TÜRKİYE CUMHURİYET MERKEZ BANKASI

WORKING PAPER NO: 14/31

Asymmetric Exchange Rate and Oil Price Pass-Through in Turkish Fuel Oil Market

September 2014

Fatih AKÇELİK
Mustafa Utku ÖZMEN

Address:
Central Bank of the Republic of Turkey
Head Office
Research and Monetary Policy Department
İstiklal Caddesi No: 10
Ulus, 06100 Ankara, Turkey

Phone:
+90 312 507 54 02

Facsimile:
+90 312 507 57 33

Asymmetric Exchange Rate and Oil Price Pass-Through

in Turkish Fuel Oil Market

Fatih AKÇELİK* & Mustafa Utku ÖZMEN*

Abstract

In this paper, we revisit the unsettled discussion of whether retail fuel oil prices respond asymmetrically to oil price shocks. Using a novel micro approach that considers each price spell separately; we find evidence of pass-through asymmetry in the fuel oil market in Turkey. With our approach it is possible to analyze asymmetry at various other grounds including source and size of the cost shock. We show that exchange rate (oil price) is the main factor fueling asymmetry in case of cost increases (decreases). Also, if the magnitude of positive cost shock is higher, pass-through will be lower. Finally, empirical evidence suggests that pricing behavior in terms of pass-through degree and asymmetry varies across firms. The market power of the firms is suggested as the main explanation of the asymmetry, yet there are factors limiting the use of market power in price setting.

Keywords: Fuel oil; oil price; exchange rate; pass-through asymmetry; gasoline; diesel; micro data; Turkey.

***JEL Classification**:* D22; D43; E31.

---

* **AKÇELİK**: Central Bank of the Republic of Turkey (TCMB), Research and Monetary Policy Department, İstiklal Caddesi, No: 10, 06100-Ulus, Ankara, Turkey. E-mail: fatih.akcelik@tcmb.gov.tr

* **ÖZMEN**: Central Bank of the Republic of Turkey (TCMB), Research and Monetary Policy Department, İstiklal Caddesi, No: 10, 06100-Ulus, Ankara, Turkey. E-mail: utku.ozmen@tcmb.gov.tr

1. Introduction

In most of the non-oil producing countries, fuel oil prices fluctuate in response to the changes in international crude oil prices. Moreover, fuel oil products are generally subject to high proportions of consumption tax[1], which makes the nominal prices much higher. Therefore, the share of fuel oil in total expenditures of the households is at non-negligible levels. Not surprisingly, price changes in fuel oil, more specifically the increases, receive a lot of public attention and discomfort at times. Such sort of public reaction is also evident in Turkey, where the price of fuel oil is one of the most expensive in the world.[2] A general view is that decreases in crude oil prices are not reflected on the prices as much as increases. Similar concerns are also raised after the implementation of price ceilings for domestic fuel oil prices by Energy Market Regulatory Authority (EMRA) in 2014. Therefore, the question of whether the response of retail fuel oil prices to changes in crude oil prices is asymmetric or not in Turkey still remains open.

Whether the response of retail fuel oil price to crude oil price increase and decrease is asymmetric has been extensively discussed in the literature. However, there is not a firm consensus as the empirical evidence regarding asymmetry provides mixed results. Amongst the earlier studies, Borenstein et al. (1997) find asymmetric behavior in most downstream prices for US, however Bachmeier and Griffin (2003) present evidence for retail gasoline price responding symmetrically to crude oil price shocks by using daily data. Lewis (2011) develops a consumer search model of asymmetric adjustment and shows that the prediction of the model is consistent with the data. However, Radchenko (2005) finds counter evidence for the asymmetry in gasoline prices being consistent with search theory.

Chen et al. (2005) provide evidence for asymmetric adjustment in U.S. retail gasoline prices by using threshold cointegration methods. Similarly, Dunis et al. (2006) apply the same methodology to NYMEX futures contract daily closing prices and

---

[1] According to Energy Market Regulatory Authority (EMRA) 2013 annual petroleum report, total taxes constitute around 60 percent of gasoline price and around 53 percent of diesel price in 2013.

[2] According to Bloomberg, Turkey has 9th highest gasoline price among 61 countries. Also, Turkey is ranked 7th in terms of portion of a day's wage needed to buy a gallon of gasoline as unaffordability measure.

unleaded gasoline and point to the presence of asymmetric adjustment. Grasso and Manera (2007) apply asymmetric error correction models to European data and find that the response of retail prices is asymmetric for all countries considered, particularly at the distribution stage. Al-Gudhea et al. (2007) also provide evidence of asymmetric transmission between upstream and downstream prices and show that the asymmetry is more pronounced for small shocks with threshold and momentum models of cointegration for US by using daily data.

The controversy over the asymmetric response of retail gasoline price to crude oil prices is evident in the recent studies as well in the literature. For example, Balaguer and Ripolles (2012) find symmetric response of gasoline and diesel prices to international wholesale oil prices by using asymmetric error correction model and daily data for Spain. However, Schalck et al. (2013) show asymmetric response of gasoline and diesel prices by using ARDL method and weekly data for France, another large European market.

Several studies analyze the fuel oil market in Turkey. Alper and Torul (2009) find asymmetric response of retail gasoline price to world crude oil prices by using SVAR method and monthly data from 1991 to 2007. Authors argue that this asymmetric behavior is a result of the frequently changing tax rate. Berument et al. (2013) find asymmetric effects of domestic currency value of oil price and exchange rate to pre-tax retail fuel oil prices with error correction model by using weekly data from January 01, 2005 to December 25, 2011. However, this effect is not the same as what is referred to as asymmetric response of fuel oil prices to crude oil prices in the literature.

One aspect of the lack of consensus in literature may well be related to the use of different methodologies and to the divergence in the frequency of price observations across studies. Focusing on data frequency, first, we see that mostly monthly, weekly and daily data are used. Using monthly data for analyzing the asymmetry of the retail fuel oil price response against an oil price increase and decrease is not sufficient as the fuel prices change very rapidly. Hence, most of the time more than one price change is recorded within a month, which makes the identification of the response difficult if the interim changes in prices are not observed. Similar concerns are also raised for the use of weekly data and superiority of using daily data is shown in several studies, i.e.

Bachmeier and Griffin (2003), Bettendorf et al. (2003) and Balaguer and Ripolles (2012).

Using daily data offers several advantages. It is possible to observe the direct prices of oil and fuel oil rather than prices averaged over a week or month. But more importantly, by using daily data more information is available including the exact duration of each price spell and the exact size of each price change. This information delivers important insights on the pricing behavior of the sector as well. However, commonly used time series techniques in asymmetry analysis are not very tractable even in the presence of daily data, given that the identification is problematic since prices change very often. For instance, if the price of fuel oil increase in day 1 and decrease in day 2, then, it is not easy to track which price change in oil prices passed through to fuel oil prices in each day. More directly, before the pass-through of an oil price shock to fuel oil price is completed, it is most likely that a new shock will occur. Thus, measuring the impact of changes becomes a difficult task.

In this study, acknowledging the short comings of time series methods and considering the high frequency of price changes in fuel oil sector, we propose a micro data approach to better identify the pass-through from oil prices and to study the evidence of asymmetry. Our strategy is based on two assumptions: price setters use all the available information rationally and the price elasticity of demand in this sector is zero in the short run. Given these, we can treat each price spell of fuel oils as separate micro observations and associate these price changes with the cumulative change in the domestic price of crude oil over the same period of time. With this, we are able to exactly match the size of cost changes with the size of retail price changes and to achieve a clean identification. Another contribution of our study is on the grounds of the composition of domestic crude oil prices. Majority of the studies do not take into account this composition.[3] For a small open economy, not only the international crude oil price but also the exchange rate changes frequently. Therefore, distinguishing the sources of change in domestic crude oil prices may provide important information on the nature of the asymmetry.

[3] Berument et al. (2013) study is an exception, but the authors look at asymmetric effects of domestic currency value of oil price instead of international crude oil price and exchange rate.

Micro data based identification approach enables us to investigate the asymmetry and differences in pricing behavior in more depth in fact. The asymmetric response to cost shocks need not only be in terms of the sign of shock. In addition, there might be asymmetry regarding the source and the size of the cost change as well as the firm-specific differences in response to shocks. Therefore, in this study we do not restrict our analysis only to sign based asymmetry but we further consider other possible dimensions of response difference to cost shocks in order to capture a more complete view on the pricing dynamics of the fuel oil market. Also, there are several reasons for this market to be a good working environment to study pricing behavior. Few large firms dominate the market where a homogeneous good is sold. This removes any possible quality bias between the goods. Moreover, the major cost items (international oil price and the exchange rate), which are the main determinant of the short term price movements, are publicly known and easily followed. This sector is a very good example of state-dependent pricing where firms adjust their prices in a cost-based manner. Finally, prices in the sector are very flexible compared to other goods and services in the economy. Hence, our approach not only enables us to investigate the sign-based asymmetry, but also to study the pricing behavior in general, considering other aspects of cost pass-through to consumer prices.

Our study contributes to the literature by applying the proposed identification strategy and by distinguishing the sources of the change in domestic crude oil prices. Our results point to the presence of asymmetry on several layers, using daily data for gasoline over the 2006-2014 and diesel prices over the 2008-2014 from different firms in Turkey. First, the pass-through of changes in domestic price of crude oil is asymmetric on diesel but symmetric on gasoline prices. For the tax free price of diesel, the increases in crude oil prices are reflected at a higher proportion than decreases. Second, the pass-through of cost changes is higher if the source of the rise (decline) is the exchange rate (oil price) when domestic price of crude oil increases (decreases). Third, when the size of change in domestic currency value of oil prices is higher, the degree of pass-through is lower in the presence of positive cost shocks. Fourth, the pass-through of changes in domestic price of crude oil to retail tax-free fuel oil price is different across firms.

This study not only presents evidence of asymmetry via a careful identification strategy, but also provides insights for the micro pricing behavior of a market that display almost perfect price flexibility. The rest of the study is organized as follows: Section 2 presents data, methodology, estimation strategy and the results. The discussion of the results is presented in Section 3. Section 4 concludes the study.

2. Empirical Analysis

2.1. Data and Methodology

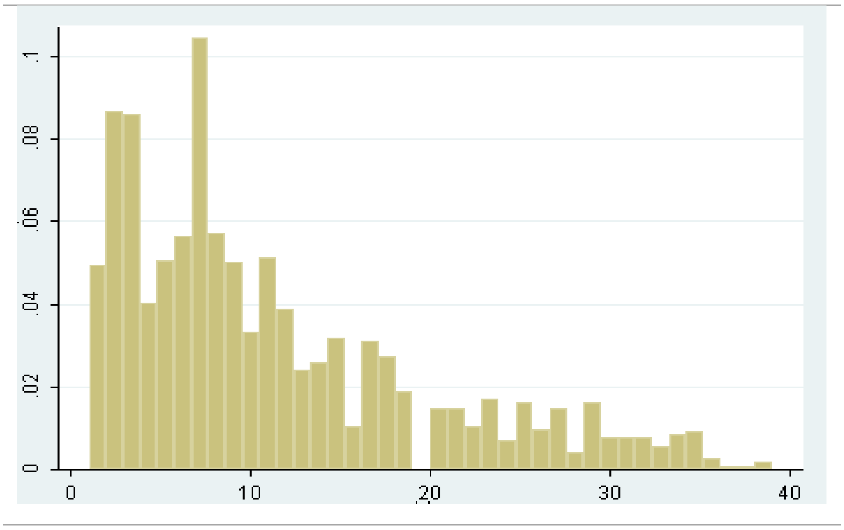
The frequency of data to be used for asymmetry detection analysis is subject to ongoing debate in the literature. Although the earlier studies focused mostly on monthly observations, recent studies increasingly employ more frequent data, where the inclination is towards daily data. Even in view of the widespread use of weekly data, two studies offer interesting evidence for the lack of robustness of derived estimates from such data. On the one hand, Bachmeier and Griffin (2003) use US retail prices of gasoline and crude oil to compare results derived from daily data with those obtained from weekly data. The paper reveals that the use of daily frequencies is sufficient to significantly reduce the evidence of price asymmetry previously obtained by Borenstein et al. (1997). On the other hand, Bettendorf et al. (2003) focus on the Dutch gasoline market and use five weekly datasets each of which is organized with a different starting working day corresponding to daily retail gasoline prices and Rotterdam spot oil prices. Authors show that the results concerning price asymmetry differ across datasets, which suggests that the estimates from weekly frequencies are not robust and highlights the importance of using daily data in empirical work. Balaguer and Ripolles (2012) show that the results critically depend on the choice of working day for Spanish fuel market as well. Therefore, the main problem of using aggregated data is the inevitable selection of a starting point and averaging over a period. However, these concerns are only limited to the use of time series techniques.

Using daily data has several advantages. First of all, with daily data, it is possible to observe the actual prices, rather than prices averaged over a period or prices corresponding to the start and end of an arbitrary period. Second, and more importantly, using daily data enables the detection of each individual price spell. With this, it is possible to determine the micro structure of the prices in the market and to employ a micro econometric perspective by focusing on each price spell separately, rather than relying on time series techniques. Thus, different from the existing literature, in this study we propose a micro data approach to better identify the pass-through from oil prices and to study the evidence of asymmetry in the pursuit of achieving a clear identification and separation of shocks to domestic crude oil prices. Thus, we prefer to use individual price spell durations calculated via daily data.

In the study, we use daily data from January 1, 2006 to February 14, 2014 for tax free retail unleaded 95 octane gasoline and daily data from July 1, 2008 to February 14, 2014 for tax free diesel prices. The data is composed of the prices of four leading companies and is received from the EMRA.[4] Other data used in the study are the daily price of Brent oil in USD, the TL/USD exchange rate and the special consumption tax excised on fuel oils in Turkey.[5] Finally, we calculate the domestic crude oil prices by multiplying the Brent price in USD and the TL/USD exchange rate.

Once the daily dataset is available, we can calculate the duration of each individual fuel oil price spell. The distribution of domestic fuel oil price spells for Turkey is presented in Figure 1.

Figure 1: Distribution of Domestic Fuel Oil Price Durations (in days)



Notes: The horizontal axis shows the number of days a price remains unchanged. The vertical axis shows the density of each frequency. Only prices remaining less than 40 days are plotted. These observations account for 96 % of the observations.

[4] The daily prices are those effective in the European district of Istanbul, which is the most populated area in Turkey.

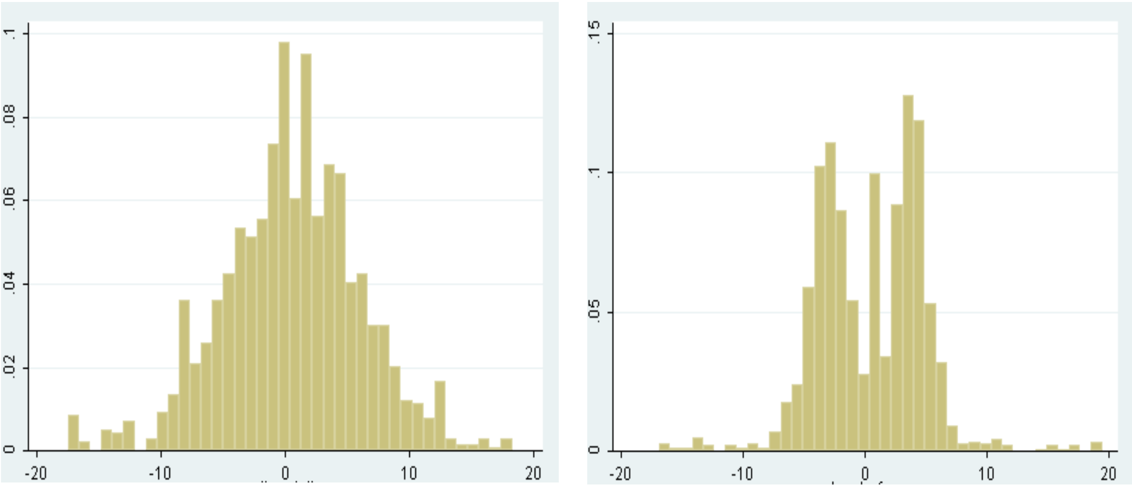
[5] The Brent crude oil price is from Bloomberg; the TL/USD exchange rate is from the Central Bank of Turkey; and the special consumption tax data is from the Ministry of Finance.

The distribution of price spells presents an interesting picture. The first point to note is that the duration of domestic gasoline and diesel prices is very low. Median duration of a price is 9 days and mode of the distribution duration is only 7 days. Second, almost one fourth of domestic fuel oil prices stayed for four days or less. The fuel oil prices therefore differ from other consumer goods and services in terms of flexibility.[6] Such a high frequency of price changes also sheds light on the pricing behavior of the fuel oil market in Turkey. Erdogdu (2014) provides evidence for the inelasticity of motor fuel demand to price changes in Turkey. Given these and the oligopoly nature of the market[7], cost-push factors are dominant when fuel oil prices are determined. Thus, we may focus on domestic oil price (oil prices in domestic currency) changes as main determinant of domestic fuel oil price changes. Figure 2 presents the histograms of the size of fuel oil price changes and the size of corresponding cost shocks that led the fuel oil prices to change.

Figure 2: Distribution of Cost Shocks and Price Changes (percentage)

a. Distribution of Domestic Oil Price Changes

b. Distribution of Fuel Oil Price Changes



Notes: The horizontal axis shows percent change of oil price in domestic currency over the period between two consecutive prices of fuel oil. The vertical axis shows the density of each frequency. Only changes over the range of 20% are plotted.

Notes: The horizontal axis shows percent change of fuel oil prices. The vertical axis shows the density of each frequency. Only changes over the range of 20% are plotted.

[6] Özmen and Sevinç (2011) show that the average duration of consumer prices is about two months in Turkey. Considering that, we can say that the fuel oil prices change much more frequently than overall basket of goods and services.

[7] According to Energy Market Regulatory Authority (EMRA) 2013 annual petroleum report, four leading distributor companies have 78.4 percent market share of gasoline and 66.5 percent market share of diesel in Turkey. The market share of each of four companies is above 10 percent for gasoline. And, these four companies have more than two third of whole fuel oil market sales.

As can be seen in Figure 2, cost shocks, in terms of the changes in oil price in domestic currency, occur in both directions and the distribution of the shocks are almost symmetric. Meanwhile the distribution of domestic fuel oil price changes is more condensed than that of the changes in domestic currency value of oil prices. Comparing two panels in Figure 2, it is easily observed that there is no one-to-one pass-through from oil prices in local currency to domestic fuel oil prices. Also, extreme price changes in domestic fuel oils are less frequent when compared to domestic currency value of Brent oil price. From another perspective, even though a large number of cost shocks in the vicinity of zero percent are observed, the corresponding domestic fuel oil price changes are rarely near zero. Looking only at the right panel of Figure 2 may lead one to consider the presence of menu costs. However, reconciling both figures suggest that firms indeed respond to small-sized shocks as well, even at larger magnitudes.

Finally, the descriptive statistics are shown in Table 1. We see that, for instance for the case of gasoline, there are more upward (510) price changes than downward (411) changes. Also, the median absolute size of increases is higher than that of price decreases. The results also point to different behavior of firms. For instance, the number of increases in the price of gasoline is higher for Firm 2, whereas, Firm 3 registered more price increases compared to others in case of diesel. The mean and median price durations also differ across firms.

Table 1: Descriptive Statistics of Domestic Fuel Oil Prices

		Duration (in days)			Domestic Fuel Oil Price Changes			
					Median (percentage)		# of observation	
	Firm	Mean	Median	# of obs.	Increase	Decrease	Increase	Decrease
Gasoline	Total	12.84	9	921	3.69	-3.04	510	411
	#1	14.01	9	210	3.88	-3.30	116	94
	#2	11.80	8	251	3.50	-3.07	141	110
	#3	13.47	9	220	3.65	-3.00	123	97
	#4	12.31	9	240	3.82	-3.00	130	110
Diesel	Total	12.96	9	633	3.31	-3.13	335	298
	#1	13.47	9	152	3.35	-3.18	77	75
	#2	13.50	9	152	3.40	-3.21	79	73
	#3	12.07	8	170	3.10	-3.11	95	75
	#4	12.91	9	159	3.29	-3.11	84	75

Before going into the estimation methodology, a final remark needs to be made regarding the tax policy on fuel oils. There are two types of tax on domestic fuel oil prices in Turkey: special consumption tax and value added tax. Special consumption tax changes from time to time, but the value added tax rate is constant at 18 percent in the sample period. In order to calculate the tax free fuel oil price from final sales price, we first divide final sales price by 1.18 in order to eliminate the value added tax, later, we subtract the special consumption tax. Taxes play an important role in the final sales price. Therefore, even though we consider the tax free prices, the ongoing special consumption tax rate may also influence tax free prices.[8]

Empirical methodology builds on the discussion about the nature of the data. Focusing on the high frequency of price changes we employ a strategy that treats each fuel oil price spell individually. We take each episode of change in the tax free price of unleaded 95 octane gasoline and diesel as separate micro observations and associate these changes with the cumulative percent change in the domestic currency price of crude oil, Brent oil prices in USD, TL/USD exchange rate and special consumption tax over the same period of time. Specifically, for instance, if the price of gasoline which is set on March 10 is changed on March 15, then this would be reflected to our data as 5-day-cumulative change in gasoline price matched with the corresponding 5-day-cumulative change in mentioned factors. In order to detect the possible asymmetric response of fuel oil prices to domestic currency oil price changes, we first consider the following specification:

$$\Delta gas_i = \alpha \Delta brent\_tl_i + \beta \Delta brent\_tl_i D_{1i} + \gamma \Delta sct_i + \varepsilon_i \qquad (1)$$

where, Δgas is tax free fuel oil price change; $\Delta brent\_tl$ is cumulative change in the domestic value of Brent oil price; D_1 is dummy variable taking the value of 1 if $\Delta brent\_tl$>0 and 0 otherwise; α is the pass-through parameter for the case where the domestic value of Brent oil price decreases, which is the base category in this specification; Δsct is cumulative change in special consumption taxes on gasoline or diesel price; ε_i is the error term; and i refers to the individual price spell. The β represents the degree of asymmetry in the response of domestic fuel oil prices to positive domestic currency oil price shocks in comparison to negative cost shocks.

As discussed previously, an important point to consider for oil importing small open economies is that the domestic currency price of oil is composed of two main components. Hence, the response of domestic fuel oil prices to cost shocks may differ

[8] According to Energy Market Regulatory Authority (EMRA) annual petroleum report, special consumption tax (SCT) constitutes 45.60 percent of gasoline price and 37.51 percent of diesel price in 2013.

according to the source of the shock, coming from international oil price or coming from the exchange rate. Thus, we consider an extended specification for domestic currency oil price increases ($\Delta brent\_tl_i$>0) in order to identify whether separate effects of Brent price and exchange rate are asymmetric or not:

$$\Delta gas_i = \alpha_1 \Delta brent\_tl_i + \beta_1 \Delta brent\_tl_i D_{2i} + \beta_2 \Delta brent\_tl_i D_{3i} + \gamma \Delta sct_i + \varepsilon_i \quad (2)$$

where, D_2 is a dummy variable taking the value of 1 if $\Delta brent\_usd_i$>0 and Δusd_i<0, and 0 otherwise; D_3 is a dummy variable taking the value of 1 if $\Delta brent\_usd_i$<0 and Δusd_i>0, 0 otherwise; where $\Delta brent\_usd$ is the cumulative percent change in Brent oil price in USD; Δusd is the cumulative percentage changes in TL/USD exchange rate. Thus, with this specification we decompose the episodes of positive cost shocks (increase in domestic currency oil price) into three categories. Here, α_1 is the pass-through parameter for the case where both the oil price and the exchange rate increase, which is the base category in this specification. Meanwhile β_1 and β_2 capture the additional asymmetry effect in the case of increasing oil price and declining exchange rate, or vice versa.

Similarly, we consider a third specification to identify whether separate effects of Brent oil price and exchange rate are asymmetric or not when domestic value of oil price decreases ($\Delta brent\_tl_i$<0).

$$\Delta gas_i = \alpha_2 \Delta brent\_tl_i + \beta_3 \Delta brent\_tl_i D_{4i} + \beta_4 \Delta brent\_tl_i D_{5i} + \gamma \Delta sct_i + \varepsilon_i \quad (3)$$

Here, D_4 is a dummy variable taking the value of 1 if $\Delta brent\_usd_i$<0 and Δusd_i>0, 0 otherwise; D_5 is dummy a variable taking the value of 1 if $\Delta brent\_usd_i$>0 and Δusd_i<0, 0 otherwise. Similarly, here, α_2 is the pass-through parameter for the case where both the oil price and the exchange rate decrease, which is the base category in this specification.[9]

The pass-through from domestic value of oil price may be in nonlinear form. We consider a fourth specification to identify whether the response of domestic fuel oil prices to Brent oil price in TL differentiate with the magnitude of cost change when domestic value of oil price increases.

$$\Delta gas_i = \alpha \Delta brent\_tl_i + \beta(\Delta brent\_tl_i\char`^2) + \gamma \Delta sct_i + \varepsilon_i \quad (4)$$

[9] The descriptive statistics regarding the categorization are reported in Appendix Table A1.

where, $(\Delta brent\_tl_i$^2) is the square of cumulative change in domestic value of Brent oil price. When α is significantly positive and β is significantly negative, it can be interpreted that as magnitude of cost shock increases, the level of pass-through decreases. This indicates that there is pass-through asymmetry depending on the size of cost shock.

2.2. Estimation Results

We first consider Specification 1 in order to detect the pass-through asymmetry between increase and decrease in domestic Brent oil prices. Results are reported in Table 2. According to the estimation results, a statistically significant asymmetry is detected for the fuel oil prices in Turkey over the sample period. While 42% (α) of the negative cost shocks are passed-through the domestic fuel oil prices, 49% ($\alpha + \beta$) of the positive cost shocks are passed-through. This pass-through asymmetry is more strongly evident for diesel. The size of the asymmetry is almost 10 percentage points. Meanwhile, although positive, the asymmetry coefficient is not statistically significant for the case of gasoline.

Table 2: Pass-through Asymmetry of Cost Shocks to Domestic Fuel Oil Prices by Type of Fuel Oil (Specification 1)

Coefficients	Fuel Oil (Total)	Gasoline	Diesel
β	0.0714**	0.0569	0.0926**
	(0.0350)	(0.0495)	(0.0426)
α	0.422***	0.449***	0.383***
	(0.0247)	(0.0355)	(0.0248)
γ	-0.608***	-0.787***	-0.485***
	(0.0582)	(0.0995)	(0.0536)
Observations	1554	921	633
R-squared	0.391	0.408	0.375

Notes: The cost shock is defined as the percent change in the value of oil price in domestic currency. β is the degree of asymmetry in the response of domestic fuel oil prices to positive domestic currency oil price shocks in comparison to negative cost shocks. α is the pass-through parameter for the case where the domestic value of Brent oil price decreases. γ is the coefficient of special consumption tax. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

As a novelty of our estimation strategy, we are able to separate the sources of the shock, i.e. from the international oil price or from the exchange rate. Thus, in the following, we estimate Specification 2 and 3 for fuel oil in order to test whether the source of cost shock introduces a pass-through asymmetry. Estimation results of Specification 2 and 3 are in Table 3 and 4, respectively. Accordingly, when positive cost shocks are considered (when domestic value of Brent oil price increases), exchange rate is the source of asymmetry. As seen in Table 3, in the case of both oil price and exchange rate increasing, 46% (α) of the shock is transmitted into fuel oil prices. Meanwhile, in the case of international oil price declining but exchange rate increasing, then 66% ($\alpha + \beta_2$) of the positive cost shock is transmitted.

Table 3: Pass-through Asymmetry by the Source of Shock (in case of $\Delta brent_{tl} > 0$) (Specification 2)

Coefficients	Fuel Oil
β_1	0.0568
	(0.0579)
β_2	0.201***
	(0.0597)
α_1	0.456***
	(0.0275)
γ	-0.272***
	(0.0972)
Observations	843
R-squared	0.350

Notes: α_1 is the pass-through parameter for the case where both oil price and exchange rate increase
β_1 is the asymmetry effect in the case of increasing oil price and declining exchange rate
β_2 is the asymmetry effect in the case of increasing exchange rate and decreasing oil price
γ is the coefficient of special consumption tax
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

For the case of negative cost shocks (when domestic value of Brent oil price decreases.), instead, the results in Table 4 show that Brent oil is the source of asymmetry. Here, when both international oil price and exchange rate falls, 36% of the cost reduction is reflected onto fuel oil prices. Whereas, when the oil price is decreasing, despite a rise in exchange rate, a much higher proportion of the cost reduction is reflected onto fuel oil prices.

Table 4: Pass-through Asymmetry by the Source of Shock (in case of $\Delta brent_{tl} < 0$) (Specification 3)

Coefficients	Fuel Oil
β_3	0.182***
	(0.0411)
β_4	0.135
	(0.108)
α_2	0.357***
	(0.0222)
γ	-0.745***
	(0.0592)
Observations	711
R-squared	0.480

Notes: α_2 is the pass-through parameter for the case where both oil price and exchange rate decline
β_3 is the asymmetry effect in the case of declining oil price and increasing exchange rate
β_4 is the asymmetry effect in the case of decreasing exchange rate and increasing oil price
γ is the coefficient of special consumption tax
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Next, we consider the relationship between the size of the shock and the level of the pass-through. One may assume that firms may not be able to reflect the cost shock to fuel oil prices with the same mark-up independent of the size of the shock. In order to detect evidence of nonlinear pass-through asymmetry depending on the size of cost shock, we estimate Specification 4 for the case of cost pushes, i.e. a rise in domestic currency value of oil price. The results are reported in Table 5. We see that as the magnitude of the cost shock increases, the degree of pass-through to domestic fuel oil price decreases (since α is significantly positive and β is significantly negative). According to the coefficients in Table 5, for instance, when domestic value of oil rises by 1%, 5% and 10%, corresponding fuel oil price pass-through are 69%, 60% and 49% on average, respectively.

Table 5: Nonlinear Pass-Through by the Size of Cost Shock (Specification 4)

Dependent variable: Δgas	**Fuel Oil**
β	-0.0230***
	(0.00724)
α	0.716***
	(0.0662)
γ	-0.301***
	(0.0940)
Observations	843
R-squared	0.364

Notes: β is the coefficient of the square of cumulative change in domestic value of Brent oil price
α is the coefficient of cumulative change in domestic value of Brent oil price
γ is the coefficient of special consumption tax
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Another type of asymmetry in terms of the reflection of the cost shocks onto consumer prices may stem from the behavior of the firms. Thus, we estimate Specification 1 for each firm separately. Results of these estimations are reported in Table 6. First thing to note is that no statistically significant pass-through asymmetry is detected when individual firms are considered.[10] Nonetheless, the coefficient estimates may indicate to pass-through asymmetry differences amongst four leading firms. The highest asymmetry parameter for gasoline is 8.1 percent (Firm 4) while the lowest one is 4.3 percent (Firm 1). For diesel, the highest asymmetry parameter is 12.1 percent (Firm 2) but the lowest one is 5.6 percent (Firm 3). Furthermore, the results also point to marked differences in the behavior of firms. For instance, for the case of gasoline, while

[10] The significance results reported here are believed to be influenced by the lower number of observations.

Firm 4 passes-through 41% of the negative cost shocks, Firm 1 passes-through 50% of such shocks to consumer prices. For the case of diesel, Firms 1, 2 and 4 are more inclined to reflect a higher proportion of the positive cost shock compared to Firm 3.

Table 6: Pass-through Asymmetry of Cost Shocks to Domestic Fuel Oil Prices (Specification 1, by Firm)

Coefficients	Gasoline				Diesel			
	Firm 1	**Firm 2**	**Firm 3**	**Firm 4**	**Firm 1**	**Firm 2**	**Firm 3**	**Firm 4**
β	0.0429 (0.0922)	0.0581 (0.0697)	0.0500 (0.126)	0.0805 (0.0649)	0.101 (0.0853)	0.121 (0.0882)	0.0559 (0.0845)	0.0915 (0.0841)
α	0.505*** (0.0690)	0.423*** (0.0486)	0.448*** (0.0855)	0.410*** (0.0444)	0.367*** (0.0431)	0.396*** (0.0518)	0.387*** (0.0563)	0.382*** (0.0479)
γ	-0.801*** (0.207)	-0.744*** (0.183)	-0.853*** (0.219)	-0.750*** (0.182)	-0.484*** (0.109)	-0.485*** (0.105)	-0.487*** (0.109)	-0.483*** (0.109)
Observations	210	251	220	240	152	152	170	159
R-squared	0.484	0.402	0.355	0.408	0.426	0.454	0.261	0.422

Notes: β is the degree of asymmetry in the response of domestic fuel oil prices to positive domestic currency oil price shocks in comparison to negative cost shocks
α is the pass-through parameter for the case where the domestic value of Brent oil price decreases
γ is the coefficient of special consumption tax
Distributor firms are ordered according to their market shares (Firm 1 > Firm 2 > Firm 3 > Firm 4).
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

3. Discussion

In this section, we shed more light on the empirical findings of the previous section and discuss the possible reasons behind and the implications of the findings. With our flexible and novel estimation strategy we are able to detect asymmetry in the reflection of cost shocks onto consumer fuel oil prices in several layers. Thus, our findings on asymmetry can be summarized under respective categories: generic asymmetry (in terms of the sign of the cost shock), source asymmetry (differing pass-through rates depending on the origin of the cost shock), size asymmetry (smaller the size of the shock higher the pass-through) and firm-related asymmetry (different response of firms to common cost shocks).

Main finding of the study points to asymmetry in the pass-through of cost shocks in terms of the sign. Over the sample period in consideration, the increases in the domestic currency oil price are reflected on fuel oil prices with a higher proportion than the decreases in the domestic currency oil price in Turkey. In the literature, the most common theoretical explanations for asymmetry in fuel oil market are the collusion of firms (i.e. Borenstein et al. (1997)) and the consumer search behavior (Lewis (2011), Yang and Ye (2008), and Cabral and Fishman (2012)). Among the studies in empirical literature, Lewis (2011) finds evidence for search-based explanation of asymmetry. On the contrary, other studies provide evidence for the relevance of market power being effective in response asymmetry, i.e. Verlinda (2008) and Deltas (2008). In a recent study, Brewer et al. (2014) also find that the retailers in fuel oil market only make reasonable positive profits in months of cost reduction, providing additional evidence for market power. In the context of our study we think that the market power argument is also valid for Turkey. In items basis, our results suggest that there is no pass-through asymmetry in gasoline, but pass-through asymmetry exists in diesel in Turkey. The reason behind this difference may be attributed to the structural change of fuel oil demand in the Turkish market. With this structural change, a rapid transition of consumers from cars operating with gasoline to cars operating with diesel and LPG has been taking place. According to TurkStat, the market share of automobiles operating with diesel, which was 9.5% in 2006, increased to 27.9% in 2014. [11] Meanwhile, in this period, the market share of automobiles operating with gasoline decreased from 62.5% to 30.2%. [12] Thus, even though the firms respond asymmetrically in the overall fuel oil market, it seems that they are able to act so only in the sector where they face ever-increasing demand (diesel). Hence, considering the oligopolistic nature of the market in Turkey (a few large firms, in fact, four firms in the study compile almost 67.1% of the retail fuel oil market according to EMRA Annual Petroleum Sector Report in 2013) and the difference in terms of response asymmetry between gasoline and diesel sectors, we may conclude that the evidence from Turkey also supports the market power argument being relevant for explaining asymmetric pass-through of positive and negative cost changes.

The second finding emerging from our analysis is that the pass-through of cost shocks also differs with the source of the change, which may be referred as source of asymmetry. That is, on the domain of upward cost changes (when domestic currency value of oil price increases), the pass-through is higher in cases where only exchange rate increases (depreciation) in comparison to other cases. On the contrary, on the domain of downward cost changes (when domestic currency value of oil price decreases), the pass-through is higher in cases where only the oil price (Brent oil price

[11]Value for 2014 refers to May 2014 data.
[12] Also, the market share of automobile with LPG increases from 24.8 percent in 2006 to 41.4 percent in 2014.

in USD) decreases, in comparison to other cases. Consequently, we may conclude that the pass-through asymmetry is exacerbated if the source of the change is the exchange rate for upward cost shocks and it is the international oil prices for downward cost shocks. This finding may be linked to two explanations. First, economy wide cost shocks may be reflected more onto consumer prices than sector specific cost shocks. Beck et al. (2011) suggest that region or country level shocks explain a higher portion of the variation in prices than sector level shocks. Also, Ashenfelter et al. (1998) and Gron and Swenson (2000) show that the pass-through of industry wide shocks are considerably higher than firm specific shocks. It would not be misleading if we form an analogy between sector/firm specific and economy/sector specific. In our case, a change in the exchange rate is an economy wide phenomenon, meanwhile, the change in international oil prices is only a fuel oil sector specific phenomenon, at least in the short run. Hence, the pass-through of economy wide shock being higher is intuitive in this sense. Second, consumer behavior is thought to play an important role in such a response asymmetry. On the theoretical grounds, consumer anger at price increases (Rotemberg, 2005) and consumers' beliefs about the fairness of the price (Rotemberg, 2011) affect decisions of the firms. From this perspective, we argue that when the cost increase stems from the exchange rate then firms in fuel oil market are able to pass-through a higher proportion of the cost shock. On the contrary, when the cost increase is due to a rise in international oil prices, which is a sector specific shock, firms cannot pass-through the shock as much as the previous case. The idea behind is that when exchange rate increases, many prices in the economy are adjusted and the fuel oil sector does not receive a special public attention. However, when only oil price increases, the sector is subject to public attention as prices are adjusted. Economy wide shock may be considered as fair, yet a sector specific one may not be considered as fair by consumers.

Third finding relates to the shock size asymmetry. As the size of cost shock increases in case of positive cost shock, the degree of pass-through is decreasing. In other words, there is nonlinear pass-through asymmetry by the magnitude of cost shock. In the Appendix Table A2, we provide further evidence for the asymmetric pass-through of different sized cost shocks. For instance, for the positive cost shocks which are of the magnitude of 2% or less, the pass-through coefficient is 1.08. Meanwhile, the coefficient comes down as the size of shock increases (drops to 0.38 for shocks greater than 10%). However, such a marked difference is not evident for cost decreases. Combining those results and the evidence in Figure 2 and 3, we see that for smaller cost shocks, there is perfectly complete pass-through. However, for large cost increases and for any cost decreases, the pass-through is incomplete. An evaluation of the above discussion suggests that even if the market power of the firms in the fuel oil retail sector enables them to asymmetrically pass-through cost increases and decreases, there are also factors restraining their market power depending on the source and the size of the cost shock. The fair price perception and anger of consumers along with focused public attention may be considered as major factors against the full use of market power, given the evidence that firms can pass-through less of the cost increases if the rise is fueled by oil prices or if the size of the cost increase is large.

Fourth, although statistically not significant, our findings provide insights for possible firm level heterogeneity in terms of the pass-through of cost shocks. We see that there are differences across firms in the perspective of pass-through degree, asymmetry and price change frequency. This difference may be attributed to structure of the fuel oil market in Turkey. For instance, Firm 1 is making less frequent price changes over same period for gasoline and diesel when compared to other three firms. This may suggest that there is one-leader and three-follower type of oligopolistic market structure in Turkey. Also, it should be noted that with a larger number of observations, robust findings regarding firm differentials will be more pronounced.

Fifth, our findings reveal that the level of pass-through asymmetry may also differ with the status of the general economic activity. Our sample period includes the effects of economic slowdown over 2008. When we consider the observations belonging to periods before and after the crisis, the evidence of asymmetry is more pronounced as shown in Appendix Table A3. However, during the crisis period (2008Q2-2009Q1), the asymmetry is reversed: cost decreases are reflected more than the cost increases to final consumer prices. This suggests that the status of economic activity may well be another factor limiting the market power of the firms in the fuel oil market.

Finally, our results point to incomplete pass-through of tax changes onto consumer prices. Even though tax-free fuel oil price is analyzed, when the tax changes are controlled for, the coefficient of special consumption tax is significantly negative in all specifications. This result can be interpreted as firms not fully reflecting the tax changes immediately to domestic fuel oil prices, a sign of reduced market power of the firms.

4. Conclusion

In this paper, we investigate the oil price and exchange rate pass-through asymmetry in retail fuel oil market in Turkey. Different from previous studies, we propose a new approach based on micro price observations and corresponding cost factors. Our results show that oil price increases pass-through more than decreases to fuel oil prices. However, the pass-through asymmetry is evident only for diesel, but not for gasoline. Our approach enables us to analyze different aspects of pricing asymmetry. In terms of the source of shock, we show that asymmetry strengthens if the source is the exchange rate (oil price) in the presence of positive (negative) cost shock. Also, as the size of shock increases, the pass-through from oil prices decreases when domestic oil price increases. In terms of firm heterogeneity, empirical analysis indicates that the degree of pass-through from oil price varies across firms in gasoline and diesel prices. Overall, the asymmetry finding suggests that the oligopolistic nature of the fuel oil market in Turkey enables firm to exercise a certain level of market power. However, other findings regarding source and size of shocks and firm heterogeneity suggest that there are limitations to use of market power in price setting.

References

Al-Gudhea, S., Dibooglu, S., Kenc, T. (2007), "Do retail gasoline prices rise more readily than they fall? A threshold cointegration approach", Journal of Economics and Business, 59, 560–574.

Alper, C.E., Torul, O. (2009), "Asymmetric adjustment of retail gasoline prices in Turkey to world crude oil price changes: The role of taxes" Economics Bulletin, 29, 775-787.

Ashenfelter, O., D. Ashmore, J. Baker, and S-M. McKernan (1998). “Identifying the Firm-Specific Cost Pass-Through Rate”, Federal Trade Commission Working Paper No. 217.

Bachmeier and Griffin (2003). “New Evidence on Asymmetric Gasoline Price Responses”, The Review of Economics and Statistics, Vol. 85, No. 3, 772-776.

Balaguer, J., Ripollés, J. (2012). “Testing for price response asymmetries in the Spanish fuel market. New evidence from daily data”, Energy Economics, 34, 2066–2071.

Beck, G., Hubrich, K., & Marcellino, M. (2011). “On the importance of sectoral and regional shocks for price-setting”. CEPR DP8357.

Berument, H., Sahin, A. and Sahin, S. (2013). “Crude Oil Price and Exchange Rate Effects of Asymmetry on Petroleum Product Prices: Evidence from a Set of Northern Mediterranean Countries”, Available at SSRN, http://ssrn.com/abstract=2215722.

Bettendorf, L., S.A. van der Geest, and Varkevisser, M. (2003). “Price asymmetry in the Dutch retail gasoline market”, Energy Economics, 26(6), 669–689.

Borenstein, S., Cameron, A.C. and Gilbert, R. (1997). “Do gasoline prices respond asymmetrically to crude oil price changes?”, Quarterly Journal of Economics, 112, 305–339.

Brewer, J., Nelson, D. M., and Overstreet, G. (2014). “The economic significance of gasoline wholesale price volatility to retailers.” Energy Economics, 43, 274-283.

Cabral, L., & Fishman, A. (2012). “Business as usual: A consumer search theory of sticky prices and asymmetric price adjustment”, International Journal of Industrial Organization, 30(4), 371-376.

Chen, L. H. C., Finney, M., & Lai, K. S. (2005). “A threshold cointegration analysis of asymmetric price transmission from crude oil to gasoline prices”, Economics Letters, 89(2), 233–239.

Deltas, G. (2008). “Retail gasoline price dynamics and local market power”, Journal of Industrial Economics, 56, 613–629.

Dunis, C. L., Laws, J. & Evans, N. (2006). “Modelling and Trading the Gasoline Crack Spread: A Non-Linear Story", Derivatives Use, Trading & Regulation, 12, 126-145.

Energy Market Regulatory Authority (EMRA). “(2013) Annual Petroleum Market Sector Report”.

Erdogdu, E. (2014). “Motor fuel prices in Turkey”, Energy Policy, 69, 143–153.

Grasso, M., & Manera, M. (2007). “Asymmetric error correction models for the oil-gasoline price relationship”, Energy Policy, 35(1), 156–177.

Gron, A., and D. Swenson (2000). “Cost pass-through in the U.S automobile market”, Review of Economics and Statistics, 82(2), 316-324.

Lewis, M. S. (2011). “Asymmetric price adjustment and consumer search: An examination of the retail gasoline market”, Journal of Economics & Management Strategy, 20(2), 409-449.

Özmen, M.U. and Sevinç, O. (2011). "Price Rigidity In Turkey : Evidence From Micro Data", Working Papers 1125, Research and Monetary Policy Department, Central Bank of the Republic of Turkey.

Radchenko, S. (2005). "Oil price volatility and the asymmetric response of gasoline prices to oil price increases and decreases", Energy Economics, 27(5), 708-730.

Rotemberg, J. J. (2005). “Customer anger at price increases, changes in the frequency of price adjustment and monetary policy”, Journal of Monetary Economics, 52(4), 829-852.

Rotemberg, J. J. (2011). “Fair pricing”, Journal of the European Economic Association, 9(5), 952-981.

Schalck, C., Lamotte, O., Porcher, T. & Silvestre, S. (2013), “Asymmetric gasoline price responses in France”, Applied Economics Letters, 20(5), 457-461.

Verlinda, J.A. (2008). “Do rockets rise faster and feathers fall slower in an atmosphere of local market power? Evidence from the retail gasoline market”, Journal of Industrial Economics, 56, 581–612.

Yang, H. and Ye, L. (2008). “Search with learning: understanding asymmetric price adjustments”, RAND Journal of Economics, 39, 547–564.

Appendix

Table A1: Descriptive Statistics of Domestic Value of Brent Oil Price Changes (percentage)

	Cases	Mean	Standard Deviation	# of obs.
Increase in domestic Brent oil price	Oil Price↑,USD/TL↑	5.52	3.49	384
	Oil Price↑,USD/TL↓	4.23	3.66	357
	Oil Price↓,USD/TL↑	2.57	2.91	97
Decrease in domestic Brent oil price	Oil Price↓,USD/TL↓	-5.30	4.04	360
	Oil Price↓,USD/TL↑	-3.74	3.98	276
	Oil Price↑,USD/TL↓	-1.36	1.51	72
	Total	0.53	5.85	1554

Table A2: Pass-Through by the Size of Cost Shock

	Size of Cost Shock (Percent, Interval)	α
Positive Cost Shocks	(0,2]	1.08
	(2,5]	0.69
	(5,10]	0.51
	>10	0.38
Negative Cost Shocks	[-2,0)	0.39
	[-5,-2)	0.60
	[-10,-5)	0.45
	<-10	0.35

Notes: The cost shock is defined as the percent change in the value of oil price in domestic currency. Our specification is $\Delta gas_i = \alpha \Delta brent\_tl_i + \gamma \Delta sct_i + \varepsilon_i$ where, α is the pass-through parameter for corresponding cost shock interval. All coefficients are statistically significant at 1 percent.

Table A3: Pass-through Asymmetry of Cost Shocks to Domestic Fuel Oil Prices (Specification 1)

Coefficients	**Before Crisis**	**During Crisis**	**After Crisis**
β	0.149**	-0.144*	0.0991**
	(0.0749)	(0.0742)	(0.0388)
α	0.374***	0.398***	0.478***
	(0.0524)	(0.0434))	(0.0295)
γ	-1.021***	-0.940***	-0.593***
	(0.0175)	(0.00284)	(0.0579)
Observations	257	266	1031
R-squared	0.429	0.385	0.408

Notes: The cost shock is defined as the percent change in the value of oil price in domestic currency. β is the degree of asymmetry in the response of domestic fuel oil prices to positive domestic currency oil price shocks in comparison to negative cost shocks. α is the pass-through parameter for the case where the domestic value of Brent oil price decreases. γ is the coefficient of special consumption tax. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Crisis period is defined as from 2008Q2 to 2009Q1.

Central Bank of the Republic of Turkey
Recent Working Papers
The complete list of Working Paper series can be found at Bank's website
(http://www.tcmb.gov.tr).

Turkish Middle Income Trap and Less Skilled Human Capital
(Gökhan Yılmaz Working Paper No. 14/30, September 2014)

The Structure of the Turkish Banking Sector Before and After the Global Crisis
(Aytül Ganioğlu , Vuslat Us Working Paper No. 14/29, August 2014)

Determinants of Bond Flows to Emerging Markets: How Do They Change Over Time?
(Yasemin Erduman, Neslihan Kaya Working Paper No. 14/28, August 2014)

Firm Leverage and the Financial Crisis
(Fatih Altunok, Arif Oduncu Working Paper No. 14/27, August 2014)

Determinants of Capital Structure: Evidence from a Major Developing Economy
(Bülent Köksal , Cüneyt Orman Working Paper No. 14/26, July 2014)

Forward Guidance or Cacophony
(Gamze Demiray, Yasin Kürşat Önder, İbrahim Ünalmış Working Paper No. 14/25, July 2014)

Reserve Requirements, Liquidity Risk and Credit Growth
(Koray Alper, Mahir Binici, Selva Demiralp, Hakan Kara, Pınar Özlü Working Paper No. 14/24, July 2014)

Identification of Monetary Policy Shocks in Turkey: A Structural VAR Approach
(Mustafa Kılınç, Cengiz Tunç Working Paper No. 14/23, July 2014)

Is Gold a Safe Haven Against Equity Market Investment in Emerging and Developing Countries?
(Gözde Gürgün, İbrahim Ünalmış Working Paper No. 14/22, July 2014)

Credit Growth, Current Account and Financial Depth
(M. Fatih Ekinci, F. Pınar Erdem, Zübeyir Kılınç Working Paper No. 14/21, June 2014)

Inflation Dynamics in Turkey: In Pursuit of a Domestic Cost Measure
(Selen Başer Andıç, Hande Küçük, Fethi Öğünç Working Paper No. 14/20, June 2014)

Does Effectiveness of Macroprudential Policies on Banking Crisis Depend on Institutional Structure?
(Aytül Ganioğlu Working Paper No. 14/19, June 2014)

International Evidence on the Interaction between Cross-Border Capital Flows and Domestic Credit Growth
(Yavuz Arslan, Temel Taşkın Working Paper No. 14/18, May 2014)

Cross Sectional Facts on Bank Balance Sheets over the Business Cycle
(Osman Furkan Abbasoğlu, Şerife Genç, Yasin Mimir Working Paper No. 14/17, May 2014)

The Relationship between Inflation Targeting and Exchange Rate Pass-Through in Turkey with a Model Averaging Approach
(Ferhat Arslaner, Doğan Karaman, Nuran Arslaner, Süleyman Hilmi Kal Working Paper No. 14/16, May 2014)