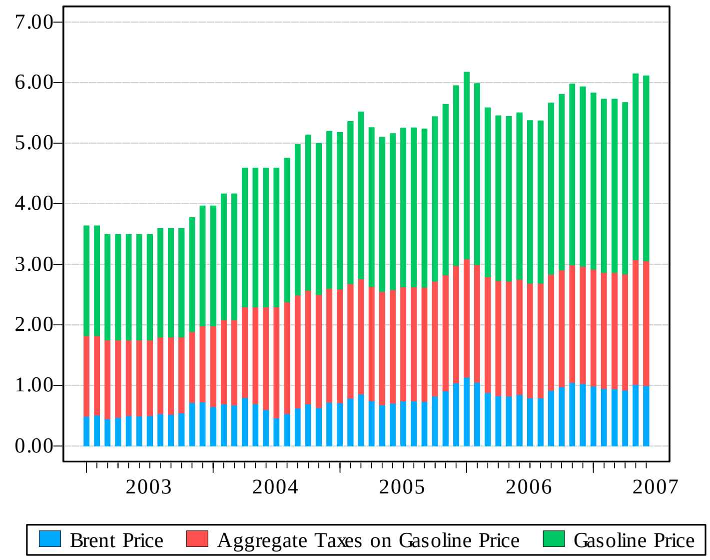
[16] Based on Energy Information Administration's "A Primer on Gasoline prices" crude oil prices and refining costs and profits make up 75% of retail gasoline prices in the U.S. in 2007.

unleaded gasoline was 0.424 Turkish Lira (TL) per liter.[17] Special Consumption Tax (SCT) of 1.4915 TL/liter (approximately USD 1) is added on the refinery price.[18] Once the refinery sales price, the SCT as well as the transportation cost, the distributor and the supply station's premium are summed up, one obtains the pre-value added tax (VAT) price of 2.3015 per liter. The retail price of gasoline inclusive of the VAT (18%) was 2.72 TL/liter on January 3, 2009 in Istanbul. To put it differently, the refinery price made up only 15.6% of the retail price. The transportation cost, the distributor and supply station's share amounted to 14.2% while the total tax (SCT and VAT) made up 70.2% of the retail price.[19] As I illustrate in Figure 9, historically taxes have contributed substantially to the end-user gasoline prices in Turkey. Also, regardless of the behavior of world crude oil prices, the sum of taxes levied on domestic gasoline have exhibited a non-decreasing behavior.

[17] Until 1998, refinery prices were announced by the government. Between 1998-2004 the Automatic Pricing Mechanism was operational which established ceiling prices for oil products based on CIF Mediterranean product prices. Since 2005, the refinery prices are formed based on the Petroleum Market Law No:5015. According to this law the refinery prices can be set freely provided that they reflect the developments in the world oil markets as well as the movements of the domestic currency.

[18] In line with the European Union directives for harmonizing the indirect tax system of Turkey, SCT on petroleum products were introduced on August 2002. This tax replaced 16 different indirect taxes on petroleum products.

[19] Two issues of interest should be noted. The first is that the VAT is levied not only on the refinery price, transportation costs and the distributor and the supply stations premia, but also on the SCT in Turkey. In a way, a tax is levied on another type of tax. Secondly, in a world where the crude oil were available for free and the transportation costs as well as the mark ups of the distributor and the supply station were set to zero, the retail price of gasoline would have been 1.76 TL/liter on January 3, 2009 in Istanbul, Turkey.



(Source: Revenue Administration of Turkey, and Petrol Ofisi Incorporation)

Figure 9 Historical pattern of Turkish gasoline price formation (in current TL per liter)

In terms of econometric modeling, I use structural vector autoregression (SVAR) models employing world crude oil price (Brent) increases and decreases as two separate variables, together with retail gasoline prices, and analyze the dynamics using impulse-response functions (IRFs).[20] Since historical data on various taxes are not publicly available, I use only world crude oil prices and retail gasoline prices in my estimations. I also employ the same methodology using the U.S. data and discuss my findings for Turkey in a comparative manner.

My results suggest that the response of retail gasoline prices in Turkey is asymmetric while the response in terms of significance seems to be symmetric in

[20] Three popular econometric methodologies employed in the literature for estimating the asymmetric response of retail gasoline prices are the autoregressive threshold error correction mechanism (ECM), asymmetric ECM and ECM with threshold cointegration. Since my data span is only 17 years, this is not enough to characterize long-term relationships properly and I decide not to do ECM.

the U.S., supporting findings by of Norman and Shin (1991) and Bachmeier and Griffin (2003). In other words, while world crude oil price increases and decreases result in significant and positive retail gasoline price responses in the U.S., Turkish retail gasoline prices increase as a result of rising world crude oil prices, whereas they do not decrease as a result of falling crude oil prices. My results also suggest that rather than smoothing the impact of world crude oil price volatility on the retail gasoline market, the Turkish government uses world crude oil price decreases as an opportunity to raise oil-related tax revenues.

Data and Methodology

I first give data sources and the definitions of the variables used in the estimations. Monthly Brent crude oil prices are obtained from the IMF's International Financial Statistics database. I obtain average daily Istanbul retail 95 Octane unleaded gasoline prices from Petrol Ofisi Incorporation (*POAŞ*) and the U.S. prices (MG_RCO_US) from Energy Information Administration online database. My monthly analysis cover the 1991-2007 period.

The consumer price indices (CPIs) are taken from the Turkish Statistical Institute and St. Louis Fed online databases.[21] Finally the exchange rate denoting the value of a U.S. dollar (US$) in terms of Turkish Lira (TL) is obtained from the Central Bank of Turkey's online database.

I present in Figure 10 world crude oil prices as well as retail gasoline prices in Turkey and in the U.S. expressed in nominal US$. Note that even though at a first glance the retail gasoline prices in Turkey and in the U.S. seem to be comparable in terms of magnitudes, the prices are quoted per liter in Turkey and per gallon in the United States.

[21] I deflate U.S. dollar denominated world crude oil and U.S. retail gasoline prices using CPI less energy. Since CPI less energy is available for Turkey only in the post-2003 period, I deflate TL-denominated prices using CPI all items. Robustness checks for the U.S. revealed that deflating prices using CPI or CPI less energy did not change the results. Also see Kibritcioglu (2003) on the impact of oil product price changes on the Turkish inflation.

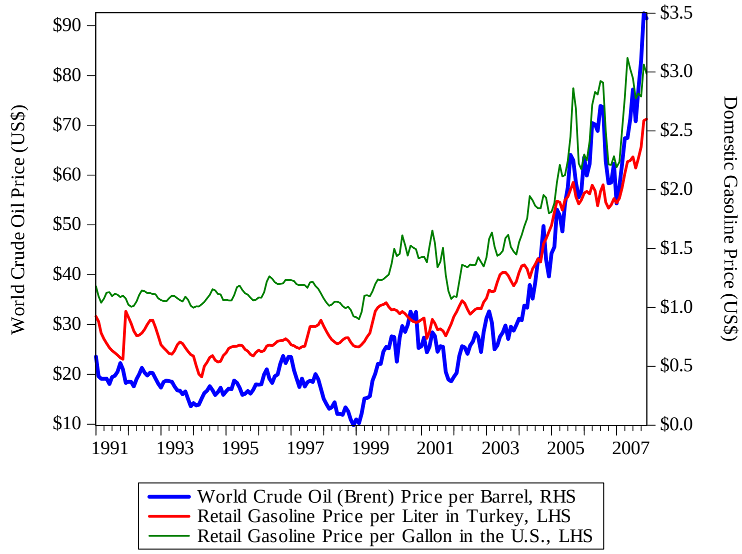


Figure 10 Historical pattern of the U.S. and Turkish gasoline prices (in current US$)

I next describe the methodology that I used to find evidence for or against the existence of asymmetry. I first take the natural logarithms and then first-difference the price series, which are found to be stationary for the two countries.

In order to investigate the effects of oil price increases and decreases, I generate two series based on the sign of the growth rate of world crude oil prices. Following Mork (1989), oil price increase is defined as:

$$o_t^+ = \begin{cases} o_t & \text{if } o_t > 0 \\ 0 & \text{else.} \end{cases} \tag{9}$$

Similarly oil price decrease is defined as:

$$o_t^- = \begin{cases} o_t & \text{if } o_t < 0 \\ 0 & \text{else.} \end{cases} \tag{10}$$

In order to capture possible asymmetric response of retail gasoline price to changes in world crude oil prices, I perform the following set of regressions.

$$\beta_0 y_t = \alpha + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \ldots + \beta_p y_{t-p} + u_t \tag{11}$$

where $u_t \sim N(0, \Sigma_u)$ denote the structural form innovations, p denotes the optimal lag-length determined by likelihood criterion, y_t denotes vector of oil price increases, oil price decreases and fuel prices, and α matrix consists of a constant for the U.S, and a constant and a dummy for the 1994 and 2001 financial crises of Turkey.

Accordingly the reduced form VAR(p) can then be written as:

$$y_t = \delta + \Gamma_1 y_{t-1} + \Gamma_2 y_{t-2} + \ldots + \Gamma_p y_{t-p} + \varepsilon_t \tag{12}$$

where $\Gamma_i = \beta_0^{-1}\beta_i$, $\delta = \beta_0^{-1}\alpha$ and $\varepsilon_t \sim N(0, \Sigma_e)$ denote the reduced from innovations and relate to the structural shocks through $\varepsilon_t = \beta_0^{-1}u_t$ so that $\Sigma_e = (\beta_0^{-1})\Sigma_u(\beta_0^{-1})'$.

Next I impose the following short-term restrictions on β_0^{-1} to disallow contemporaneity between oil price increases and decreases.

$$\begin{bmatrix} \varepsilon_{o^+t} \\ \varepsilon_{o^-t} \\ \varepsilon_{ft} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 \\ 0 & b_{22} & 0 \\ b_{31} & b_{32} & b_{33} \end{bmatrix} \begin{bmatrix} u_{o^+t} \\ u_{o^-t} \\ u_{ft} \end{bmatrix} \tag{13}$$

where o^+t, o^-t and ft subscripts refer to oil price increase, oil price decrease and fuel price growth variables.

After estimating the reduced form, and obtaining structural form solutions by imposing the restrictions on the system, I derive accumulated impulse-responses to reach conclusions based on optimal lag length of 12.

Estimation Results

I start by estimating the accumulated response of nominal TL-denominated retail gasoline prices in Turkey to structural oil price increase and decrease shocks. As displayed in Figure 11, while domestic gasoline prices go up as a result of increasing world crude oil prices, the reverse is not true, i.e. domestic gasoline prices do not respond significantly to decreasing world crude oil prices in Turkey. When I investigate the response of nominal US$-denominated gasoline prices in the U.S. using the same methodology for comparison, I reach a different conclusion: As illustrated in Figure 12, gasoline prices respond positively and significantly to both increases and decreases in world crude oil prices, implying the lack of asymmetry that the U.S. gasoline prices increase for rising world crude oil prices, and decrease for falling crude oil prices.[22]

[22] By the lack of asymmetry, I refer to the presence of the significant responses of the U.S. gasoline prices to both world crude oil price increases and decreases, even though gasoline prices are observed to respond more profoundly to the world crude oil price increases.

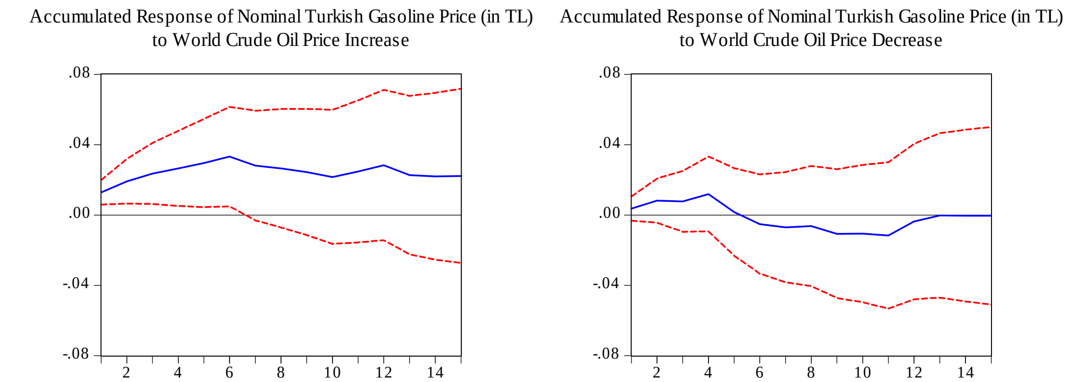


Figure 11 Accumulated response of Turkish gasoline prices (in current TL)

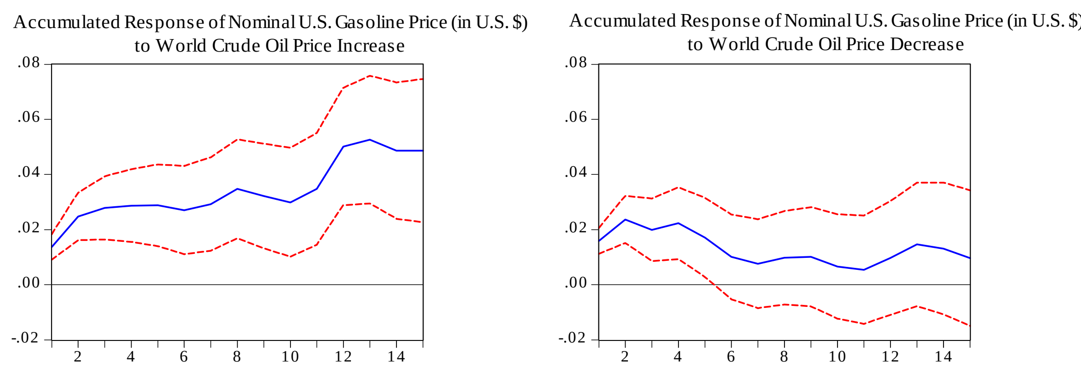


Figure 12 Accumulated response of the U.S. gasoline prices (in current US$)

I next investigate whether the reported results for Turkey and the U.S. are robust to different transformations of the retail price series. The asymmetric response of nominal TL-denominated retail gasoline prices in Turkey to world crude oil prices could be attributed to three reasons. First, as previously mentioned, there exist substantial government taxes on gasoline which are time-varying (and unobserved). Accordingly, the retail gasoline price movements which households and firms face may differ from the world crude oil price fluctuations.

Second, as Turkey is an emerging market economy pursuing floating exchange rate, the TL fluctuates frequently *vis-à-vis* the US$ and since world crude oil price are denominated in US$, the domestic prices of gasoline vary even for periods in which world crude oil prices do not change.

Third, country specific nominal factors may also affect domestic retail prices of gasoline in Turkey and in the United States.

In order to investigate which of these factors is more influential for the existence of the asymmetry, I next convert TL-denominated retail gasoline prices to US$ to eliminate the influence of exchange rate fluctuations and then perform the SVAR analysis.[23] Figure 13 illustrates the existence of asymmetry in Turkey for the US$ denominated gasoline prices as well: nominal US$-denominated retail gasoline prices in Turkey respond positively and significantly to increasing world crude oil prices, and do not respond significantly to decreasing world prices.[24]

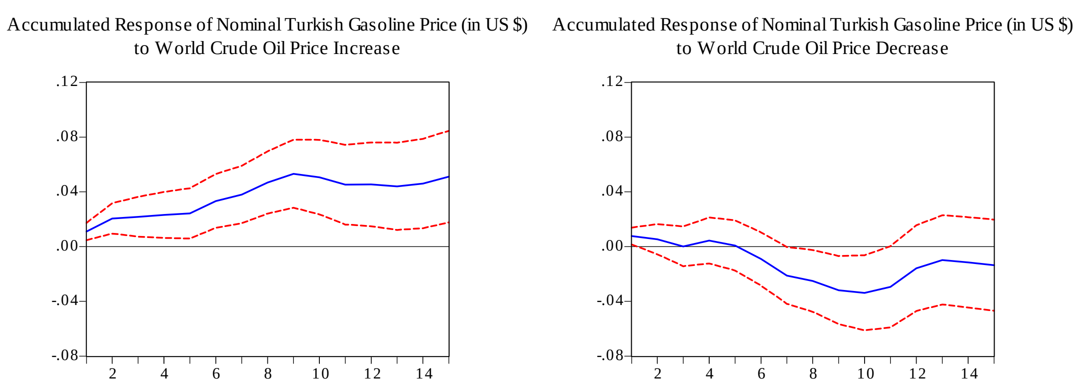


Figure 13 Accumulated response of Turkish gasoline prices (in current US$)

Next, I deflate retail gasoline prices in Turkey and in the U.S. using their CPIs respectively and then perform the SVAR. Estimated accumulated

[23] In a similar fashion, I also first use real TL-denominated gasoline prices to avoid the effect of CPI differences, and next use real U.S. dollar-denominated gasoline price series. My findings suggest equivalent statistical conclusions.

[24] Further the response of gasoline price is observed to be negative and significant between 7th to 11th month after the shock, which implies increasing domestic gasoline prices as a result of decreasing world prices. Yet, the robustness of this finding is questionable given that this significance lasts only for a very short period of time, and disappear afterwards.

impulse-responses for Turkey confirm that retail gasoline prices respond positively and robustly only to world crude oil price increases, as shown in Figure 14. When I carry out the same estimation using real U.S. retail gasoline prices, I observe that the U.S. gasoline price responds positively and significantly not only to increasing world prices, but also to decreasing world prices, as shown in Figure 15.

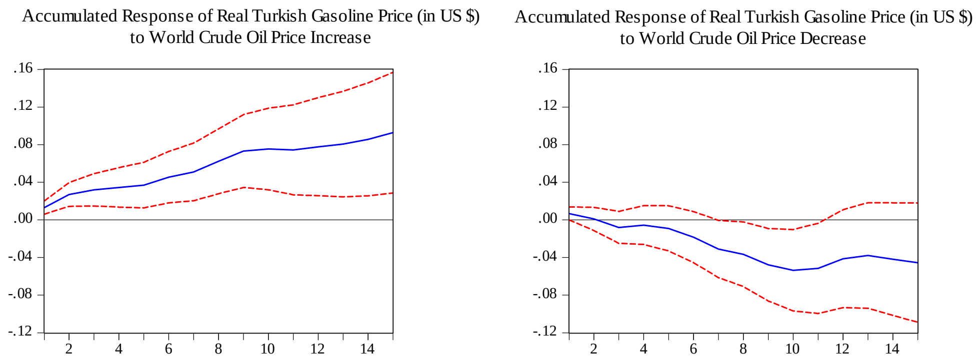


Figure 14 Accumulated response of Turkish gasoline prices (in US$, 2000 prices)

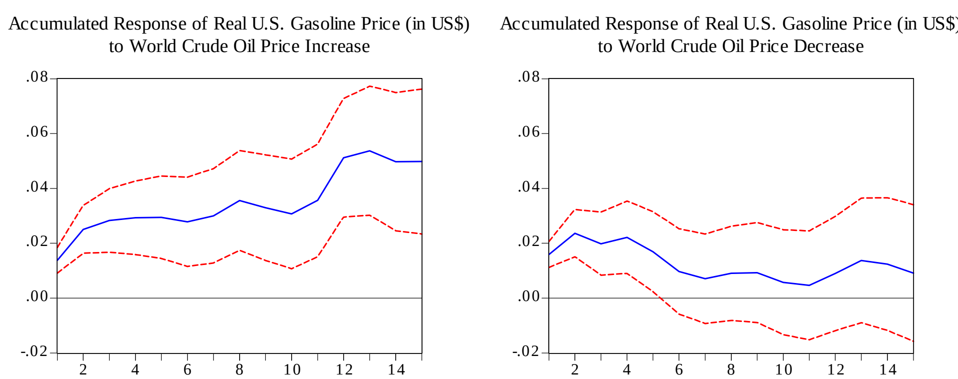


Figure 15 Accumulated response of the U.S. gasoline prices (in US$, 2000 prices)

In light of these findings, I argue for Turkey that gasoline price asymmetry exists due to government price setting and frequently changing tax rates. Further, given that gasoline prices respond to only world price increases, but not to decreases, rather than smoothing the impact of world crude oil price volatility on retail gasoline prices, successive governments used declining world crude oil prices as a source of tax revenues.

Conclusions

I empirically investigate the responses of retail gasoline prices in Turkey to world crude oil price changes. Using SVAR methodology for estimations and a variety of price specifications, I report that Turkish gasoline prices respond significantly only to increasing world crude oil price increases, but not to decreases. I also do the same analysis using retail gasoline prices in the U.S. and report symmetric response of retail gasoline prices. I argue that since unlike other countries where there are many intermediate margins, gasoline prices in Turkey are mainly determined by the governments, the source of asymmetry is attributable to substantial time-variant taxes on gasoline. My results suggest that successive governments in Turkey mostly cared about tax revenue collection rather than price smoothing while changing taxes on gasoline.

CHAPTER 3

ASYMMETRIC EFFECTS OF OIL PRICES ON THE MANUFACTURING SECTOR OF TURKEY

Introduction and Literature Review

Understanding the nature of the relationship between oil price and real output has been an issue of concern to both policymakers and researchers in the recent decades. While numerous studies have achieved remarkable progress in explaining the dynamics for the U.S. economy[25], there are relatively less studies devoted to developed economies, and almost none to oil-importing small open economies like Turkey.

Turkish economy distinguishes from the U.S. and other examined developed and/or oil-producing economies in several aspects: First, Turkey is a small open economy which can influence neither the world oil demand nor the supply.[26] Hence when compared to the previously examined countries, oil price is exogenous to the Turkish economy.

Second, since Turkey depends mainly on oil imports for energy production and consumption[27], compared to rest of the OECD countries, oil price movements are expected to have more drastic effects on the Turkish economy. The ratio of oil expenditure to GDP is higher relatively[28], and imports on oil and natural gas is an

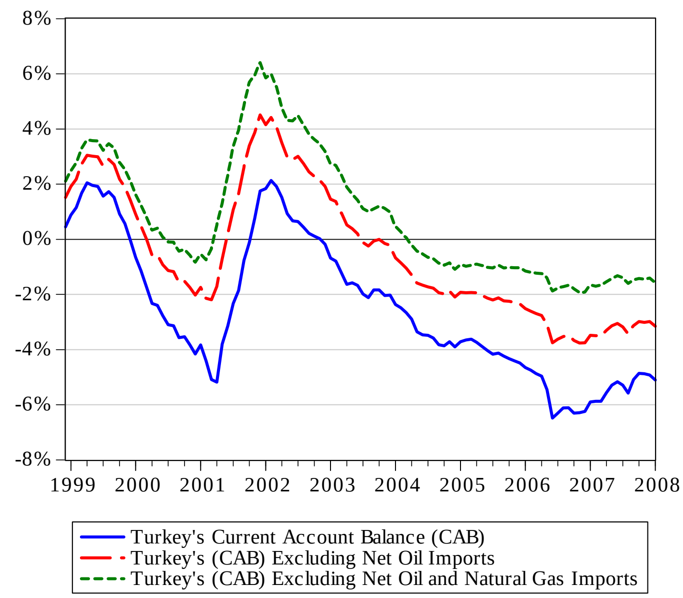
[25] See Mork (1989), Lee *et al.* (1995), Hamilton (1996,2003) on asymmetric effects of oil prices on aggregate output, Bernanke (1983), Pindyck (1991), Lilien (1982), and Borenstein *et al.* (1997) on the sources of the asymmetry, Barsky and Kilian (2004), Edelstein and Kilian (2007) on endogeneity of oil prices, and demand-side concerns, Kliesen (2005) on manufacturing sector of the U.S., and Kilian (2008) for a detailed discussion about the literature.

[26] According to EIA Country Analysis Briefs : Turkey October 2006, Turkey accounts for 0.73% of world oil consumption as of 2005, and produces comparably negligible amount of oil.

[27] Based on Turkey State Planning Organization projections in 9th Development Plan Publication, the Turkish Statistical Institute and Turkey General Directorate of Petroleum Affairs statistics, oil leads primary energy sources of Turkey by 36.68% and, 92.3% of the domestic demand is met by imports as of 2005.

[28] According to Turkish Statistical Institute, expenditure on oil corresponds to 3.27% of Turkey's nominal GDP in 2005, and varies around 2.5% historically, as opposed to recent 1.3% of nominal GDP of the U.S. (Blanchard and Galí, 2007).

important contributor to the current account deficit. In Figure 16, I display the historical pattern of current account balance of Turkey with and without oil and natural gas expenditures. By the beginning of the year 2008, the annualized current account deficit is slightly higher than 5% of Turkey's GDP, oil imports account for almost 40% of this ratio alone, and together with natural gas imports this ratio adds up to 68%.



(Source: Central Bank of Turkey and Turkish Statistical Institute)

Figure 16 Annualized current account balance of Turkey as a ratio to Turkey's GDP

Third, as a financially liberalized small open economy, Turkey is more susceptible to sudden stops in capital flows, hence global liquidity conditions[29]. Therefore, global liquidity conditions should be attempted to be taken into account while measuring the effect of oil price changes.

[29] *A priori*, the relationship between world oil prices and global liquidity conditions is ambiguous: As a result of rising oil prices, current account surpluses of OPEC and other major oil exporting countries could improve global liquidity conditions. On the other hand, due to increase in petrodollars, the resultant current account deficits of oil importers will have the opposite effect.

Fourth, as a developing country, Turkey's GDP exhibits higher variability when compared to developed economies, which makes detecting the net effect of oil price changes on macroeconomy more difficult.[30] "The Great Moderation" experienced in developed economies has not been seen in Turkey, and as a result of higher observed noise in output, estimating the net impacts of oil price changes is expected to be a more challenging task for Turkey.

Finally, in Turkey direct and indirect taxes constitute no less that 60% of the prices of major fuel types. Hence, other than changes in world oil prices, changes in the exchange rate movements as well as revenue concerns for the Turkish government play a major role in determining the domestic oil product prices that the households and firms face. This generates another departure of the relationship between world oil prices and real output when compared to the other developed economies.

There are only a few studies which analyze the impacts of of energy prices on Turkish economy. Previous empirical studies mostly focus on the inflationary effects of oil price changes.[31] Some studies focus on real effects of energy prices and consumption.[32] The only exception is Alper and Torul's (2008) investigation of the relationship between oil prices and the aggregate output in Turkey, where they report negative and significant response of GDP to oil price increases.

In this study, I empirically investigate the effects of world oil prices and domestic oil product prices on the manufacturing sector and its sub-categories in Turkey. This study distinguishes from the previous studies mainly in three aspects. This study is the first of its kind to examine the responses of the manufacturing

[30] As opposed to the standard deviation of real GDP growth of the U.S. for the 1992-2007 period: 0.0049, Turkey has much higher volatility: 0.0627. Further, standard deviation of industrial production index growth of the U.S. is 0.0048 whereas it is 0.0510 for Turkey.

[31] Among others, see Kibritcioglu and Kibritcioglu (1999), Kibritcioglu (2003), Berument and Tasci (2002), Diboglu and Kibritcioglu (2004).

[32] See Sari and Soytas (2003, 2004) and Lise and Monfort (2006) on the relationship between energy consumption and GDP, and Sari and Soytas (2007) on electricity consumption and value-added in the manufacturing sector.

sub-sectors of Turkey to oil price changes. Following Alper and Torul (2008), I incorporate global liquidity conditions, as well as domestic financial conditions and exchange rate dynamics.[33] Also, I employ monthly data in my estimations in contrast to majority of previous studies which employ quarterly or less frequent data.

My multivariate vector autoregression (VAR) estimation results for the 1991-2007 reveal that even though overall industrial production do not respond to either world oil prices or domestic oil product prices, 6 out of 22 the manufacturing sub-sectors respond significantly to domestic oil product prices. Further, I also find evidence for the necessity of incorporation of global liquidity and domestic financial conditions, as well as real exchange rate dynamics.

Data, Variable Definitions and Methodology

In this section I present the variables employed in estimating the effects of oil price changes on the real production series, and their data sources.

In order to proxy the effects of oil price changes, I use both world crude oil prices and domestic oil product prices. While the use of the former price series is standard in the literature, I also employ the latter variable since decision makers base their energy input and consumption decisions on end-user oil product prices rather than world prices, and the fluctuations of the two real prices series have differed noticeably in the recent decades as shown in Figure 17. The different growth rates of the two series can be explained by the price asymmetry of domestic oil product prices when responding to world crude oil prices: I show that parallel to the findings by Alper and Torul (2009) for gasoline prices, while the weighted oil product price index, the details of which will be discussed shortly, is observed to

[33] As response to Blanchard and Galí (2007) who argue for the diminishing effects of oil price increases in 2000s, Alper and Torul (2008), present that controlling for the global liquidity and finance conditions, the negative effects of oil price shocks still persist for Turkey in the 2000s at aggregate level.

respond positively and significantly to world oil price increases, it does not respond significantly to oil price decreases as shown in Figure 18.[34,35]

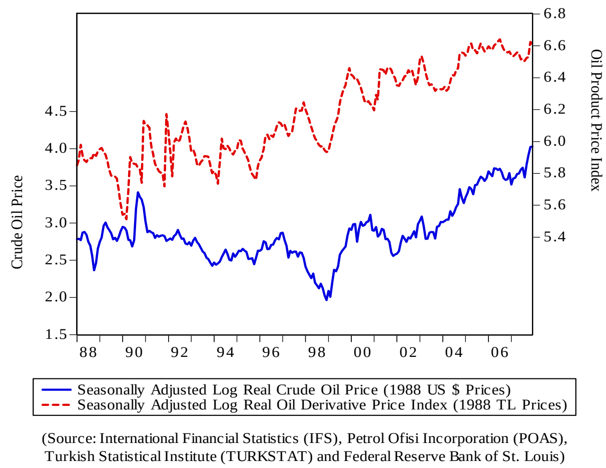


Figure 17 Historical pattern of real crude oil prices and real oil product price index

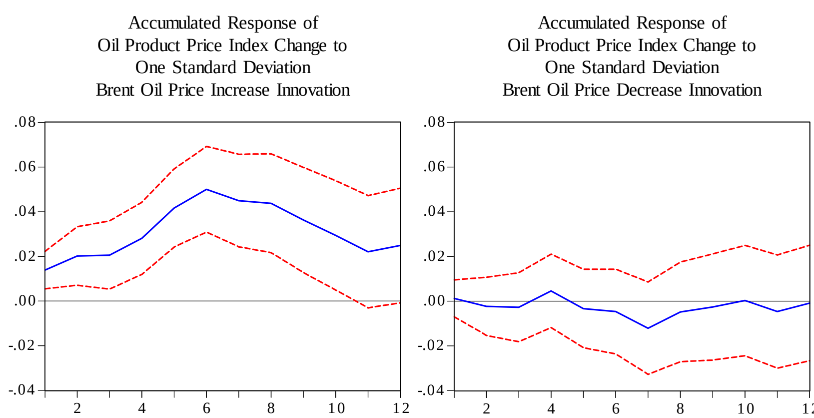


Figure 18 Accumulated response of oil product price index

[34] Using a basic trivariate VAR model for 1991-2007 period with Brent oil price increase and decrease, and domestic oil product price index as three separate endogenous variables, and a constant and a dummy for Turkey's 1994 and 2001 financial crises as exogenous variables, I derive and display the resultant accumulated impulse-response functions.

[35] Also, Block-exogeneity Wald test results suggest that crude oil price increases significantly predict oil product price changes, whereas oil price decreases do not with the respective p values of 0.024 and 0.3268. Equivalent statistical results are observed with different modeling approaches.

The asymmetric response of domestic oil product prices to world crude oil prices could be attributed to three reasons. First, as a result of substantial time-varying government taxes on major oil products, the price changes which households and firms face differ from the world crude oil price fluctuations. As shown in Table 1, Turkish governments alter the tax rates on the the two major types historically, which constitute no less than 60% of the final prices[36]. Following Alper and Torul (2009), it is reasonable to believe that taxes are the major contributor to the price asymmetry.

Second, as the domestic currency of Turkey fluctuates against the U.S. dollar in which world crude oil price is denominated, the domestic prices of oil products vary even for fixed world oil prices.

Third, the consumer price indices (CPIs) to deflate for nominal world and domestic price series to generate real series differ, which suggests that even for equivalent fluctuations, the growth rate of the two series vary depending on the relative price changes of the other goods in the CPI bundles.

Table 1 Tax Rates and Prices For Gasoline and Diesel Oil

Gasoline 95 Octane	1998	1999	2000	2001	2002	2003	2004	2005	2006
Distillery Output Price	0.034	0.067	0.160	0.253	0.303	0.361	0.459	0.551	0.695
Tax-added Price	0.173	0.321	0.518	0.860	1.320	1.616	1.772	2.260	2.429
End-consumer Price	0.203	0.364	0.584	0.995	1.481	1.799	1.979	2.550	2.790
Direct and Indirect Taxes	80.3%	79.0%	69.1%	70.6%	76.9%	77.7%	74.1%	75.6%	71.4%
Diesel Oil	1998	1999	2000	2001	2002	2003	2004	2005	2006
Distillery Output Price	0.027	0.057	0.145	0.233	0.280	0.348	0.452	0.602	0.747
Tax-added Price	0.102	0.206	0.380	0.629	0.965	1.238	1.363	1.697	1.867
End-consumer Price	0.125	0.240	0.432	0.724	1.099	1.389	1.537	1.940	2.200
Direct and Indirect Taxes	73.6%	72.5%	61.8%	62.5%	71.0%	71.9%	66.8%	64.5%	60.0%
Prices in TL, source: Petroleum Industry Association of Turkey (PETDER)									

I construct the mentioned domestic nominal oil product price index variable as

[36] As a result of these various direct and indirect taxes, Turkish consumers pay the highest prices for light fuel oil, automotive diesel oil and unleaded gasoline, and second highest price for heavy fuel oil in the world. (International Energy Agency Key World Energy Statistics 2007)

follows: I first acquire the monthly average end-user nominal prices from Petrol Ofisi Incorporation (*POAŞ*) for the five major oil product types, diesel oil, gasoline, kerosene, heating oil and fuel oil, which account for almost the entire consumption on oil products. Using these nominal prices, I generate a nominal index of oil product prices based on their relative weights among the oil products[37]. Real domestic oil product price series is obtained after deflating the nominal series by Turkish CPI[38].

Other than the growth rate of price index, in order to proxy asymmetric effects of oil price changes as documented in the literature, I employ three non-linear series: Mork's (1989) Oil Price Increase, Lee *et al.*'s (1995) Scaled Oil Price Increase (SOPI), Hamilton's (1996) Net Oil Price Increase (NOPI)[39].

The first non-linear series, which is oil price increase variable due to Mork (1989) is defined as:

$$o_t^+ = \begin{cases} o_t & \text{if } o_t > 0 \\ 0 & \text{else.} \end{cases} \tag{14}$$

where o_t denotes log-difference of oil product price index.

Lee, *et al*'s (1995) SOPI series is derived using AR(4)-GARCH(1,1) specification for quarterly frequency. I use monthly data, hence use AR(12)-GARCH(1,1) specification:

$$o_t = \alpha_0 + \alpha_1 o_{t-1} + \alpha_2 o_{t-2} + \ldots + \alpha_{12} o_{t-12} + u_t \tag{15}$$

[37] For weighting purposes, I make use of annual consumption expenditure data on the major oil products by Turkey General Directorate of Petroleum Affairs.

[38] While Turkey's CPI basket includes the oil product prices and deflating nominal prices with the CPI could arise problems, the shorter horizon of CPI excluding energy prices restricts for the use the former CPI series.

[39] While there are further specifications in the literature, such as Ferderer's (1996) volatility-based non-linear variable, following Hamilton (2003) who argue that SOPI and NOPI perform better than the rest of the price specifications in capturing the asymmetric effects of oil price shocks, I employ these variables. In addition, as a fundamental yet practical and reasonable threshold variable, I also use oil price increase specification in my estimations.

where

$$(u_t|u_{t-1}) \sim N(0, \sigma_t^2) \qquad \sigma_t^2 = \gamma_0 + \gamma_1 \sigma_{t-1}^2 + u_{t-1}^2 \tag{16}$$

$$SOPI_t = \max\{0, (\hat{u}_t/\hat{\sigma}_t)\} \tag{17}$$

Following Hamilton (1996), NOPI based on maximum price over 3 years is defined as:

$$NOPI_t^{36} = \max\{0, p_t - max(p_{t-1}, p_{t-2}, \ldots, p_{t-36})\} \tag{18}$$

where p_t denotes the natural logarithm of nominal oil product price index.

In order to examine the net effects of oil product price changes on the Turkish real sector, I employ industrial production index and manufacturing sub-sector indices as output variables, which are available on Central Bank of Turkey's (CBT) online database. I also incorporate macroeconomic fundamentals including domestic overnight interest rate and real effective exchange rate (REER) based on producer price index, which I obtain from CBT's online database. Additionally, I include two variables to proxy global liquidity conditions as used in the international financial literature: Effective Fed Funds Rate (FFR) and the Chicago Board of Exchange Implied Volatility Index (VIX) which are available in St. Louis Fed, and the Chicago Board of Exchange online databases, respectively. Since domestic interest rate and VIX data series are available since 1990, my estimation sample covers 1990-2007 period.[40,41]

I conduct the following set of estimations: I use multivariate VAR models with one of the oil price specifications, one of the real production indices, FFR, VIX, domestic overnight average interest rate, and REER. Other than these endogenous

[40] Because the data for the manufacturing of wood and wood products is available only after 1997, for this specific sub-sector, my estimations cover 1997-2007 period.

[41] While the seasonally-adjusted real oil product price index, real industrial output indices, and real effective exchange variables are observed to have unit root, and are included in estimations in log-difference forms, the remaining variables, VIX and interest rates are found to be stationary at levels, and hence included as they are.

variables, I include a constant and a dummy variable for the 1994 and 2001 financial crises of Turkey as the exogenous variables.

After determining the optimal lag-length of the VAR models by log-likelihood ratio criterion, I compute the sum of oil product price coefficients as an indicator for the responses of growth rates of the industrial output indices, and I conduct block-exogeneity Wald tests to check for significant uni-directional causality from oil product prices to output. Finally, I calculate the adjusted R-squared values, and use these as a measure for goodness of fit for the regressions.

Empirical Results

First, using world crude oil prices as oil price specifications, I estimate multivariate VARs, and observe that except for the manufacture of coke and refined petroleum products, none of the manufacturing sub-sector growth is predicted significantly by all linear and non-linear crude oil price variables.

Next, employing symmetric and asymmetric domestic oil product price index variables in my multivariate VAR models, I derive different results, suggesting heterogenous effects of oil product prices on the sub-sectors. I report my findings in Table 2. Each row displays the VAR results of a manufacturing sub-sector for each of the oil price specifications. The first column refers to the leg-length, second column refers to the sum of oil coefficients, and the third column refers to the adjusted R-squared value for the specific regression.

Optimal lag-lengths are observed to be no less than 12 months for majority of the regressions, which imply that in order for oil price changes to be reflected fully on the manufacturing sector and the sub-categories, it takes no less than 4 quarters using the first three of the oil specifications and slightly shorter horizons using SOPI. These optimal lag-length results are in accordance with the 4 quarterly lags of Hamilton (1983, 1996, 2001), Hooker (1996), Mork (1989), Jiménez-Rodríguez and Sánchez (2005) for developed aggregate economies, and 13 months of Alper and Torul (2008) for the Turkish aggregate output, but distinguishably longer than Kliesen's (2005) for the U.S. manufacturing sub-sectors.

Table 2 Effects of Oil Product Price Changes Estimated via Multivariate VAR

	Log-Difference			Increase			NOPI			SOPI		
	p	Γ_{oil}	$\bar{R}^2$	p	Γ_{oil}	$\bar{R}^2$	p	Γ_{oil}	$\bar{R}^2$	p	Γ_{oil}	$\bar{R}^2$
Total Industry	12	0.14	0.51	12	0.03	0.51	12	0.12	0.52	12	0.01	0.53
Manufacturing Industry	13	0.24	0.48	12	0.06	0.46	12	0.07	0.47	12	0.01	0.48
Food and Beverage Prod.	15	0.93	0.45	13	0.41	0.41	15	0.95	0.47	7	-0.03	0.43
Tobacco Prod.	12	0.63	0.33	12	0.01	0.33	12	0.12	0.34	12	0.03	0.34
Textile	13	0.40	0.49	12	-0.07	0.48	12	0.45	0.49	12	-0.01	0.48
Wearing Apparel	13	0.10	0.33	13	0.33†	0.35	13	0.47	0.34	6	0.00‡	0.39
Leather Prod.	13	-1.13	0.22	13	0.37	0.21	13	-0.14	0.18	12	-0.04	0.18
Wood and Wood Prod.	15	-2.89‡	0.52	2	-1.32‡	0.22	2	-0.52†	0.18	7	-0.09‡	0.40
Paper and Paper Prod.	13	0.50	0.28	12	0.31	0.28	12	0.32	0.30	7	0.00	0.29
Publishing and Recorded Media	13	-0.29	0.12	12	0.61	0.13	12	0.00	0.17	7	-0.03	0.17
Coke and Refined Oil Prod.	13	-1.36	0.22	13	-0.62	0.18	13	-0.88	0.20	7	-0.04	0.19
Chemicals and Chemical Prod.	15	-0.92‡	0.27	12	-1.54‡	0.31	15	-1.25‡	0.27	3	-0.06‡	0.16
Rubber and Plastics Prod.	13	-0.28‡	0.48	12	-0.59‡	0.45	12	-0.60†	0.45	7	-0.02‡	0.41
Other Non-Metallic Min. Prod.	12	-0.49	0.44	12	0.01	0.43	12	-0.46	0.45	12	0.01	0.45
Basic Metals	12	0.05‡	0.22	12	0.18‡	0.21	12	0.00†	0.19	6	0.01	0.21
Fabricated Metal Prod.	12	-0.26	0.15	12	-2.38‡	0.21	12	-0.97	0.17	12	-0.06	0.14
Machinery and Equipment .	13	0.17	0.47	12	-0.08	0.45	12	-0.03	0.46	10	0.02	0.46
Office and Computing Mach.	14	4.33‡	0.29	14	2.57‡	0.28	13	5.73‡	0.31	12	0.13	0.19
Electrical Machinery n.e.c.	13	0.97‡	0.50	12	-2.34‡	0.53	12	-2.38‡	0.52	12	-0.06‡	0.45
Radio, TV and Commun. App.	13	1.44‡	0.55	13	-1.10‡	0.57	13	-0.07‡	0.56	12	-0.01†	0.46
Medical and Optical Instrum.	12	1.83	0.32	12	5.48†	0.37	12	1.48	0.35	12	0.27	0.35
Motor Vehicles,etc.	12	1.39	0.29	12	2.00	0.28	12	0.84	0.30	12	0.08	0.27
Other Transport Equipment	13	8.29	0.27	13	12.66	0.28	12	12.07	0.30	12	0.58	0.27
Furniture	13	-0.97‡	0.35	13	-3.90‡	0.45	13	-2.33‡	0.33	7	-0.11‡	0.23

p : Lag-Length ; Γ_{oil}: Sum of Oil Coefficients ; $\bar{R}^2$: Adjusted R-Squared

†Significant at 10% , ‡Significant at 5% by Block-Exogeneity Test

According to the block-exogeneity tests , I observe that neither aggregate industrial output growth nor aggregate manufacturing production growth is predicted significantly by oil product price changes. Further, while the endogenous variables altogether predict industrial output growth at 10% significance level regardless of the price specifications, they fail to predict overall manufacturing production growth separately.[42]

Regarding the sub-sectors, I find that increases in domestic oil product price index significantly reduce the real growth rate the manufacture of wood and wood products, chemicals and chemical products, rubber and plastic products, and furniture sub-sectors regardless of the price specifications. Of these sub-sectors, negative and significant impacts of oil product price increases on the manufacture of chemicals, chemical products, rubber and plastic products sectors are rather expected: These sub-sectors use oil products heavily as both production inputs and primary sources of energy according to previous energy surveys. The cause of negative and significant impacts on wood, wood products and furniture sectors could be attributed to the fact that transportation costs are major input costs for these industries.

Also, the manufacture of electrical machinery and radio, television and communication apparatus sub-sectors are predicted significantly by all price specifications. Except for price growth variable which fails to capture the asymmetric effect, unfavorable consequences of oil product price increases on these manufacturing sub-sectors is significantly documented. Regarding these two sub-sectors, previous surveys indicate that oil products are not the primary sources of energy, and have smaller share of oil relative to many other sectors. Given that some other sub-sectors such as food and beverage products use higher portion of energy from oil products, and are not significantly predicted by oil product price increases, the main reason of the significant effects on these industries is not very clear.[43]

For the remaining sectors, only the manufacture of basic metals and office and

[42] Except for oil product price increase variable, which is significant at 10.58% significance level.

[43] My findings are similar to those of Kliesen (2005) who document negative and significant impacts of oil price increases on manufacture of wood and furniture products, and fabricated metal products of the U.S. economy.

computing machinery are observed to be potential candidates to be predicted by oil product price changes as they respond positively and significantly to all price specifications but SOPI. However, since SOPI, by definition, captures the unexpected increases in prices better than the other specifications, positive uni-directional causality from domestic oil product prices to growth of these sub-sectors is not likely.

One manufacturing sub-sector of special interest, namely the manufacture of motor vehicles is observed not to be significantly predicted by oil product price increases. *A priori*, one could expect this sub-sector to be negatively affected by price increases as a result of less demand because of higher operating costs.[44] However, higher operating costs for motor vehicles also create incentives for fuel-efficient motor vehicles, and accordingly opportunities for the automobile producers of these types. Hence, rather than an overall reduction in the growth of this sub-sector, substitution to fuel-efficient cars is more probable, yielding overall insignificance of the response of the output of this sub-sector.

Block-exogeneity tests on the significantly-predicted sub-sectors reveal that additional variables in my multivariate VAR models heterogeneously predict the growth of the manufacturing sub-sectors.[45] Further, the exclusion of these additional variables result in decrease in statistical significance of the predictive power of oil product price index, deterioration of adjusted R-squared values, and reversion in the sign of sum of oil coefficient for many sub-sectors. Hence, in the light of these findings, incorporation of global liquidity conditions, as well as domestic finance and exchange rate dynamics are critical in estimating the net

[44] Further, automobile industry is documented to be the the main source of unfavorable supply-side impacts of oil prices for the U.S. economy by Kilian, 2008.

[45] Effective Fed funds rate predict growth of the manufacture of wood and wood products, furniture and basic metals; implied volatility index predict growth of the manufacture of rubber and plastic products, electrical machinery, and radio, television and communication apparatus; domestic interest rate predict growth of the manufacture of chemicals and chemical products, radio, television and communication apparatus; and real effective exchange rate predict growth of the manufacture of wood and wood products, radio, television and communication apparatus sectors, significantly.

effect of oil price changes, and exclusion of these factors may lead to omitted variable bias.

Conclusions

Investigating the relationship between oil price and macroeconomy has been an issue of interest in the recent decades. While numerous studies have been conducted and substantial progress has been achieved on developed economies, particularly on the U.S. economy, the dynamics for emerging small open economies have not been revealed, yet.

In this study, I investigate the effects of world oil and domestic oil product price changes on manufacturing sub-sectors of Turkey and I present real-world evidence based on vector autoregressive models. Due to the structural differences between developed economies and Turkey, namely exogeneity of oil prices to small open economies, extreme oil-dependance and import-reliance, high output volatility, and additional asymmetric response of domestic oil product prices to world crude oil price changes, I take a different methodological approach.

Using linear, and non-linear oil price variables in the literature, and incorporating global liquidity and domestic finance conditions, as well as real exchange rate dynamics, I perform multivariate VARs in order to estimate the net effect of oil price changes.

I report that contrary to the common belief, neither crude oil nor oil product price increases impede overall production growth of Turkey. Yet, I find that oil product price increases robustly impede production growth of several manufacturing sub-sectors, including wood and wood products, furniture, chemicals and chemical products, and rubber and plastic products, electrical machinery, and radio, TV and communication apparatus. Further, I present evidence on the essentiality of incorporation of the additional variables.

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