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## Article

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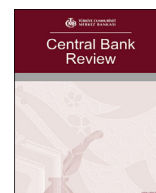
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# Pass-through of crude oil prices at different stages in Turkey<sup>☆,☆☆</sup>



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## ABSTRACT

This paper examines the degree of oil price pass-through to domestic prices at different stages of supply chain in Turkey. Our results, based on vector autoregressive models, point out that the pass-through to domestic motor fuel prices is considerably fast as expected and just one third of a change in crude oil prices is reflected to the motor fuel prices due to the high share of taxes on retail prices. On the other hand, it is shown that impact of oil prices on transport services takes a longer time compared to other domestic prices. Over the 2004–2014 period, estimates suggest that a 10% permanent change in the international crude oil prices is associated with a 0.42 percentage points change in consumer inflation at the end of one year. The final accumulated pass-through to consumer inflation reaches 0.50 percentage points. Moreover, the pass-through to producer prices is nearly twice as much as that to consumer prices. Findings also provide some evidence for a strengthening in oil price pass-through to consumer inflation over time, which might reflect the growing natural gas intensity of the economy.

## 1. Introduction

Oil prices have declined prominently since June 2014 after hovering around \$110 per barrel from early 2011 to first half of 2014 (Fig. 1). Baffes et al. (2015) called this sharp decline as “the great plunge” as oil prices have nearly halved since mid-2014.<sup>1</sup> Given that the past oil price declines are associated with the slowdown in inflation rates, this severe drop in oil prices has once again raised the interest in the impact of oil prices on consumer inflation. Understanding this connection is crucial for the implementation of

monetary policy as the authorities form their policies according to the future course of inflation. For this purpose, this study estimates the pass-through of crude oil prices at different stages of supply chain including import, producer, and consumer prices.

Many studies in the literature point out to a limited or negligible impact of oil prices on inflation. Besides, they document a decline in the pass-through over time, which appears to be a common phenomenon especially for industrialized economies. Hooker (2002) finds that oil price changes have a significant impact on U.S. core inflation before 1981 but little or no pass-through since that time. Blanchard and Gali (2007) document that oil price shocks have smaller effects on prices for six major economies. Possible causes could be a decrease in real wage rigidities, the increased credibility of monetary policy, and simply the reduced oil dependence of production and consumption. Chen (2009) investigates the pass-through for 19 industrialized countries and presents a diminishing effect of oil shocks on inflation over time. Some potential explanations to this weakening in the inflationary effect of oil prices include appreciation of the domestic currency, a more active monetary policy in response to inflation and a higher degree of trade openness. Limited impact of oil prices on inflation is also documented in Alvarez et al. (2011) for Spain and Euro area. De Gregorio et al. (2007) present similar results not only for industrialized but also for emerging market economies though the fall in the average estimated pass-through is to a lesser extent in the latter.

\* The views expressed in this paper belong to the authors only and do not represent those of the Central Bank of the Republic of Turkey or its staff.

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<sup>1</sup> Baffes et al. (2015) presents a comprehensive assessment of this sharp drop in oil prices involving causes and possible consequences. They put forward the following factors for this severe fall: several years of upward surprises in the production of unconventional oil; weakening global demand; a significant shift in OPEC policy; unwinding of some geopolitical risks; and an appreciation of the U.S. dollar. Among these, they express that “OPEC’s renouncement of price support and rapid expansion of oil supply from unconventional sources appear to have played a crucial role since mid-2014”.

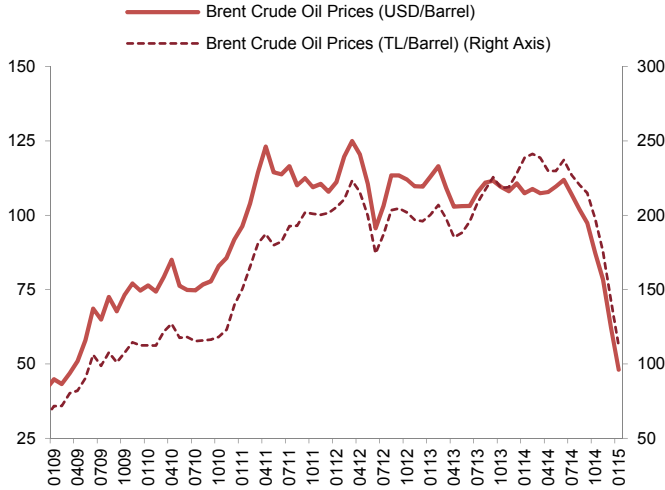


Fig. 1. Oil price developments.

Source: Bloomberg, CBRT.

They assert that the decline in oil pass-through is a generalized fact for a large set of countries.

For Turkey, Kibritçioglu and Kibritçioglu (1999), by utilizing a vector autoregression (VAR) methodology and the data between 1986:01 and 1998:03, obtain a subdued role for oil price pass-through to inflation. Berument and Taşçı (2002), using the 1990 input–output table, state that unless the second round effects appear, oil prices play a limited role on inflation under fixed nominal wages, profits, interest and rent earnings. On the other hand, a recent study by Dedeoğlu and Kaya (2014) claim the opposite and put forward that the oil pass-through to inflation has increased over time in Turkey. They argue that oil might be becoming more binding in the overall cost structure of the firms due to changes in the relative prices.

The aim of our paper is to analyze in detail the pass-through of oil prices to domestic prices at different stages of supply chain in Turkey and thus to present a clear understanding of oil price pass-through dynamics. Literature mostly focuses on the later stages of the distribution chain, namely pass-through to producer and consumer prices, whereas this paper, by examining the link between oil and import prices as well as motor fuel and transport service prices, also pays attention to the intermediate stages. Oil prices affect not only the consumer energy prices like motor fuels, but also other consumer goods and services prices such as transport services indirectly through production costs. Besides, indirect effects can also work through import prices (ECB, 2014). Specifically, to the extent that changes in international oil prices trigger a change in the output price of our trading partners, they also influence our domestic consumer inflation through the import price developments. Given that the import price pass-through is as critical as the exchange rate pass-through in Turkey (Kara and Ögünç, 2012), it is worthwhile to investigate the oil price pass-through to import prices as well.<sup>2</sup>

Turkey imports almost all of its oil supplies owing to limited oil reserves.<sup>3</sup> In 2014, oil imports are \$ 16.1 billion, constituting

approximately 6.6% of total imports. When it comes to total energy imports, these figures are \$ 54.9 billion and 22.7%, respectively. Hence, the exchange rate developments are as important as crude oil prices in assessing the pressures on domestic energy prices. Another key factor effective in the repercussions of crude oil prices to domestic prices in Turkey is the tax burden on motor fuel products. As of November 2014, value added tax (VAT) and special consumption tax (SCT) on motor fuel products in all account for a substantial share (63%) of final consumer prices. This feature introduces a price smoothing mechanism for domestic motor fuel prices and restrains the impact of oil prices on domestic prices.

We use a vector autoregression setup to investigate the impact of changes in oil prices on various prices. We focus on the period after 2003 because of the structural change experienced in the Turkish economy following the 2001 crisis. Our main results can be summarized as follows: (i) VAR evidence suggests that crude oil price pass-through to import prices is around 32%, (ii) one third of the changes in oil prices pass into domestic motor fuel prices and most of the response occurs over the first two months, (iii) the emergence of the impact of oil prices on transport services take a long time compared to other domestic prices, (iv) a 10% increase in the international crude oil prices causes consumer inflation to go up by 0.42 percentage points at the end of one year, (v) the pass-through from oil prices to producer prices is about two times higher than that to consumer prices, (vi) the pass-through from oil prices to consumer inflation seems to have been strengthening over time. We argue that this finding might be mainly owing to the following features: the share of oil in consumer basket has risen over time, and much more importantly, the natural gas intensity of the economy specifically in electricity generation and industry sectors has been increasing.

The remainder of this paper has the following structure. Section 2 discusses the methodology together with data used in the paper. Section 3 presents the pass-through findings concerning the motor fuels, transport services, import, producer, and consumer prices. Final part of this section investigates whether there is any change in oil pass-through over time. Finally, some concluding remarks are put forward in the last section.

## 2. Methodology and the data

### 2.1. Methodology and the baseline Model

In order to investigate the pass-through effect, we use a monthly VAR model based on McCarthy (2006). He examines the impact of exchange rates and import prices on producer and consumer prices for 9 selected industrialized countries by estimating an eight-variable VAR model with the following ordering of the variables: oil price inflation denominated in local currency, output gap, nominal exchange rate, import price inflation, producer price (PPI) inflation, CPI inflation, short-term interest rate and money growth. Here, we use a similar set up to examine the pass-through of oil price fluctuations to domestic prices, which are motor fuel prices, transport services prices, import prices, producer and consumer prices, at different stages of the supply chain both via direct and indirect channels. For the structure of identification to be understood, the baseline model can be written as:

$$\Delta rp_t = E_{t-1}(\Delta rp_t) + \varepsilon_t^{rp} \quad (1)$$

$$\Delta e_t^b = E_{t-1}(\Delta e_t^b) + a_1 \varepsilon_t^{rp} + \varepsilon_t^e \quad (2)$$

<sup>2</sup> Besides, Central Bank of the Republic of Turkey makes assumptions on import prices in its inflation reports. Thus, improving the understanding of oil price pass-through to import prices may also help when building up assumptions or scenarios.

<sup>3</sup> According to TPAC (2014), Turkey's total crude oil production averaged 48,000 barrels per day, whereas crude oil consumption was nearly 500,000 barrels per day in 2013. Therefore, more than 90% of crude oil consumption came from imports. As of 2013, Turkey's estimated proved oil reserves stand at 296 million barrels.

$$\pi_t^{oil} = E_{t-1}(\pi_t^{oil}) + b_1 \varepsilon_t^{rp} + b_2 \varepsilon_t^e + \varepsilon_t^{oil} \quad (3)$$

$$\pi_t^m = E_{t-1}(\pi_t^m) + c_1 \varepsilon_t^{rp} + c_2 \varepsilon_t^e + c_3 \varepsilon_t^{oil} + \varepsilon_t^m \quad (4)$$

$$\tilde{y}_t = E_{t-1}(\tilde{y}_t) + d_1 \varepsilon_t^{rp} + d_2 \varepsilon_t^e + d_3 \varepsilon_t^{oil} + d_4 \varepsilon_t^m + \varepsilon_t^d \quad (5)$$

$$\pi_t^p = E_{t-1}(\pi_t^p) + e_1 \varepsilon_t^{rp} + e_2 \varepsilon_t^e + e_3 \varepsilon_t^{oil} + e_4 \varepsilon_t^m + e_5 \varepsilon_t^d + \varepsilon_t^p \quad (6)$$

$$\pi_t^c = E_{t-1}(\pi_t^c) + f_1 \varepsilon_t^{rp} + f_2 \varepsilon_t^e + f_3 \varepsilon_t^{oil} + f_4 \varepsilon_t^m + f_5 \varepsilon_t^d + f_6 \varepsilon_t^p + \varepsilon_t^c \quad (7)$$

where  $\Delta rp_t$ ,  $\Delta e_t^b$ ,  $\pi_t^{oil}$ ,  $\pi_t^m$ ,  $\tilde{y}_t$ ,  $\pi_t^p$ , and  $\pi_t^c$  are the change in risk premium (EMBI + Turkey), change in exchange rate basket, oil price inflation denominated in \$ terms, import price inflation in dollar terms, output gap, PPI inflation, and core consumer price (CPIX) inflation, respectively.  $\varepsilon_t^{rp}$ ,  $\varepsilon_t^e$ ,  $\varepsilon_t^{oil}$ ,  $\varepsilon_t^m$ ,  $\varepsilon_t^d$ ,  $\varepsilon_t^p$ , and  $\varepsilon_t^c$  are risk premium, exchange rate, oil price, import price, demand, PPI and CPIX shocks respectively;  $E_{t-1}(\cdot)$  is the expectation of a variable based on information set available at the end of period  $t-1$ . We assume that expectations are introduced into the model by linear projections of the lags of the variables in the system. The shocks are assumed to have no serial correlation as well as uncorrelated with each other within the same period.

Following Kilinc and Tunç (2014), the risk premium measured by EMBI+ is included to the model to capture the emerging market dynamics of the Turkish economy.<sup>4</sup> This bond spread represents the financial conditions in general and is appended to the system to identify the effect of related shocks, such as exchange rate, properly. According to the Cholesky ordering of the variables, the model comprises risk premium, exchange rate, crude oil and import prices both denominated in foreign currency, output gap, domestic producer price, and core consumer price index.

According to Muñoz and Dickey (2009), changes in the U.S. dollar affect oil prices as oil prices are quoted in U.S. dollar. Brown et al. (2008) and Lizardo and Mollick (2010) affirm the opposite movement between the US dollar and oil prices, i.e. a weakening of U.S. dollar causes oil prices to rise and an appreciation of the US dollar conversely causes oil prices to fall. To capture this empirical relationship, we allow the exchange rate shocks, which are influenced vastly from the global shock environment, to affect oil prices contemporaneously in our setup.

We assume that risk premium shocks are directly identified from the dynamics of the EMBI + Turkey, which is a relevant risk indicator for Turkey. In our setup, exchange rate responds to risk premium shocks, whereas oil price shocks are identified from dynamics of Brent oil prices after taking into account the contemporaneous effect of risk premium and the exchange rate shocks. Import prices are affected by risk premium, exchange rate, and oil price shocks. Moreover, we assume that demand shocks are identified from the dynamics of the output gap after taking into account previous consecutive shocks. Finally, the producer and consumer price measures include sequential shocks that can be attributed to the various stages of the supply chain. In general, this setup reflects the small-open economy nature of Turkey. The shocks are identified from the VAR residuals by using the Cholesky

decomposition of the variance-covariance matrix of the reduced form residuals.

## 2.2. Data

The main data sources are CBRT Electronic Data Delivery System, Turkish Statistical Institute (TurkStat), Ministry of Finance, and Bloomberg. The models take the output gap in levels, while other variables are in percentage changes. We use monthly data for the period 2004:01 to 2014:09. Structural change experienced in the Turkish economy after the 2001 financial crisis, disinflation process, new methodology with 2003 base year in CPI index and the stationary behavior of consumer inflation are the main reasons behind the selection of this period.

For the risk premium, monthly average of daily EMBI + Turkey index is utilized. Currency basket is the average of US dollar (\$/TL) and euro (€/TL) exchange rates. Kara and Ögünç (2012) argue that there is an apparent opposite movement between US dollar and commodity prices (in particular oil prices) after the global financial crisis, which is caused by a common factor in the US-related global shocks environment. Thus, using US dollar as exchange rate measure in VAR models can result in some identification problem with regard to exchange rate and import price effects. To mitigate this fact, we prefer to utilize the currency basket as the exchange rate measure in our VAR models. The oil price is Brent crude oil price in US dollar per barrel. The import price is seasonally adjusted import unit value index denominated in US dollar terms. The output gap is HP-filtered quarterly GDP series, which is converted to monthly frequency by Fernández (1981) methodology using the seasonally adjusted monthly industrial production data as the reference series.

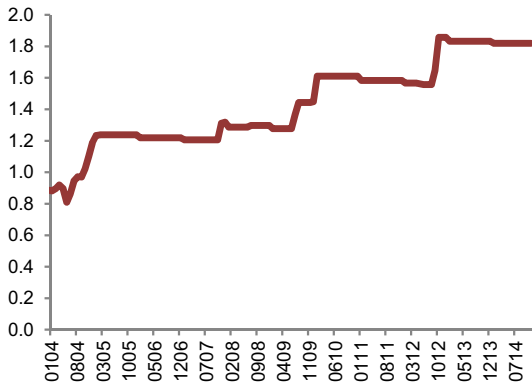
The core consumer price index is the seasonally adjusted CPI excluding unprocessed food, alcoholic beverages, and tobacco products (CPIX). We prefer to use the core inflation measure rather than the headline inflation, since we seek to achieve a more “fundamental” measure of the oil price pass-through. Short-term noisy movements in consumer prices that can arise from purely exogenous affects, such as weather conditions and changes in tax policy, can blur the inflation dynamics. In that respect, unprocessed food and tobacco prices exhibit short-term noisy movements and have the highest unexpected volatility among the CPI sub-components in Turkey. Hence, we prefer to exclude these items from the index and use a more refined measure, which accounts for about 82.3% of the headline CPI on average during the estimation period.

In addition, we have calculated a weighted lump sum special consumption tax on motor fuel products (95 octane unleaded gasoline, liquid petroleum gas (LPG), and diesel) and include this to the VAR models as an exogenous variable. The weights of the products are determined according to their shares in the consumer basket for the relevant year. As shown in Fig. 2, the lump sum SCT on motor fuel products can vary over time (see Fig. 3).

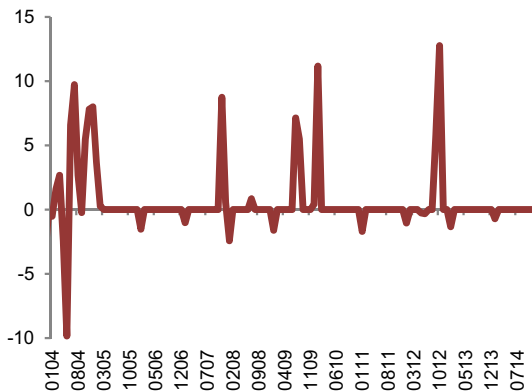
## 3. Empirical findings

Before proceeding with the empirical analysis, we introduce some statistical facts about Turkish energy market, which might help to understand the pass-through of oil prices to several domestic prices and so form a basis for discussions. First, according to TPAC (2014), while natural gas is in the first place with 30.9%, oil ranks second with 25.3% in the Turkey's primary energy supply of 120 million tons of oil equivalent (MTOE). Second, 26.3% of Turkey's primary energy consumption was in housing, 26% was in industry, 25.7% was in conversion sector, and 16.8% of it was used in transportation sector in 2012 (Fig. 4).

<sup>4</sup> Apart from the risk indicator, we have also tried some variables concerning global liquidity or risk appetite such as VIX index, EPFR data of capital flows to Turkey and Credit Suisse risk appetite index. It appears that EMBI + performs better in capturing the empirical dynamics of Turkish economy.



**Fig. 2.** The weighted lump sum SCT amount (TL/liter).  
Source: Ministry of Finance, Authors' own calculations.



**Fig. 3.** The weighted lump sum SCT (percentage change).  
Source: Ministry of Finance, Authors' own calculations.

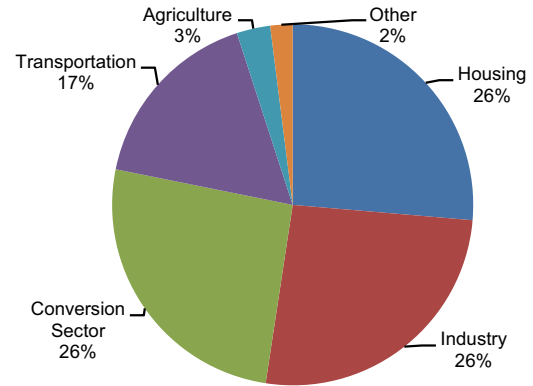
Third, the rate of primary energy demand met by domestic production was 27.5% in 2012. In other words, the level of Turkey's dependence on foreign energy was as high as 72.5%. Domestic crude oil production covered only 9.6% of oil consumption in 2013; the corresponding figure for the domestic natural gas production was even lower with 1.5%.

### 3.1. Pass-through to domestic motor fuel and transport services prices

As depicted in Fig. 5, the immediate effects of changes in international oil prices on consumer inflation are observed through domestic motor fuel and bottled gas prices.<sup>5</sup> In particular, the price of motor fuels is the first item in the consumer basket that should fluctuate in response to changes in crude oil prices. Hence, it might be useful to start the analysis with this early stage. The motor fuel price index of consumer price index consists of gasoline, diesel, and LPG products.

The changes in oil prices do not completely reflect to fuel prices due to shares and taxes on final sale prices. The following formula specifies how the prices of fuel products are set in Turkey (EMRA, 2014):

<sup>5</sup> As of 2014, the share of these two items in consumer basket is 5.08 and 1.17%, respectively.

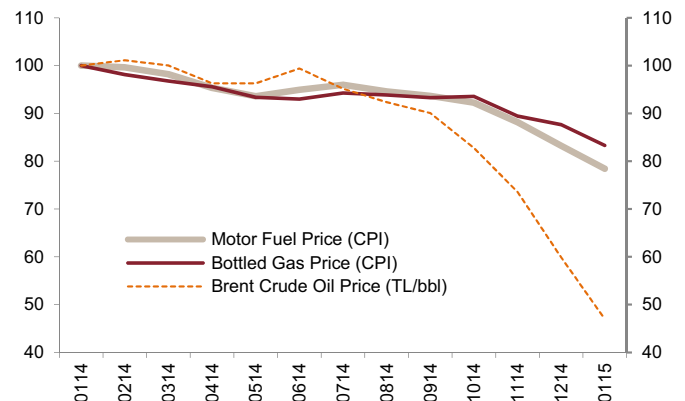


**Fig. 4.** The energy consumption by sectors (% , 2012).  
Source: Ministry of Energy and Natural Resources.

$$\begin{aligned} \text{Final Sales Price of Motor Fuel} = & (\text{Ex-refinery price} \\ & + \text{Wholesaler margin} \\ & + \text{EMRA Revenue Share} \\ & + \text{Distributor and Dealer Margin} \\ & + \text{Lump sum SCT}) * (1 + \text{VAT}) \end{aligned} \quad (8)$$

The 18% VAT on all fuel products is applied to the sum of the ex-refinery price, the revenue share, wholesalers, distributors and dealers margin and the lump sum special consumption tax. The lump sum SCT paid in TL per liter varies by the type of fuel. For example, currently, the lump sum SCT per liter is 2.1765 TL for 95 octane-unleaded gasoline, 1.5945 TL for diesel and 1.5780 TL for LPG (Table 1). The tax burden on fuel products accounting for a substantial share of final consumer prices contains the pass-through of oil prices to domestic fuel prices (the share of excise duties in total pump rates is 54 and 62% for diesel and 95 octane unleaded gasoline, respectively, as of November 2014). Based on the values presented in Table 1 and the above formula, the final sales price of motor fuels falls by 3.2% in response to a 10% decline in the ex-refinery price, ceteris paribus. Therefore, assuming that the decreases in oil prices are fully passed into the ex-refinery price, about 1/3rd of the fall in international oil prices are reflected into the final domestic sales price of motor fuels.

To estimate the degree of pass-through from changes in oil prices to domestic motor fuel prices, we estimate a monthly VAR model using data from 2004:01 to 2014:09. According to Cholesky



**Fig. 5.** Effects of oil prices on domestic energy prices (January 2014 = 100).  
Source: Bloomberg, TurkStat.



**Table 1**  
Price formation of motor fuel products<sup>a</sup>.

	Ex-refinery prices	Wholesaler margin	EMRA revenue share	Distributor and dealer margin	Lump sum SCT (TL/liter) <sup>b</sup>	VAT	Final sales price	Total tax
Unleaded 95 (TL/liter)	1.27	0.08	0.00231	0.42	2.1765	0.71	4.66	2.89
Shares (%)	27.3	1.7	0.0	9.0	46.7	15.3	100.0	62.0
Diesel (TL/liter)	1.4	0.05	0.00231	0.45	1.5945	0.63	4.13	2.22
Shares (%)	33.9	1.2	0.1	10.9	38.6	15.3	100.0	53.9

<sup>a</sup> EMRA (2014), Istanbul prices (on the European side), as of November 2014.

<sup>b</sup> Revenue Administration, Ministry of Finance, SCT amounts and rates, list no (I), section (A).

ordering, the variables include risk premium (EMBI + Turkey), currency basket, Brent crude oil prices per barrel (in US dollar), output gap, and motor fuel price index. Besides, the fuel lump sum SCT amount variable is added to the model as an exogenous variable. Note that here we use a more parsimonious VAR model compared to one presented in Section 2.1 as we analyze an early stage of the distribution chain. We choose the lag length as two, considering the selection criteria and sequential modified likelihood ratio test results.

Following Rabanal and Schwartz (2001), we compute the pass-through coefficient as the ratio of j-month cumulative response of the change in motor fuel prices to the j-month cumulative response of the change in oil prices, to a change in oil price shock.<sup>6</sup> Since our focus is to compute the pass-through effect of oil prices, we do not report the responses for other variables.<sup>7</sup>

The results of the impulse-response analysis are standardized to a 10% change in Brent crude oil prices. Accordingly, a 10% change in international Brent crude oil prices causes domestic motor fuel prices to change by 2.8, 3, and 3.3% at the end of two months, 12 months, and 24 months, respectively (Fig. 6). As expected, most of the pass-through is completed within the first two months. As a rule of thumb, we can say that domestic motor fuel prices change about one third in response to a change in the Brent oil price.

As a final point to note about motor fuel prices, the pass-through from exchange rate to domestic motor fuel prices is higher than the pass-through from oil prices (Figs. 6 and 7). This finding is in line with Akçelik and Özmen (2014), which show that the exchange rate causes pass-through asymmetry in case of upward cost changes due to being economy wide shock.

In the next step, to examine the effect of oil prices on the prices of related services items, we have extended the VAR model of domestic motor fuel prices by adding the prices of transport services.<sup>8</sup> Results of the impulse-response analysis imply that a 10% persistent increase (decrease) in international Brent crude oil prices causes the prices of transport services to increase (fall) by 0.40 and 0.66 percentage points at the end of the first 12 months and 24 months, respectively (Fig. 8). It appears that the pass-through to transport service prices is very slow relative to other domestic prices. Effect on transport services seems to be rather limited in the first two quarters and it takes eleven months to accomplish the half of the pass-through. It appears that around 85% of the pass-through is completed in seventeen months.

<sup>6</sup> Specifically, it is denoted by the following ratio:  $PT_{t,t+j} = P_{t,t+j}/E_{t,t+j}$  where  $P_{t,t+j}$  is the cumulative response in inflation and  $E_{t,t+j}$  is the cumulative response in the change in oil prices between months  $t$  and  $t + j$  to the oil price shock.

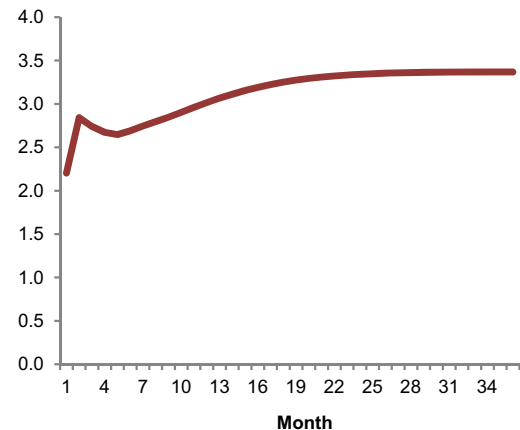
<sup>7</sup> Only exception is accumulated responses of domestic motor fuel prices to exchange rate shock in order to make a comparison with the oil price pass-through.

<sup>8</sup> The model includes the following variables: risk premium, currency basket, Brent crude oil prices, output gap, motor fuel prices, and seasonally adjusted transport services prices.

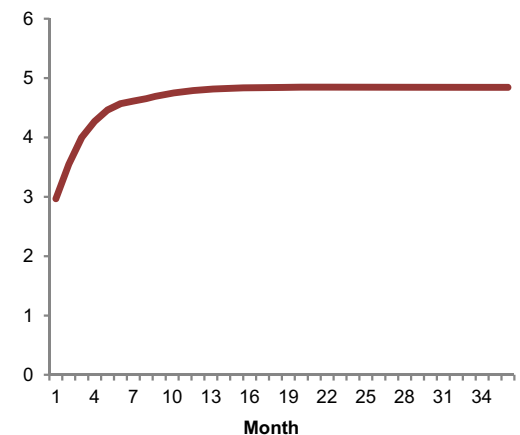
### 3.2. Pass-through to import prices

The findings of Kara and Ögünç (2012) suggest that a 10% increase of import prices will eventually cause around 1.5 percentage points hike in CPI inflation at the end of 12 months. Given this substantial impact, there might be some value to investigate the oil price pass-through to import prices (denominated in US dollar) as well.

Oil prices could affect import prices through two different channels. First one is the direct channel, which includes the prices of imported oil and related products, such as primary and processed fuels and lubricants. Second channel works through import prices of other goods. If a change in oil prices influences the producer prices of our trading partners, then this might feed into our



**Fig. 6.** Accumulated response of change in domestic motor fuel prices to 10% change in oil prices (percentage points).



**Fig. 7.** Accumulated response of change in domestic motor fuel prices to 10% change in exchange rate (percentage points).

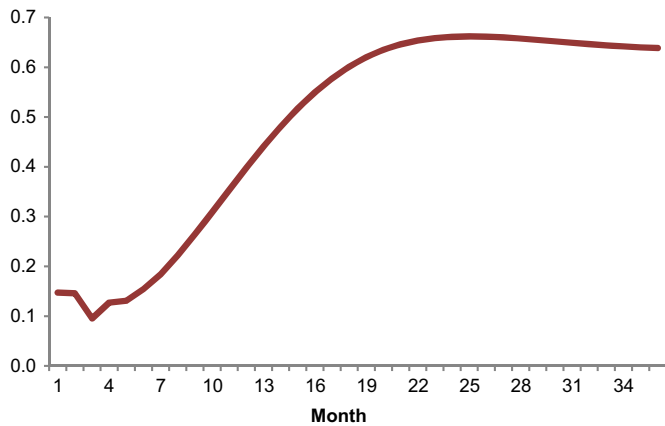


Fig. 8. Accumulated response of change in prices of transport prices to 10% change in oil prices (percentage points).

import prices. For instance, plastic, rubber or chemical products might be subject to such an effect intensively.

By using the baseline model, Fig. 9 shows the response of import inflation to one standard deviation shock to change in oil price alongside  $\pm 2$  (asymptotic) standard errors. Response of import prices appears to be somewhat significant in the first three months even though it takes 10 months to die out entirely. Accumulated responses reveal that roughly 19% of the changes in the oil prices are passed to the import inflation within three months, whereas the pass-through is 32% in fifteen months after the shock (Fig. 10). In this regard, oil price pass-through is considered to be an important factor in import price dynamics. Completion of the pass-through takes about almost one and a half year. However, it is rather fast in the first three months in which 60% of the total pass-through is completed.

To see how reasonable this pass-through estimate is, we have done the following exercise by running a number of regressions for the period 2010–2014. We have regressed the monthly change of each subcomponent of import prices (according to classification by broad economic categories) on monthly changes in the oil prices up to nine lags. Then by using general to specific modeling approach, we have reported the sum of coefficients of significant lags of oil prices in Table 2. For example, results suggest that a 10% increase in Brent oil prices will lead to 8% rise in the price of processed fuels and lubricants. Taking into account the effect of other subcategories, we have calculated the weighted average of these coefficient estimates that points to an

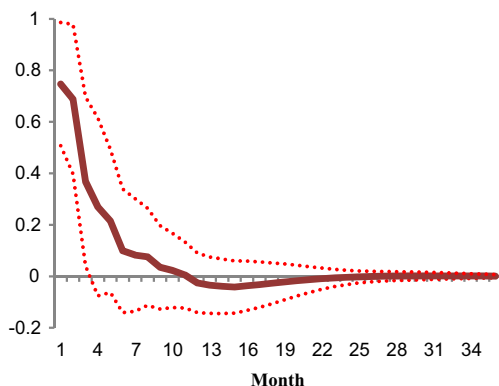


Fig. 9. Response of change in import prices to Cholesky one s.d. innovation in change in oil price  $\pm 2$  S.E.

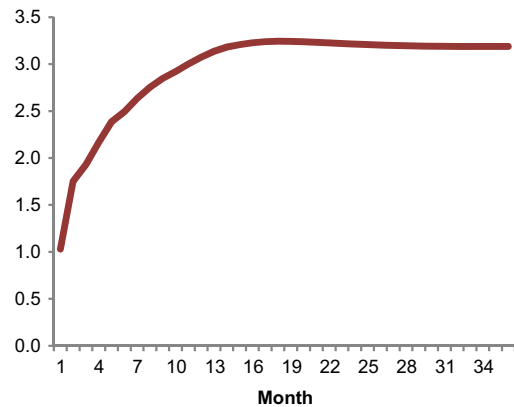


Fig. 10. The accumulated response of change in import prices to 10% change in oil prices (percentage points).

upsurge in import prices by 2.8%. If we make an assumption of full pass-through to first-degree oil related products (shown as bold in Table 2) to get some idea about the possible pass-through range, then the impact of changes in oil prices reaches to 3.3%. Overall, we can conclude that these figures for pass-through to changes in import prices are broadly in line with the above VAR findings.

### 3.3. Pass-through to producer (PPI) and consumer prices (CPI)

The first-round effects of oil price changes on consumer inflation, which occur rapidly, emerge through the prices of energy items such as motor fuels and bottled gas. Meanwhile, the pass-through to other energy prices, such as natural gas and electricity, occurs with a lag.<sup>9</sup> On the other hand, the notion of indirect effects are defined as the pass-through of oil price changes to consumer prices via production costs and it takes time to emerge. The impact of fuel prices on the prices of transport services, such as local transportation, courier services and aviation, are examples to such effects. Indirect effects can also work through import prices. Second-round effects on the other hand refer to the notion that the first-round price changes may cause a revision of the inflation expectations and nominal wages, which in turn leads to inflation. Note that this paper focuses on direct and indirect effects and disregards the second-round effects of oil prices.

In order to measure the likely impact of oil price changes on inflation, we use two different econometric approaches. First, following Hooker (2002), we estimate a quarterly Phillips curve model presented in Table 3. As a second method, we utilize the VAR model. Column labeled as (1) shows the results of a standard Phillips curve model in which core consumer inflation (CPIX) is modeled as a function of output gap, changes in exchange rates, import prices, and non-durable producer prices (mostly reflecting the impact of food manufacturing prices). Then, in (2), instead of employing import prices directly, we use oil prices and non-energy import prices as separate variables. By doing this, we can measure the impact of international oil price changes on consumer inflation. In (3), we present the accumulated coefficients for the changes in oil prices. The augmented Philips curve model implies that a 10%

<sup>9</sup> Motor fuel and bottled gas prices are set mainly according to developments in oil price, exchange rate, and special consumption tax. An automatic pricing mechanism was adopted for electricity and natural gas after 2008 by EMRA and BOTAS (Petroleum Pipeline Corporation), which are the regulatory governmental institutions in Turkey.

**Table 2**

Regression results: the effect of oil prices on import price subcomponents.

Dependent variable (change in import price of)	Weight <sup>a</sup>	Sum of oil coefficients <sup>b</sup>	Sum of oil coefficients (assumption of full pass-through to fuel and lubricants)
Capital goods			
Capital goods (except transport equipment)	0.12	0.00	0.00
Intermediate goods			
Primary industrial supplies	0.06	0.29	0.29
Processed industrial supplies	0.32	0.22	0.22
<b>Primary fuels and lubricants</b>	<b>0.13</b>	<b>0.74</b>	<b>1.00</b>
Parts and accessories of capital goods	0.05	0.19	0.19
Parts and accessories of transport equipment	0.06	0.17	0.17
Primary food and beverages	0.01	0.20	0.20
Processed food and beverages	0.01	0.39	0.39
<b>Processed fuels and lubricants</b>	<b>0.07</b>	<b>0.80</b>	<b>1.00</b>
Consumer goods			
Passenger motor cars	0.04	0.00	0.00
Durable consumer goods	0.01	0.00	0.00
Semi-durable consumer goods	0.07	0.11	0.11
Non-durable consumer goods	0.03	0.35	0.35
Primary food and beverages mainly for household consumption	0.01	0.08	0.08
Processed food and beverages mainly for household consumption	0.01	0.14	0.14
<b>Processed fuels and lubricants: motor spirit</b>	<b>0.00</b>	<b>0.71</b>	<b>1.00</b>
<b>Oil pass-through to change in import prices (% sum product of sum of coefficients and respective weights)</b>		<b>0.28</b>	<b>0.33</b>

Notes:

<sup>a</sup> The average weight of each subcomponent is estimated through OLS regression.<sup>b</sup> The sum of coefficients of significant lags only.

rise (fall) in oil prices results in 0.39 percentage points increase (decrease) in consumer inflation in nearly one and a half year period.

In the second approach to estimate the degree of pass-through from oil price changes to producer and consumer

prices, we use the baseline VAR model. The lag length is set at three based on the selection criteria and sequential modified LR test results.

Results of the impulse-response analysis show that a 10% change in international crude oil prices causes producer prices to

**Table 3**

Philips curve regressions (quarterly data, dependent variable: CPIX).

	Standard model (1)	Oil and non-energy import prices as separate variables (2)	Accumulated oil price coefficients for CPI <sup>x</sup> standardized to 10% change (3)
Constant	0.953 (13.41)	0.692 (4.00)	
$\bar{y}_t$	0.062 (4.59)	0.063 (3.07)	
$\bar{y}_{t-6}$	0.042 (4.47)	0.045 (3.42)	
$\Delta e_t^{usd}$	0.048 (4.79)	0.048 (3.58)	
$\Delta e_{t-1}^{usd}$	0.031 (3.13)	0.029 (2.45)	
$\pi_t^m$	0.063 (3.91)		
$\pi_{t-1}^m$	0.070 (4.64)		
$\pi_t^{mee}$		0.063 (4.21)	
$\pi_{t-1}^{mee}$		0.054 (2.49)	
$\pi_{t-1}^{ppi\_nd}$	0.206 (5.18)	0.256 (4.88)	
$\pi_{t-2}^{ppi\_nd}$	0.085 (1.96)	0.093 (1.96)	
$\pi_t^{oil}$		0.0039 (1.03)	0.03
$\pi_{t-1}^{oil}$		0.0109 (3.33)	0.12
$\pi_{t-2}^{oil}$		0.0071 (1.49)	0.18
$\pi_{t-3}^{oil}$		0.0099 (2.31)	0.26
$\pi_{t-4}^{oil}$		0.0046 (1.04)	0.30
$\pi_{t-5}^{oil}$		0.0022 (0.40)	0.32
$\pi_{t-6}^{oil}$		0.0091 (3.24)	0.39
$\Delta_t^{fueltax}$	0.047 (4.32)	0.043 (2.71)	
D0802	1.551 (6.52)	1.456 (4.60)	
Adj R <sup>2</sup>	0.83	0.81	
SC(4)	0.78	0.38	
NOR	0.88	0.84	
HET	0.77	0.99	

Notes: Sample is 2004:I to 2014:III. Heteroskedasticity and autocorrelation-consistent (HAC) t-statistics are in parentheses.  $\pi_t^{ppi\_nd}$  is the percentage change of seasonally adjusted non-durable consumption goods under producer price index,  $\Delta_t^{fueltax}$  is the percentage change of weighted SCT on fuel products on the consumer basket,  $\pi_t^m$  is the percentage change of seasonally adjusted import price index,  $\pi_t^{mee}$  is the percentage change of import prices excluding energy,  $\Delta e_t^{usd}$  is the percentage change of US dollar exchange rate,  $\bar{y}_t$  is output gap, D0802 is dummy variable that is 1 for 2008:II, 0 otherwise. SC, NOR and HET are p-values of test-statistics for serial correlation (LM), normality (Jarque-Bera) and heteroscedasticity (Breusch-Pagan-Godfrey) respectively.

<sup>a</sup> To find the pass-through to CPI inflation, the findings of CPIX in column (2) are adjusted according to the share of CPIX in consumer basket.



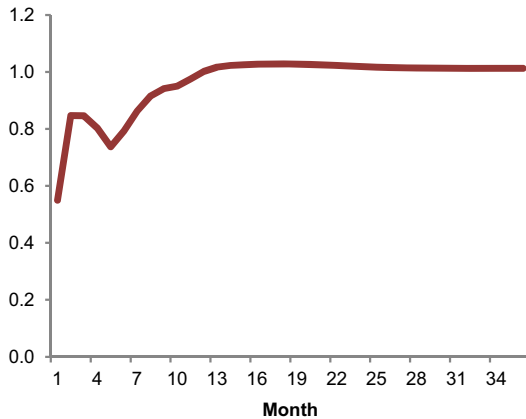


Fig. 11. Accumulated response of producer inflation to 10% change in oil prices (percentage points).

change by 1.00 and 1.02% whereas consumer prices by 0.42 and 0.50% at the end of the first 12 months and 24 months, respectively (Figs. 11 and 12).<sup>10</sup> The pass-through from oil prices to producer prices is approximately two times higher than the pass-through to consumer prices, which is in line with the findings of Dedeoğlu and Kaya (2014). Higher impact of oil prices on producer prices is an expected finding, since producer prices exclude any VAT or similar deductible taxes, but consumer prices do not. Taxes on retail prices smooth out the effect of oil price changes on consumer prices. In short, the estimates point that a permanent 10-percent increase (decrease) in oil prices is associated with a surge (fall) in consumer inflation of 0.42 percentage points on a cumulative basis within a year.<sup>11</sup>

Producer prices respond to oil prices immediately. Half of the pass-through occurs in the first month and it takes just two months around 80% of it to be completed. This rapid response reflects the direct effect of import prices. On the other hand, findings suggest that half of the pass-through to consumer prices takes place in the first two quarters, whereas 85% of it takes place within a year. However, it takes about a year and a half for oil prices to be fully reflected on consumer prices (Fig. 12).

Fig. 13 exhibits that the oil price pass-through to consumer prices estimated from the VAR model is higher than that of estimated from Philips curve model. This result is reasonable, since the VAR model captures the dynamic interactions among economic variables.

<sup>10</sup> Balkan et al. (2015) find that fuel price increases are transmitted to the wholesale prices of truck-transported fresh fruit and vegetables. When we conduct an impulse response exercise for unprocessed food inflation, all responses are within the error bands including zero implying that there is no significant pass-through from change in oil prices to unprocessed food inflation at aggregate level. A similar result is attained for the prices of alcoholic beverages and tobacco products. Therefore, the pass-through for the consumer inflation is estimated by multiplying the impulse-responses for the CPIX inflation of the relevant period by the average weight of the CPIX in the consumer basket.

<sup>11</sup> The following back of the envelop calculation can be used to assess overall consistency of the findings. According to our results, a 10% increase in the oil prices leads to nearly 3% hike in import prices at the end of 12 months. Import price pass-through to consumer inflation is roughly 15% during this period (Kara and Ögünç, 2012). Therefore, 3% rise in import prices due to 10% upsurge in oil prices will eventually lead to 0.45-percentage point increase in consumer inflation. Moreover, our results are in line with the findings of Dedeoğlu and Kaya (2014) that estimate a recursive VAR. Their last rolling window corresponds to the period between 2002:03 and 2012:02, in which the oil price pass-through to CPI and PPI inflation are estimated to be around 0.4 and 1 percentage points respectively for a 10% change in oil prices.

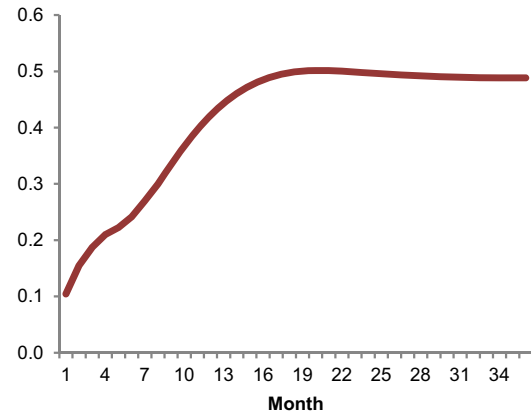


Fig. 12. Accumulated response of consumer inflation to 10% change in oil prices (percentage points).

Are the pass-through findings pertaining to consumer inflation in line with the recent developments? Brent crude oil prices in US dollar terms dropped by 45% from July to December 2014 that pulled consumer inflation down directly by 0.76 points through fuel and bottled gas prices, despite the weakening Turkish lira. Taking into account the declines in prices of transport services in the last two months of the year, the inflation fell by 0.81 percentage points. The pass-through prediction of the above VAR model for consumer prices at end-2014 is around –0.8 percentage points. In this regard, the short-term projections of the above VAR model appear to be consistent with the recent inflation realizations.

#### 3.4. Is there a change in oil pass-through to consumer inflation over time?

Many studies present evidence of a decline in the pass-through from the oil prices to inflation for both industrialized and emerging market economies. However, a recent paper by Dedeoğlu and Kaya (2014), suggesting just the opposite, assert that the oil pass-through to inflation has increased over time in Turkey. We have conducted a separate analysis to assess whether the pass-through varies over time by using recursive accumulated impulse response function estimates.

The evolution of the accumulated response of the consumer inflation to 10% increase in oil prices is presented in Fig. 14. This enables us to trace the evolution of responses at various periods as more and more of the sample data are used in the estimation. Here, we keep the end date (2014:09) fixed and increase the starting point recursively commencing from 2004:01. Therefore, the first sample period (2004:01 to 2014:09) in the figures corresponds to the findings presented in Section 3.3.

While the findings point that short-term (3 months) oil price pass-through to consumer inflation remains almost unchanged over time, they suggest that medium-term pass-through (for one or two-year periods) gradually increases. For example, while the effect of a 10% increase in oil prices is estimated as 0.42 percentage points rise in consumer inflation at the end of first year for the observations starting from January 2004, it goes up to 0.52 percentage points when the sample begins from January 2006. The corresponding figures at the end of second year are 0.50 and 0.56 percentage points. If we take the average of impulse responses for dates shown in figures, then the average response at the end of first quarter, first year, second year and third year are 0.21, 0.50, 0.55 and 0.55 percentage points, respectively.

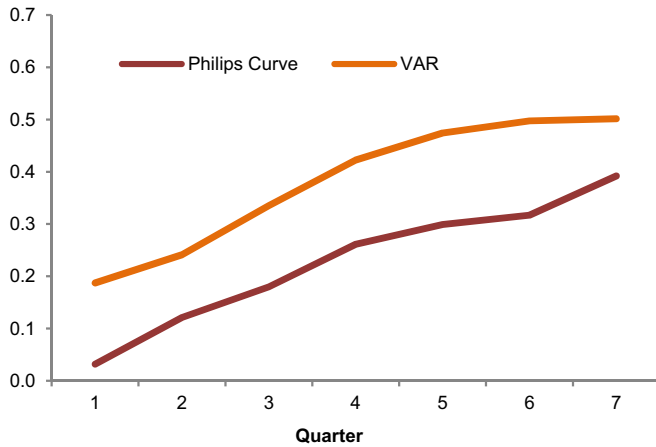


Fig. 13. Accumulated response of consumer inflation to 10% change in oil prices under different model settings (percentage points).

Dedeoğlu and Kaya (2014) attribute the increase in the oil pass-through to the changes in relative prices stating that oil gets higher share in the cost structure of the firms. Gürcihan-Yüncüler and Ögünç (2015), using TurkStat Annual Industry and Service Statistics micro data set, compute the share of main expenses in the company cost accounts for 11,841 firms. Their balanced panel

results, presented in Fig. 15, indicate that the share of fuel expenses is relatively small and have a declining trend contrary to expectations. On the other hand, as depicted in Fig. 16, the share of fuels and lubricants in consumer basket has increased from around 3.5 to 5% over time possibly reflecting the upsurge in the number of automobiles. There is also a slight rise in the share of natural gas in the consumption of household. However, the share of residential sector in Turkey's consumption of natural gas was roughly 20% in 2011. Bulk of natural gas is used in power generation. To be precise, electric power sector accounted for 48% of the natural gas use in 2011. Another significant amount of natural gas (21%) consumed by the industrial sector (EIA, 2014). Overall, natural gas consumption of Turkey has increased briskly over the past decade (Fig. 17), and the import price of natural gas closely follows that of Brent oil prices as presented in Fig. 18. Therefore, among the potential explanations regarding the increase in oil pass-through to consumer inflation, we argue that the rise in the natural gas intensity of Turkish economy, especially in electricity generation and industry, might be an important factor.

#### 4. Concluding remarks

This paper estimates the effect of changes in oil prices on various prices in Turkey. Literature mostly concentrates on the final stages in the supply chain, which are oil price pass-through to producer and consumer prices. This paper also focuses on oil price pass-

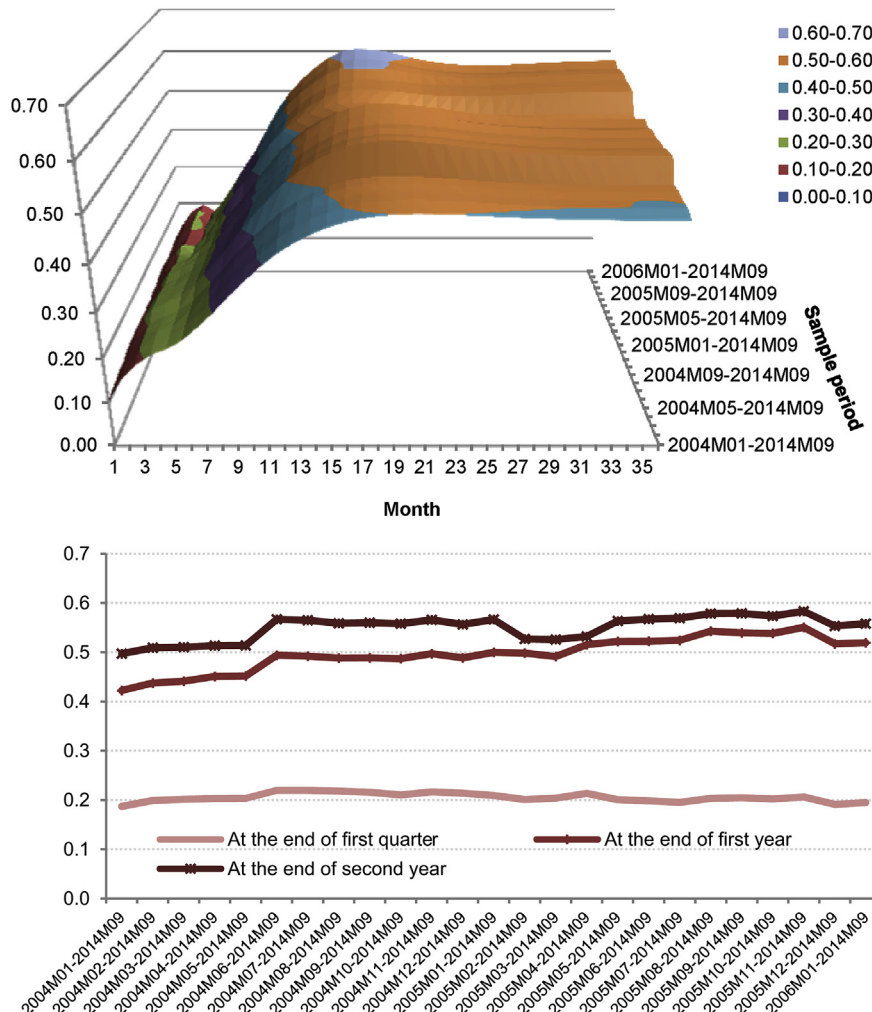
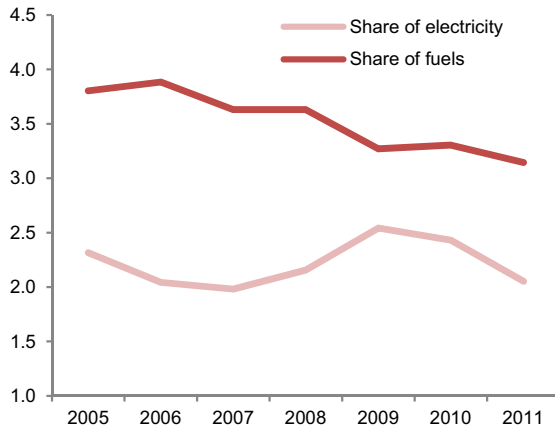
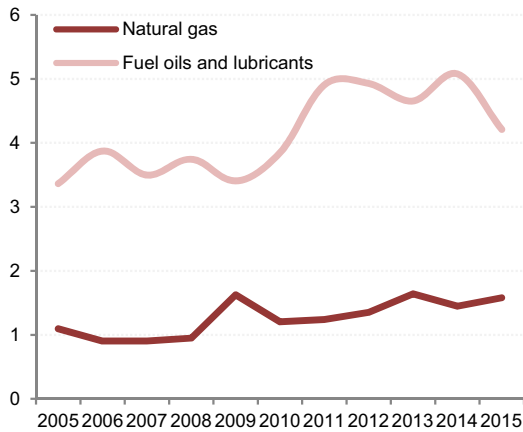


Fig. 14. The recursive accumulated pass-through of change in oil prices to consumer inflation.



**Fig. 15.** Share of some energy items in company cost accounts (balanced panel results for 11,841 firms, as % of 100).

Source: Gürcihan-Yüncüler and Ögünç (2015), Table 2.

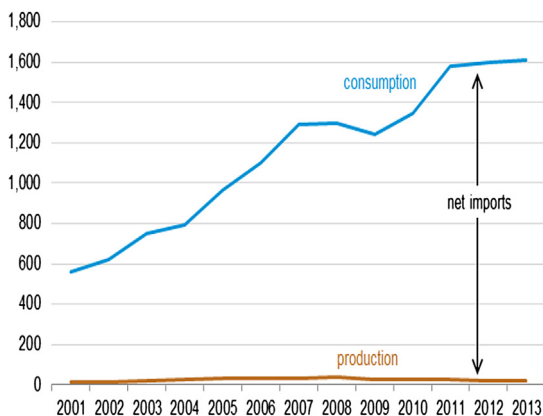


**Fig. 16.** Share of energy items in CPI basket (%).

Source: TurkStat, Eurostat.

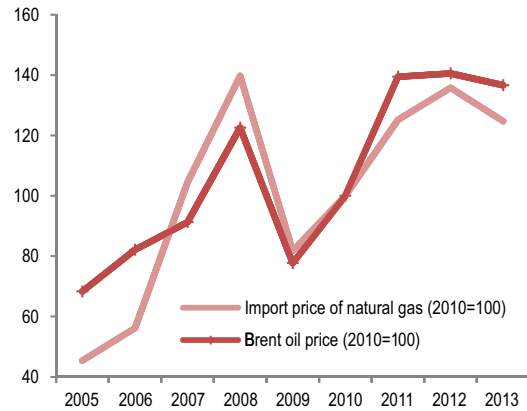
through to the intermediate stages, such as import prices, domestic motor fuel prices and transport services prices.

The first effects of oil price changes on consumer prices occur through domestic motor fuel prices. Our VAR findings reveal that just one third of the change in international Brent crude oil prices



**Fig. 17.** Turkey's natural gas consumption and production (billion cubic feet per year). Note: 2013 data are estimates.

Source: U.S. Energy Information Administration, International Energy Statistics, IEA.



**Fig. 18.** Import price of natural gas and oil prices (2010 = 100).

Source: Bloomberg, EMRA, TurkStat, Authors' own calculations.

pass into domestic motor fuel prices due to substantial tax burden on oil products and most of the impact takes place over the first two months. The pass-through from exchange rates to motor fuel prices is higher than that from oil prices, which is consistent with Akçelik and Özmen (2014). Although the effect on domestic motor fuel prices is reasonably fast, the pass-through to the prices of transport services takes relatively a long time to emerge.

We believe that there is some value in analyzing the impact of oil prices on import prices as well due to the significant role of import prices in inflation dynamics in Turkey. Response of import prices appears to be somewhat significant in the first three months. Accumulated responses reveal that overall 32% of the changes in oil prices are passed into import inflation. The key point of our study is the pass-through to consumer prices; our findings on this issue imply that, over the 2004–2014 period, a 10% permanent change in the international oil prices is associated with a 0.42 percentage points change in consumer inflation at the end of one year. The final accumulated pass-through on consumer inflation stabilizes around 0.50 percentage points. The pass-through from oil prices to producer prices is nearly as twice as the pass-through to consumer prices. These evidences are broadly consistent with the findings in Dedeoğlu and Kaya (2014).

This paper further shows that short-term (3 months) oil price pass-through to consumer inflation remains almost unchanged over time, however the medium-term (for one or two-year periods) pass-through tends to increase gradually. According to Gürcihan-Yüncüler and Ögünç (2015), the share of fuel expenses in cost structure of firms appears to be relatively small and has been declining over time. Therefore, the rise of oil share in cost composition of the firms may not be the main reason fueling the strengthening in oil price pass-through. We argue that this finding might be mainly owing to the following features: the share of oil products in consumer basket has risen over time, and more importantly, natural gas intensity of the Turkish economy (specifically in electricity generation and industry sectors) has been increasing.

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