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Asymmetric adjustment of retail gasoline prices in turkey to world crude oil price changes: the role of taxes

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Abstract

We empirically investigate the impact of shocks to world crude oil prices on retail gasoline prices in Turkey during the 1991-2007 period. Using a Structural-VAR methodology and monthly frequency data, we report that Turkish retail gasoline prices respond significantly to increasing world crude oil prices, but not to decreases. During the estimation period, 70 to 80% of the retail gasoline price was attributable to taxes which were subject to frequent changes by the council of ministers. Although historical data on gasoline taxes is not publicly available, based on the importance of taxes on gasoline price formation in Turkey, we argue that the source of asymmetry is mainly attributable to government price setting policy choice for gasoline. Based on the observed asymmetry from empirical analysis, we further argue that rather than smoothing the impact of volatility in world crude oil prices on Turkish retail gasoline prices, the Turkish fiscal authorities attempted to maximize tax revenue from gasoline.

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1. Introduction

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.[1] While numerous theoretical explanations have been offered for the existence of the asymmetry, econometric evidence, so far, has been mixed.[2] 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.

We empirically investigate the response of retail gasoline prices in Turkey to world crude oil price changes. This paper contributes to the burgeoning literature on gasoline and crude oil price asymmetry in two fronts. First, to our 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 domestic retail gasoline prices.[3] 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.[4] 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.[5] 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,

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

[2] 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.

[3] 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.

[4] 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.

[5] 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.

makes up only 15% of the retail price.[6] 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 response to world crude oil price changes would 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 unleaded gasoline was 0.424 Turkish Lira (TL) per liter.[7] Special Consumption Tax (SCT) of 1.4915 TL/liter (approximately USD 1) is added on the refinery price.[8] Once the refinery sales price, the SCT as well as the transportation cost, the distributor and the supply station's premium are summed, 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.[9] As we illustrate in Figure 2, 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.

In terms of econometric modeling, we use structural vector autoregression models (SVAR) 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).[10] Since historical data on various taxes are not publicly available, we use only world crude oil prices and retail gasoline (and diesel) prices in our estimations. We also employ the same methodology to the U.S. data and discuss our findings for Turkey in a comparative manner.

Our results suggest that the response of retail gasoline prices in Turkey is asymmetric

[6]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.

[7]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.

[8]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.

[9]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.

[10]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 our data span is only 17 years, this is not enough to characterize long-term relationships properly and we decided not to do ECM.

while the response in terms of significance seems to be symmetric in 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. We also unveil that similar results are obtained when retail diesel oil prices are used instead, suggesting that the results are robust to the choice of oil product for Turkey and the U.S.[11] Our results indicate 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.

The outline of the paper is as follows. In section 2, the data and methodology are described. In section 3, we present the empirical results and section 4 concludes.

2. Data and Methodology

We 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. We 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. Our monthly analysis cover the 1991-2007 period.

The consumer price indices (CPIs) are taken from Turkish Statistical Institute and St. Louis Fed online databases.[12] 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.

We present in Figure 1 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 U.S.

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

In order to distinguish the effects of oil price increases and decreases, we generated two series based on the sign of the growth rate of world crude oil prices. Following Mork (1989),

[11] We do not report the results when retail diesel prices are utilized. The results are available from the authors upon request.

[12] We 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, we 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 Kibritçioğlu (2003) on the impact of oil product price changes on the Turkish inflation.

oil price increase is defined as:

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

Similarly oil price decrease is defined as:

$$o_t^- = \begin{cases} o_t & \text{if } o_t < 0 \\ 0 & \text{else.} \end{cases} \tag{2}$$

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

$$\beta_0 y_t = \alpha + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \ldots + \beta_p y_{t-p} + u_t \tag{3}$$

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:

$$y_t = \delta + \Gamma_1 y_{t-1} + \Gamma_2 y_{t-2} + \ldots + \Gamma_p y_{t-p} + \varepsilon_t \tag{4}$$

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

$$\begin{bmatrix} \varepsilon_{o^+t} \\ \varepsilon_{o^-t} \\ \varepsilon_{ft} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 \\ 0 & b_{22} & 0 \\ b_{31} & b_{32} & b_{33} \end{bmatrix} \begin{bmatrix} u_{o^+t} \\ u_{o^-t} \\ u_{ft} \end{bmatrix} \tag{5}$$

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 deriving structural form solutions by imposing the restrictions on the system, we derive accumulated impulse-responses to reach conclusions based on optimal lag length of 12.

3. Estimation Results

We 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 3, we observe that 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 we investigate the response of nominal US$-denominated gasoline prices in the U.S. using the same methodology for comparison, we reach a different conclusion: As we illustrate in Figure 4, gasoline prices respond positive 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 when crude oil prices fall.[13]

We next investigate whether the results reported above 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 mentioned in the first section, there exists substantial government taxes on gasoline which are time-varying (and are unobserved), as a result, 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-a-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 price of gasoline in Turkey and in the U.S..

In order to investigate which of these factors is more influential for the existence of the asymmetry, we next convert TL-denominated retail gasoline prices to US$ to eliminate the influence of exchange rate fluctuations and then perform the SVAR analysis.[14] Figure 5 confirms the existence of asymmetry in Turkey for the US$ denominated gasoline prices as well: nominal US$-denominated retail gasoline prices in Turkey respond positive and significantly to increasing world crude oil prices, and do not respond significantly to decreasing world prices[15].

Next, we deflate retail gasoline prices in Turkey and in the U.S. using their CPIs respectively and then perform the SVAR. Estimated accumulated impulse-responses for Turkey confirm that retail gasoline prices respond positive and robustly only to world crude oil price increases, as illustrated in Figure 6. When we carry out the same estimation using real U.S. retail gasoline prices, we observe that the U.S. gasoline price responds positive and significantly not only to increasing world prices, but also to decreasing world prices, as shown in

[13]By the lack of asymmetry, we 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.

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

[15]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.

Figure 7.[16]

In light of these findings, we 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.

4. Conclusions

We 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, we report that Turkish gasoline prices respond significantly only to increasing world crude oil price increases, but not to decreases. We also do the same analysis using retail gasoline prices in the U.S. and report symmetric response of retail gasoline prices. When we conduct the same analysis with retail diesel oil prices in the two countries, our conclusions do not change. We argue that since unlike other countries where there are many intermediate margins, gasoline prices in Turkey are heavily determined by the governments, the source of asymmetry is attributable to substantial time-variant taxes on gasoline. Our results suggest that successive governments in Turkey mostly cared about tax revenue collection rather than price smoothing while changing taxes on gasoline.

[16]We also conduct the analysis using Turkish and U.S. retail diesel oil instead of gasoline prices. We reach the same conclusions. All results are available from the authors upon request.

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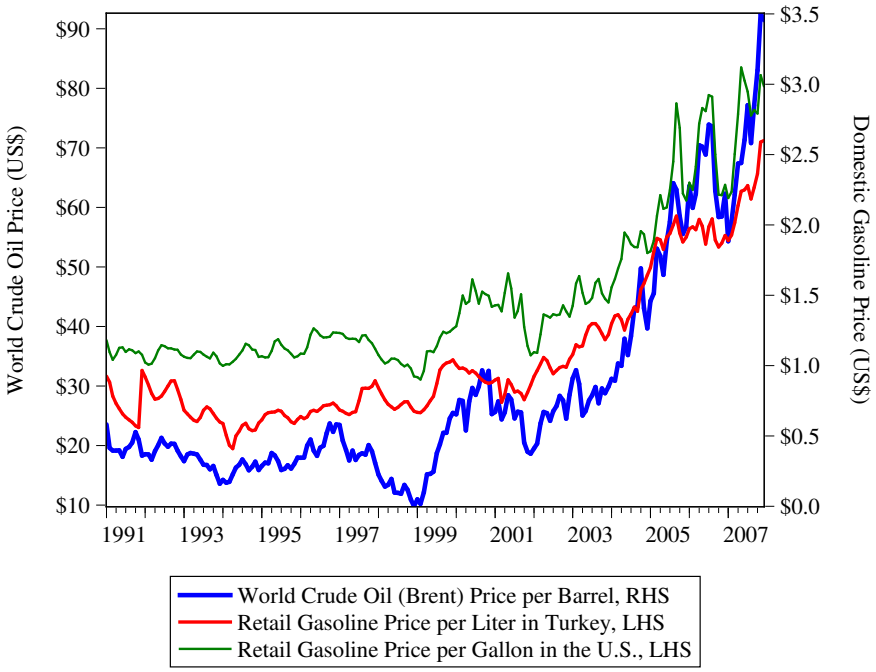
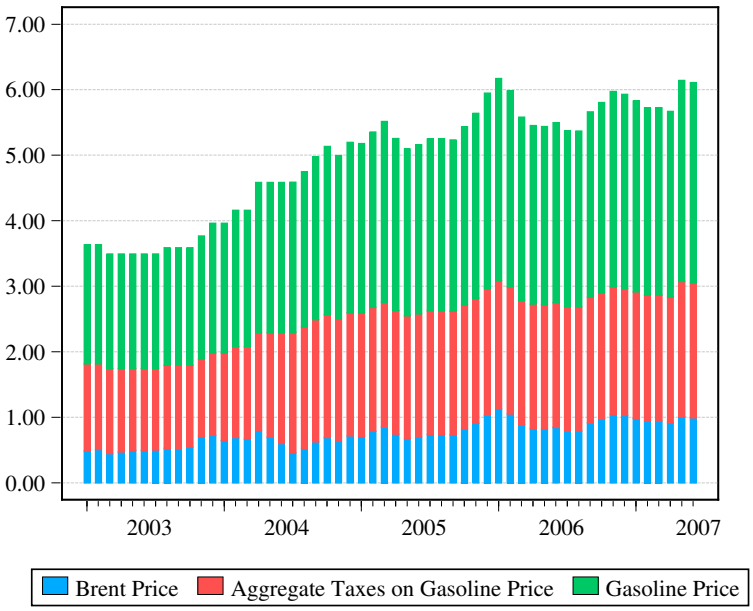
Figures

Figure 1: Historical Pattern of the U.S. and Turkish Gasoline Prices (in current US$)



(Source: International Financial Statistic, Energy Information Administration, and Petrol Ofisi Incorporation)

Figure 2: Historical Pattern of Turkish Gasoline Prices, Aggregate Taxes Levied on Turkish Gasoline and Brent Oil Prices (in current TL per liter)



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

Figure 3: Accumulated Response of Turkish Gasoline Prices (in current TL)

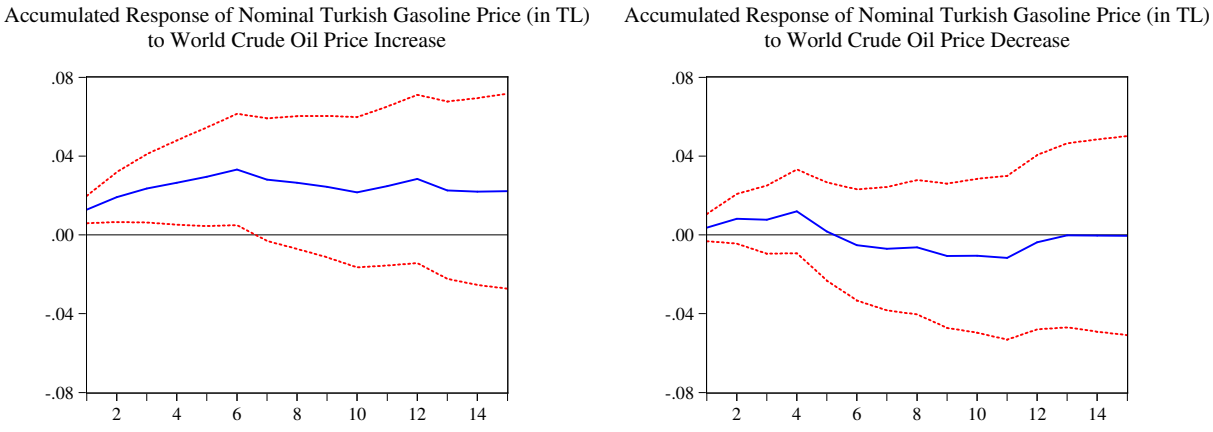


Figure 4: Accumulated Response of the U.S. Gasoline Prices (in current US$)

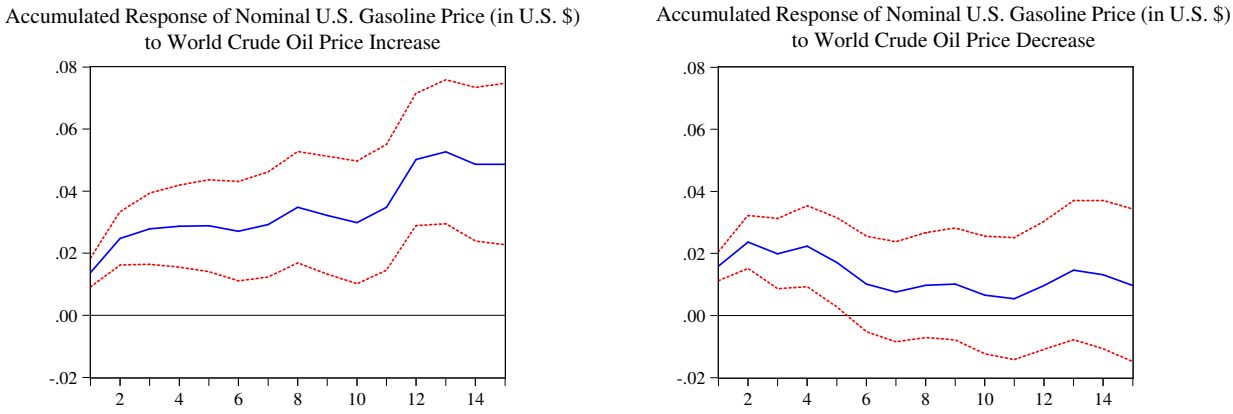


Figure 5: Accumulated Response of Turkish Gasoline Prices (in current US$)

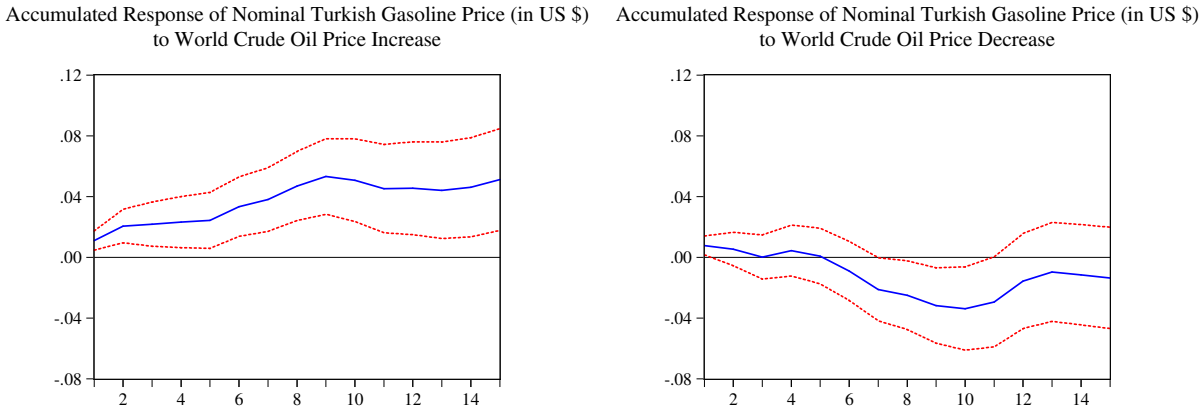


Figure 6: Accumulated Response of Turkish Gasoline Prices (in TL, 2000 prices)

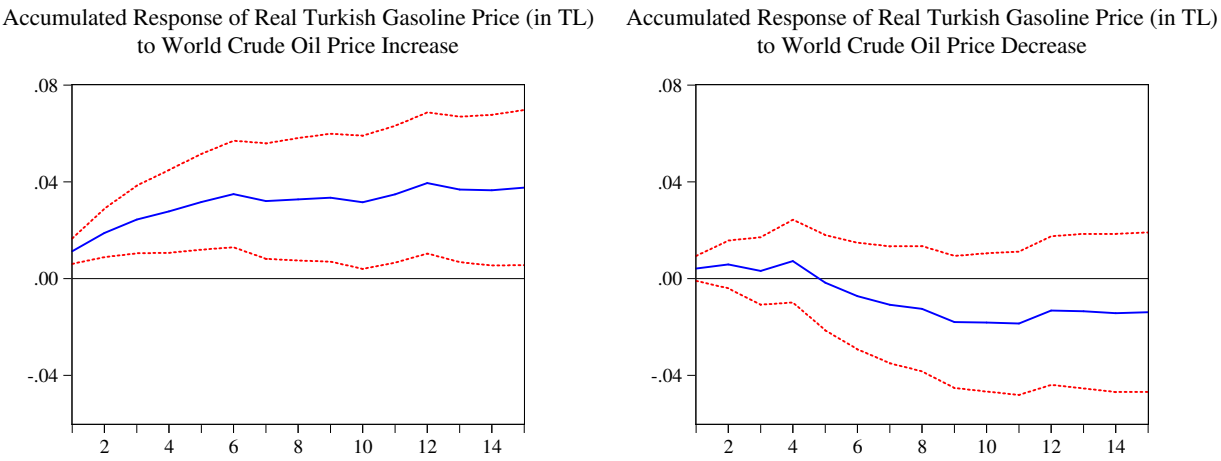


Figure 7: Accumulated Response of the U.S. Gasoline Prices (in US$, 2000 prices)