TÜRKİYE CUMHURİYET MERKEZ BANKASI

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Dilara ERTUĞ
Pınar ÖZLÜ
M. Utku ÖZMEN
Çağlar YÜNCÜLER

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Address:
Central Bank of the Republic of Turkey
Head Office
Structural Economic Research Department
Hacı Bayram Mh. İstiklal Caddesi No: 10
Ulus, 06050 Ankara, Turkey

Phone:
+90 312 507 80 04

Facsimile:
+90 312 507 78 96

The Role of Imported Inputs in Pass-through Dynamics[1]

Dilara Ertuğ, Pınar Özlü, M. Utku Özmen and Çağlar Yüncüler

Research and Monetary Policy Department

Central Bank of the Republic of Turkey

Abstract

In this paper, we analyze the extent to which the use of imported inputs affects exchange rate and import price pass-through into domestic producer and consumer prices for services in Turkey. We first calculate the use of imported inputs on sectoral level by analyzing the input-output tables. Then, by taking the sectoral heterogeneity regarding the use of imported inputs into account, we estimate import price and exchange rate pass-through by utilizing import prices, producer prices (consumer prices for services) and output gap on sectoral basis. Our results point to a substantial heterogeneity across sectors in terms of exchange rate and import price pass-through. While the import price (in foreign currency) pass-through is in line with the share of imported input to a large extent, the pass-through of exchange rate shocks to domestic prices are generally higher than the share of imported inputs in costs inclusive of labor. Our findings also reveal that this excess exchange rate pass-through has strengthened over the recent period. Additional analyses carried out reveal that the high share of foreign currency debt is associated with higher exchange rate pass-through, suggesting that the management of foreign exchange liability might play a critical role to enhance the effectiveness of monetary policy and to create room for maneuver to fight against inflation by reducing the excess exchange rate pass-through.

Keywords: Imported inputs; import price pass-through, exchange rate pass-through; FX liability

JEL Codes: D57; E31; E52

[1] The views expressed in this paper are only those of the authors and should not be interpreted as reflecting those of the Central Bank of the Republic of Turkey. Email addresses:Dilara.Ertug@tcmb.gov.tr; Pinar.Ozbay@tcmb.gov.tr, Utku.Ozmen@tcmb.gov.tr; Caglar.Yunculer@tcmb.gov.tr.

Non-technical Summary

Over the last two decades, increased global trade and integration of local economies to the global value chains have led to a considerable rise in the share of imported inputs in domestic production. Imported input use has tended to grow over time both across countries and industries. As a byproduct, the elevated use of imported inputs has also served as a factor increasing the responsiveness of an economy to import price and exchange rate shocks. In this framework, this study investigates to what extent the use of imported inputs weigh on exchange rate and import price pass-through to domestic prices in Turkey. To better understand the dynamics, we build on a sectoral level analysis incorporating manufacturing and services sub-sectors.

Our empirical results reveal that there is a considerable amount of heterogeneity across industrial sectors in terms of the size of the pass-through and that the pass-through of exchange rate shocks is in general higher than the pass-through of shocks to import price in USD. More importantly, we find that while the extent of import price pass through is in line with the share of imported inputs use across sectors, the exchange rate pass-through is higher than the share of imported inputs in most occasions. Results regarding the services point to several sectors with substantial level of exchange rate pass-through as well, where the share of imported input use is high.

Although the use of imported inputs is the main source of exchange rate and import price pass-through, there are factors that can affect the extent to which foreign prices and exchange rates transmit into domestic producer prices. In our analysis, we highlight the foreign currency debt as a channel that might have driven the excess exchange rate pass-through (difference between the exchange rate pass-through and the share of imported inputs) observed in the recent period in Turkey. Our empirical results suggest that the excess exchange rate pass-through is associated with the high share of foreign currency debt in total assets, especially the short-term debt.

Overall, our results suggest that the intensive use of imported inputs *per se* help explain the heterogeneity in the pass-through of import prices to a large extent. However, its relation with the exchange rate pass-through is not one-to-one, suggesting that other factors also weigh on exchange rate pass-through. Considering the possible impact of foreign currency debtedness, the management of foreign exchange liability turns out to be critical also for controlling inflation by reducing the excess exchange rate pass-through.

1. Introduction

Increased globalization has made most of the countries more vulnerable to external factors, i.e. exchange rate and import price shocks, via the trade channel (Auer and Mehrotra, 2014). Accordingly, quantifying the extent of the impact of such factors has become more important for better forecasts of macroeconomic indicators, e.g. inflation, growth, and an optimal economic policy design in emerging market economies, whose integration to global value chains has increased significantly over the last couple of decades.

Globalization of production has increased the use of imported inputs causing local costs to be more sensitive to exchange rates. Imported input use has tended to grow over time both across countries and industries. This tendency has increased the predicted sensitivity of retail prices of imported goods and other tradable goods to exchange rates. Stylized facts suggest that import prices are more responsive to exchange rate shocks than domestic producer and consumer prices. Meanwhile, a few recent studies show that when manufacturing sectors tend to use more imported intermediate inputs and also export their products, the degree of import price pass-through to producer prices increases significantly.[2] Indeed, in many emerging market economies the share of foreign value added in value added of exports has substantially increased (Figure A1 in the Appendix).

A significant number of studies in the vast literature of pass-through dynamics focus on estimating the pass-through coefficient, which provides valuable information for the policy makers and forecasters on to what extent shocks would be transmitted to the prices. Yet, a less studied but equally important aspect of pass-through is the factors determining its extent. These studies, which mostly concentrate on exchange rate pass-through, have pointed out that factors such as the composition of trade, the degree of openness of the economy, the substitutability of imported goods, the size of the economy, distribution margins and the flexibility of mark-ups, the firms' pricing strategy, inflation outlook, exchange rate volatility, current account deficit and the direction and size of exchange rate shocks may affect the extent of pass-through.[3]

[2] See Kiyotaka and Hoang (2016); Campa and Goldberg (2008).

[3] See Burstein, Eichenbaum and Rebelo (2002); Goldberg and Knetter (1997); McCarthy (2007), among others.

The channels that the external factors affect prices are important determinants of the extent of pass-through. In this regard, one may consider direct and indirect channels. The direct channel is through imported final consumer goods included in the consumption basket. In this case, increases in import prices are expected to fully pass-through to product prices to the extent of pricing to market strategy. The latter is through production costs arising from the use of imported inputs in domestic production. In this case, the extent of pass-through is expected to be proportional to the share of imported inputs in production costs. Meanwhile, consumption goods generally constitute a smaller portion of total imports in most countries. Particularly, the dominance of imported input channel is more pronounced in countries for which the share of intermediate goods constitutes a significant portion of total imports and the intensity of imported input use is non-negligible. Turkey can be categorized among the countries, where the indirect channel is very influential on the pass-through into final prices, where the intermediate inputs have a high share, around 73 percent, in total imports (Figure 1).

Recently, the examples of a growing body of this literature such as Campa and Goldberg (2008), Auer and Mehrotra (2014), Ahn et al. (2016) and Casas (2019) emphasize the costs arising from imported input use as a more important channel for the sensitivity of consumer price changes to exchange rate shocks compared to imported final consumer goods. For example, the manufacturing supply chain in Asia is closely integrated. Auer and Mehrotra (2014) argue that in closely integrated supply chains any shock to domestic production costs or exchange rates can easily pass-through to other economies in the supply chain affecting intermediate prices. This structure has potential implications for both headline inflation and is also a concern for policy makers. Increased interconnectedness is likely to lead to greater sensitivity of aggregate inflation to cost of imported inputs especially when the cost changes are larger in magnitude. Similarly a recent study on Colombia shows that exchange rate pass-through to prices tends to be larger for industries in which firms use a larger share of imported inputs. While this link is stronger in the case of exports, it is positive for import prices.[4]

[4] See Casas (2019).

On the other hand, it should be underlined that the import content of both consumption and production in many countries has steadily increased. According to OECD figures, as of 2015, the share of foreign value added in final consumption ranges between 10 and 75 percent in major advanced and emerging economies; it is considerably higher in EU countries and it is less than 30 percent in Turkey (Figure A2 in the Appendix). Stylized facts have shown that a generalized fall in exchange rate pass-through has taken place despite an increase in the import content over the past decades.[5] Swallow et al. (2016) argue that not only import prices but also other prices such as wages, distribution costs, retail markups and that of non-tradables respond to the exchange rate shocks. Thus, despite the fact that the increased import content affect exchange rate pass-through adversely through imported input channel, the response of other prices are largely responsible for the decline in overall pass-through to consumer prices.

Against this background, in this study, we estimate and elaborate on the sources of import price pass-through into producer prices in Turkey on a sectoral basis. Here, we focus on producer prices rather than consumer prices for three reasons. First, there has been a well-documented literature in Turkey for pass-through of external shocks and producer price shocks to consumer prices, yet the pass-through to producer price itself is rather neglected. Second, we aim to contribute to the literature by extending our analysis to individual sectors rather than working on aggregate price data to show the heterogeneity in the pass-through dynamics across sectors. Third, we aim to identify the source of the heterogeneity in the degree of pass-through across sectors by relating it to the sectoral differences in the use of imported input in domestic production and foreign exchange liability.

Our study departs from the likes in the overall pass-through literature in some aspects. First, unlike most of the studies, which treat exchange rate shock as the main source of import price shock in domestic currency, we distinguish the exchange rate and import prices in foreign currency as two different sources of change in import prices and analyze their impact on producer prices separately. Stylized facts have revealed the importance of change in import prices in foreign currency. For example, in the case that

[5] See Swallow et al.(2016); Mihaljek and Klau (2008).

exchange rate and commodity prices move in opposite directions to offset the impact of each other on import prices in domestic currency, if import prices in foreign currency are not included in the analysis as a separate variable, then pass-through effects are estimated as non-existent. However, Yüncüler (2011), Kara and Öğünç (2012), Özmen and Topaloğlu (2017) have shown that the degree and speed of the pass-through to prices might be different for each factor and, thus, decomposing their effect may enrich the information content. Second, estimating pass-through coefficients for each sector is not our ultimate aim. Rather, we consider them as a means to analyze the factors leading to different pass-through effect across sectors. In this regard, we compare the estimated pass-through coefficients for the two components of import prices with the share of imported input use in costs inclusive of labor, which is calculated from Input-Output Tables for Turkey, and examine if they are proportional to each other. Later, we elaborate on the sources why the pass-through coefficients for exchange rate and import prices might differ for a specific sector. Such distinction provides different policy implications to mitigate the impact of pass-through. Third, we do not restrict our analysis to industrial sectors and extend the analysis to services sector, where production is known to be less import dependent compared to industrial sectors. Our aim in such extension is to show that even within services sector some sub-sectors are more prone to external factors due to their exposure to imported input use.

We use Vector Auto Regression (VAR) models to empirically estimate the pass-through effects using monthly data covering the period between 2010 and 2017. We find that both exchange rate and import price pass-through effects on producer prices vary significantly across industrial and services sectors. As expected, on average, the degree of pass-through for both shocks is higher in industrial sectors compared to services sectors. More importantly, we find that there is a significant heterogeneity in estimated pass-through coefficients across sub-sectors within industrial and services sectors as well. We mainly relate the variation in estimated pass-through coefficients across sectors to the intensity of imported input use in the production process. We find that there is a significant positive linear relationship between the intensity of imported input use and pass-through coefficient estimates for both exchange rate and import price shocks. Another striking finding is that the exchange rate pass-through estimates are higher than import price pass-through for the majority of industrial sectors. While the import price

pass-through is on average proportional to the intensity of imported input use, exchange rate pass-through is beyond that threshold. This may be attributed to the presence of factors other than production costs, such as foreign exchange liabilities and investment costs, which affect the pricing behavior and the firm's balance sheet. In fact, we run cross-section regressions with estimated pass-through coefficients for two different samples (pre and post 2010) and find that higher foreign exchange liability is associated with excess exchange rate pass-through, which is defined as the difference between the exchange rate pass-through and the share of imported inputs. Thus, we conclude that considering the pros and cons of the use of high levels of imported inputs and management of foreign exchange liability are critical to enhance the effectiveness of monetary policy and to create room for maneuver to fight against inflation.[6]

The study proceeds as follow. In the next section, we briefly introduce the production structure of the Turkish economy on a sectoral basis and explain the motivation of this study. In the third and fourth sections, data and the methodology are presented. In the fifth section, we share the results of the empirical analysis and discuss them in detail. The last section concludes the study.

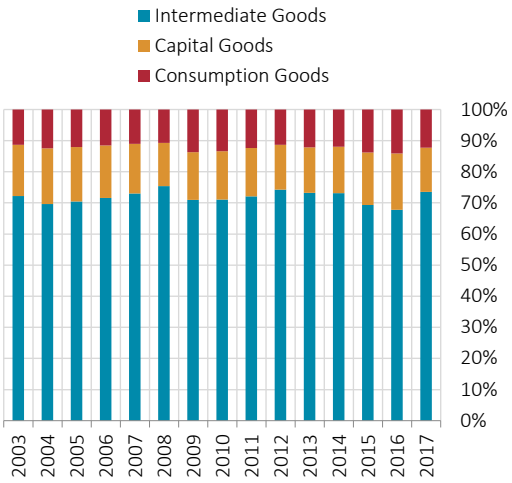
2. Background on Turkish Economy

In this section, we provide data on the production and trade structure of Turkish economy to highlight the importance of indirect pass-through channel, i.e. effect through production costs arising from the use of imported inputs. Further, we elaborate on the trajectory of exchange rate and import prices in foreign currency to give more insight on the characteristics of the external shocks that Turkish economy encounters.

From a historical perspective, intermediate goods, which also include energy items, constitute most of the total imported goods in Turkey (Figure 1). On average, while they account for 73 percent of all imported goods, the share of consumption goods is as low as 12 percent. The rest of the imported goods are capital goods. This hints that imported input use in production may be at significant levels, while the share of directly imported consumption goods in consumer basket is relatively low.

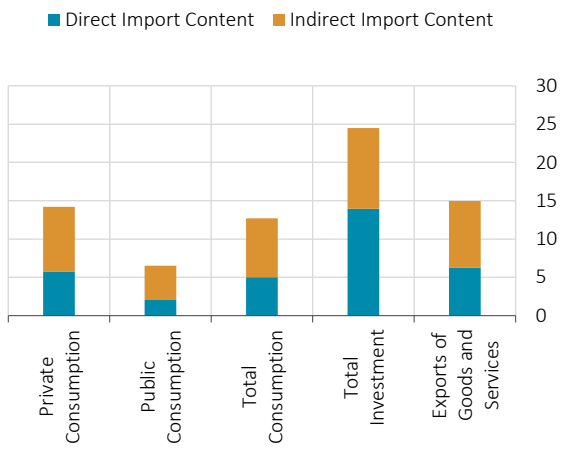
[6] See Erduman et al. (2019); Akgündüz and Fendoğlu (2019); Özcan and Sevinç (2019) for the use of imported intermediate goods in both production and export sectors.

Figure 1. The Composition of Imported Goods in Turkey (%)



Source: TURKSTAT.

Figure 2. Import Content of Final Demand Components in Turkey (%)



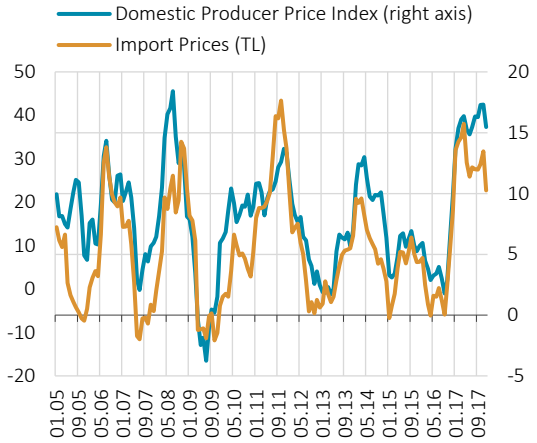
Source: Authors' own calculation from 2012 I-O Tables.

No official data is provided on the share of directly imported consumption goods in consumer basket in Turkey. Yet, we construct a proxy and provide a supportive argument for the higher influence of indirect pass-through channel on prices utilizing data from 2012 Input-Output (I-O) Tables. An I-O table describes the sale and purchase relationships between producers and consumers within an economy (see Table A1 in Appendix). In this regard, it is possible to measure the direct and indirect import content of each final demand component. We define direct import content of a demand component as the ratio of the value of the directly imported goods to the total value of the demand component. On the other hand, indirect import content of a demand component is the ratio of the value of imported input in domestic production of the demand component to its total value. As shown in Figure 2, in Turkey, the indirect import content constitutes a higher share for consumption and exports, whereas the opposite is true for total investments probably due to machinery and equipment investments. This hints that similar to many countries, consumer basket consists more of domestic goods.

Another way to illustrate how imported goods affect the prices through cost channel is to study the relationship between producer and import price changes. We would expect a high correlation between the two, if imported input use is a significant portion of domestic production. As shown in Figures 3 and 4, the strong relationship between the changes in producer prices and import prices denominated in Turkish lira confirms the importance of cost shocks through imported inputs for the domestic prices. The correlation of annual changes is 0.81, while correlation of monthly changes is as high

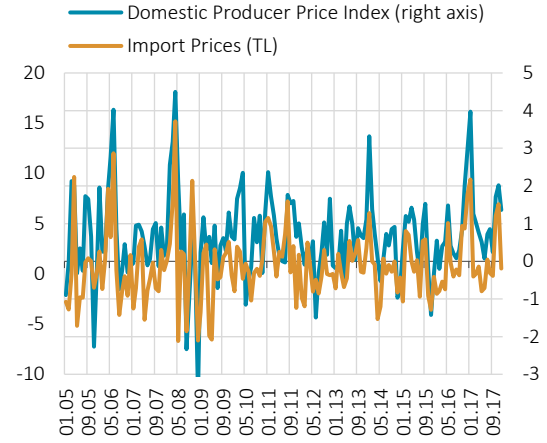
as 0.65. Similarly, Ahn et al. (2016) state that the correlation between monthly changes of total producer price index and import price index is 0.63 in Korea.

Figure 3. Domestic Producer Price and Import Price Indices (Annual % Change)



Source: TURKSTAT.

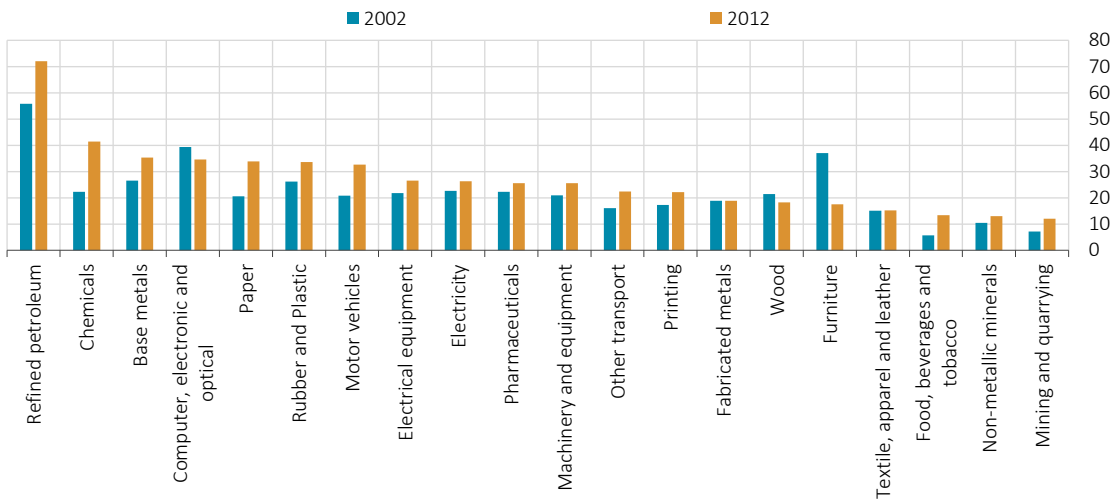
Figure 4. Domestic Producer Price and Import Price Indices (Monthly % Change)



Source: TURKSTAT.

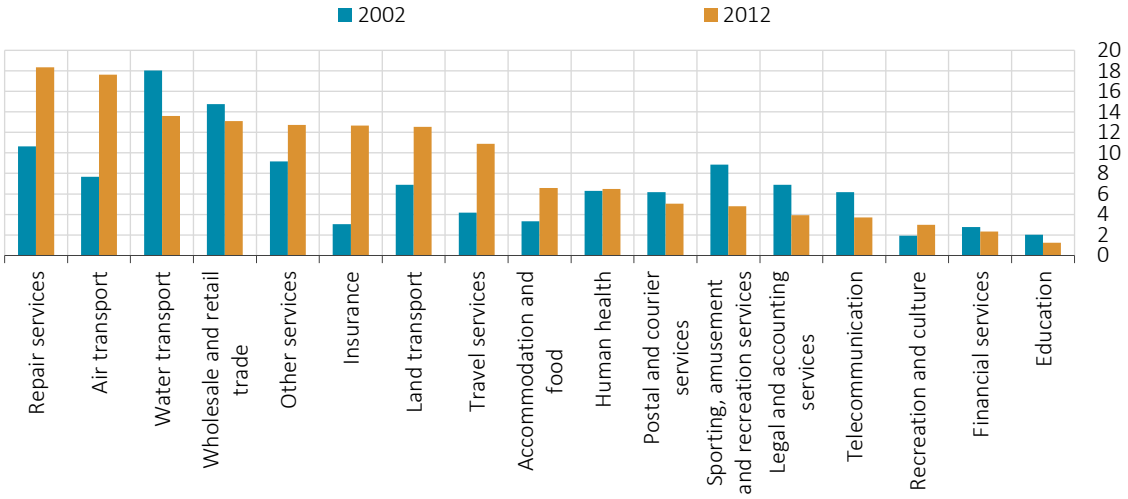
In fact, I-O tables allow for detecting the sectors in which the domestic production is dependent on imported inputs. Figures 5 and 6 present the intensity of imported input use in domestic production for each of the industrial and services sectors in 2002 and 2012, comparatively. Here, we define the intensity of imported input use as the ratio of the value of imported inputs to the sum of total intermediate input consumption and compensation of employees.

Figure 5. The Intensity of Imported Input Use in Domestic Production of Industrial Sectors in Turkey (%)



Notes: The intensity of imported input use in domestic production (import dependency ratio) is calculated by dividing the value of imported inputs in the domestic use table among the I-O tables for 2012 by the sum of total intermediate consumption and compensation of employees.

Figure 6. The Intensity of Imported Input Use in Domestic Production of Services Sectors in Turkey (%)



Notes: The intensity of imported input use is calculated by dividing the value of imported inputs in the domestic use table among the I-O tables for 2012 by the sum of total intermediate consumption and compensation of employees.

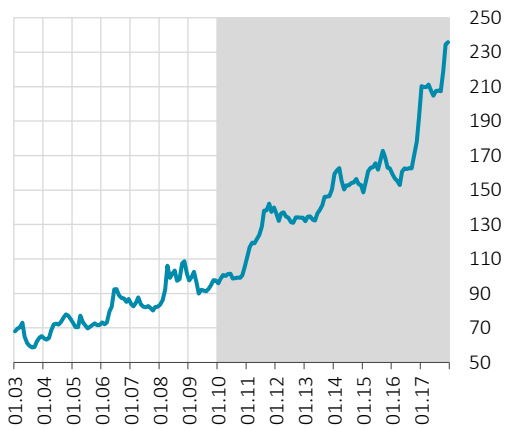
Figures 5 and 6 show that as of 2012, the share of imported input in total production costs inclusive of labor costs is on average 25 and 7 percent for industrial and services sector, respectively. In addition, the intensity of imported input use shows significant variation across subsectors. In the industrial sector, the highest imported input intensity belongs to production of refined petroleum and coke with 72 percent, whereas the lowest reading is as low as 12 percent for mining and quarrying. In addition, sectors such as base metals, chemicals, motor vehicles and electrical equipment, which account for significant portion of Turkish exports, have higher than the average imported input intensity in industry. On the other hand, in the services sector, transport, wholesale and retail trade and repair services sectors use the most imported inputs in proportion to their production costs, while sectors such as education, financial services, recreation and culture have very low imported input use. The rises in abovementioned leading exporting sectors are also striking. Therefore, this heterogeneous outlook in imported input use feeds our motivation to pursue a pass-through analysis on sectoral basis and account for this heterogeneity in understanding the extent of both exchange rate and import price pass-through into producer prices.

Last but not least, we share information about the course of external factors, of which we will be analyzing the impact on domestic prices. In this context, Figure 7 shows the path import prices in TL has followed. It is seen that Turkish economy has been exposed to rises in import prices in domestic currency steadily. However, the rise in

import prices seems to be more resilient after 2010, as shown in grey shaded area. This means that pass-through dynamics of external factors have put more pressure on prices in Turkey after 2010. In order to understand the reasoning behind the rises, it would be better to disentangle the import prices to its two core components: exchange rate and import prices in foreign currency.

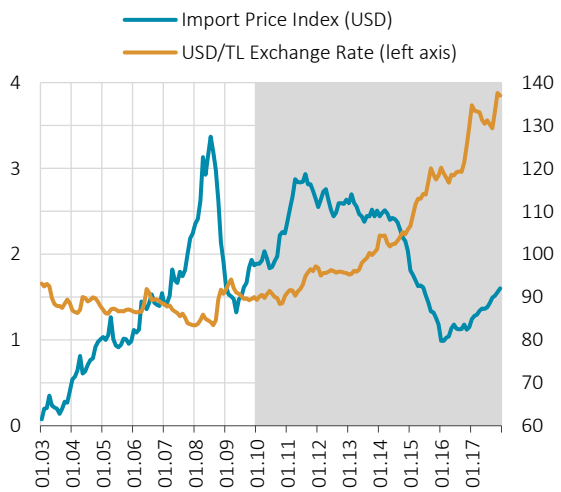
The separate analysis of components, which is presented in Figure 8, provides important information about the dynamics and sources of import price rises in domestic currency. In the period after 2010 the changes in import prices in USD have been more moderate, while there has been gradual weakening of the Turkish lira, especially with the heightened uncertainty about global monetary policies after May 2013 when the US Federal Reserve signaled a tapering of its asset purchases. On the contrary, the source of import price rise in pre-financial crisis period was the robust rise in commodity prices, where Turkish lira followed a stable course. This distinction in the sources of change in import prices between the sub-periods is the major reason why we should take into consideration the sources of shocks in pass-through analyses. In fact, previous studies for Turkey by Yüncüler (2011), Kara and Öğünç (2012), Özmen and Topaloğlu (2017) stress the importance of this decomposition to enrich the information content of pass-through, as the persistency and volatility of different shocks affect the estimated coefficients (Taylor, 2000).

Figure 7. Import Price Index in TL terms (2010=100)



Source: TURKSTAT.

Figure 8. The Components of Import Price Index in TL Terms



Source: TURKSTAT, CBRT.

3. Data

In this section, we present the details of dataset on sectoral basis. In the construction of dataset, we utilized the Input-Output (I-O) tables of 2002 and 2012, as well as foreign trade index, domestic producer price index (D-PPI), consumer price index (CPI), industrial production index (IPI) and turnover index using Turkish Statistical Institute's (TURKSTAT) database. Exchange rate is the monthly average value of nominal TL/USD.

We construct data on a sectoral basis. The selection is based on the sectoral classification of I-O tables. Normally, I-O tables contain 64 different sub-sectors under agriculture, industry, services and construction sectors. However, due to data limitations we restrict our analysis to only industrial and services sectors. We also have to eliminate some industrial and services sectors due to lack of price, production or turnover data. Thus, we run the empirical analysis with 37 sectors in which 20 of them belongs to industrial sectors[7, 8].

We use monthly data for the period between January 2005 and December 2017, and run regressions for two different sub-samples as 2005-2009 and 2010-2017 for the industrial sector. The reason is that we see a notable change in the dynamics of the external factors during the period of 2010-2017 compared to 2005-2009 (Figure 8). In order to focus on the most recent pass-through dynamics, we consider regressions between 2010 and 2017 as baseline analysis. The application of the same empirical analysis for 2005-2009 time period allows us to make robustness checks and to further investigate whether the determinants of the degree of pass-through based on imported input use has changed over time. We should note that regression analysis for two different time periods is only done for industrial sector as lack of monthly turnover data before 2009 prevents us from repeating the same analysis for services sector.

[7] Industrial sector includes mining and quarrying, refined petroleum, chemicals, base metals, computer, electronic and optical, paper, rubber and plastic, motor vehicles, electrical equipment, electricity, pharmaceuticals, machinery and equipment, other transport, printing, fabricated metals, wood, furniture, textile, apparel and leather, food, beverages and tobacco, other non-metallic minerals.

[8] Services sector includes repair services, travel services, financial services, education, wholesale and retail trade, repair, land transport, legal and accounting services, accommodation and food, water transport, telecommunication, air transport, human health, recreation and culture, postal and courier services, sporting, amusement and recreation services, insurance, other services.

Construction of sectoral import price index

Unlike many other studies in the literature, which use aggregate import price indices in pass-through coefficient estimates, we construct import price indices in US dollar terms at sectoral level to better reflect the sectoral cost pressures arising from imported input use. This is particularly important as the composition of the use of imported goods changes across sectors. To be specific, according to 2012 I-O tables, refined petroleum sector's imports consist mainly of crude oil. Therefore, using aggregate import price index instead of crude oil price index would be inappropriate to measure the imported input cost pressures that refined petroleum sector is exposed to. This is particulary important when relative prices change significantly. Therefore we calculate an effective import price index for each sector, where the price of imported goods are weighted according to the shares given in Import Use Table, which shows the decomposition of the use of imported input in the production process of each sector. The mathematical representation of the effective import price index for each sector is as follows:

$$IMP_i = \sum_j w_{i,j} * IMP_j$$

Here IMP defines the import price index, *i* defines the 37 sectors that we include in our analysis, j defines the type of imported goods on a sectoral basis, $w_{i,j}$ represents the weight of imported good j in total imports of sector i.

Construction of sectoral output gap measures

We construct output gap measures for each sector in order to reflect the impact of demand conditions on producer prices. To this end, for each industrial sector, we use their own industrial production index. On the other hand, we use turnover indices for services sectors. Sectoral output gaps for each industrial and services sector is defined as the logarithmic difference of its seasonal and calendar adjusted production/turnover index from the trend obtained by the Hodrick-Prescott filter.

Construction of sectoral producer price indices

For the industrial sectors, we use the producer price indicator. For the sectors, which were merged into one sector in I-O tables, e.g. clothing, textile and leather, we calculate appropriate price indices by using the sectoral weights in D-PPI. On the other

hand, since producer prices cover only industrial sectors, we construct price indices for the services sectors by using the related items in CPI. The items were aggregated by their weights in the CPI basket.

Summary Statistics

Table 1 presents descriptive statistics for import prices (both in USD and TL), output gap and prices. The first row shows the aggregated values of the variables. In the rest of the table, the variables are evaluated on a sectoral basis. Average values and standard deviations are reported at both sectoral and aggregate levels.

Heterogeneity can be observed among the sectors for all of the variables. The average monthly percentage change of the aggregate import price index in Turkish lira is 0.96. In 22 out of 37 sectors the sectoral monthly import price inflation is higher than this average. Similarly, in the vast majority of sectors, we see that the sectoral import price inflation is more volatile than the aggregate import price inflation. Then again, among the industrial sectors, almost half of the sectors have a higher average monthly change than the average monthly D-PPI inflation (0.69%). On the other hand, while analyzing the service sector, we use services prices, which are sub-groups of overall CPI. The average monthly inflation of the services group is 0.62 with a standard deviation of 0.22. The average and volatility of monthly inflation for each sector are different from these values. Moreover, output gap for the total industry is 0.11 on average while it ranges between -0.37 and 0.78 across different sectors. Finally, it should be emphasized that both in aggregate level and across sectors, the average monthly import price inflation in terms of USD is close to 0. However, when the import prices are evaluated in terms of Turkish lira, import price inflation rises in both sectors and at general level.

To sum up, the descriptive statistics show that demand pressures, imported input use and the related cost pressures may differ across sectors. The remaining challenge is to account for this heterogeneity in the pass-through analysis on sectoral basis.

Table 1: Descriptive Statistics: Aggregate and Sector Level (2010-2017)

	Import Prices (TL)	Import Prices (USD)	Output Gap **	Producer/Consumer Prices
Aggregate*	0.96 (2.70)	-0.05 (1.58)	0.11 (1.77)	0.69/0.62 (0.94/0.22)
Industrial Sectors				
Mining and quarrying	0.91 (3.67)	-0.10 (2.72)	-0.37 (4.18)	0.69 (1.56)
Manufacturing Sectors				
Refined petroleum	0.85 (4.63)	-0.16 (3.85)	0.06 (6.95)	1.02 (5.96)
Chemicals	0.98 (3.05)	-0.03 (1.84)	0.07 (2.85)	0.80 (1.52)
Base metals	1.07 (4.21)	0.05 (3.30)	0.12 (2.37)	1.08 (3.03)
Computer, electronic and opt.	1.09 (3.64)	0.08 (2.81)	0.78 (11.64)	0.55 (1.78)
Paper	1.03 (2.79)	0.02 (1.48)	0.08 (2.28)	0.69 (1.33)
Rubber and plastic	1.01 (2.96)	0.00 (1.55)	0.19 (2.34)	0.72 (1.00)
Motor vehicles	0.97 (2.47)	-0.03 (1.61)	0.45 (5.18)	0.70 (1.11)
Electrical equipment	1.00 (2.67)	-0.01(1.59)	0.32 (3.61)	0.74 (0.99)
Pharmaceuticals	0.91 (4.24)	-0.08 (3.27)	-0.23 (5.75)	0.04 (1.15)
Machinery and equipment	0.97 (2.65)	-0.04 (1.36)	0.38 (3.26)	0.62 (1.04)
Other transport	0.98 (2.65)	-0.03(1.48)	0.15 (14.76)	0.52 (1.59)
Printing	1.03 (2.73)	0.02 (1.45)	-0.16 (6.22)	0.39 (1.43)
Fabricated metals	1.01 (2.86)	0.01 (1.92)	0.20 (2.81)	0.62 (1.18)
Wood	1.05 (2.80)	0.03 (1.57)	0.34 (4.00)	0.69 (0.88)
Furniture	1.04 (2.64)	0.03 (1.50)	0.00 (4.73)	0.83 (1.13)
Textile, apparel and leather	1.05 (2.74)	0.03 (1.19)	0.11 (2.56)	0.72 (0.98)
Food, beverages and tobacco	1.03 (2.68)	0.03 (1.70)	-0.13 (1.85)	0.67 (0.62)
Non-metallic minerals	0.92 (3.42)	-0.10 (2.43)	0.14 (3.90)	0.57 (0.59)
Electricity, Gas	0.85 (4.57)	-0.16(3.80)	0.08 (1.88)	0.30 (4.42)
Services Sectors				
Repair services	1.05 (3.08)	0.03 (1.93)	-0.13 (2.75)**	0.63 (0.52)
Other services	0.99 (2.91)	-0.04 (1.57)	0.02 (4.30)	0.57 (1.40)
Travel services	0.93 (3.29)	-0.08 (2.22)	-0.16 (8.28)	0.86 (3.36)
Financial services	1.01 (2.69)	0.00 (1.55)	-0.13 (2.75)**	0.98 (2.26)
Education	0.95 (3.41)	-0.06 (2.47)	-0.13 (2.75)**	0.61 (0.40)
Wholesale, retail, repair service	0.95 (2.58)	-0.05 (1.70)	0.03 (2.71)	0.87 (1.06)
Land transport	0.91 (4.73)	-0.10 (4.03)	-0.14 (4.56)	0.63 (0.44)
Legal and accounting services	0.94 (3.25)	-0.07 (2.29)	-0.13 (1.73)	0.56 (1.58)
Accommodation and food	1.06 (2.75)	0.05 (1.54)	-0.13 (3.43)	0.84 (0.28)
Water transport	0.92 (5.47)	-0.10 (4.77)	0.26 (7.37)	0.83 (2.93)
Telecommunication	1.06 (3.40)	0.04 (2.32)	-0.11 (2.36)	0.21 (0.95)
Air transport	0.92 (5.57)	-0.10 (4.87)	-0.45 (5.35)	0.63 (1.59)
Human health	0.95 (3.14)	-0.05 (2.06)	-0.13 (2.75)**	0.50 (0.70)
Recreation and culture	1.04 (2.85)	0.02 (1.50)	-0.13 (2.75)**	0.63 (1.24)
Postal and courier services	0.92 (4.64)	-0.09 (3.91)	-0.12 (3.22)	1.77 (10.70)
Sporting, recreation services	0.99 (2.86)	-0.04 (1.40)	-0.13 (2.75)**	0.56 (1.24)
Insurance	0.92 (4.63)	-0.09 (3.89)	-0.13 (2.75)**	0.98 (2.31)

Notes: Descriptive statistics are both reported at sectoral and aggregate level. Output gap is in level, other variables are in monthly percent change form. In the table, mean and standard deviations (in parentheses) are reported. The series are seasonally adjusted if deemed necessary.

* Domestic producer price index (D-PPI) is used for industrial sectors. However, for the service sector, the service price index, which is the sub-index of the CPI is used.

** The output gap could not be calculated for some sectors in the services group. In these cases the output gap calculated for the total service sector is used.

4. Methodology

4.1. VAR Framework for Pass-Through Coefficient Estimates

In estimating the pass-through coefficients for each industrial and services sector, we use vector auto regression (VAR) model approach following the lines of McCarthy (2007) paper, which is frequently used in the pass-through literature. We estimate separate VAR models for each sub-sector. As previously stated in Section 2, import prices in domestic currency has two components, import prices in foreign currency and exchange rate, which may exhibit distinctive movements at different times (Figure 8). Therefore, we include USD-denominated import prices and the USD/TL exchange rate, the key drivers of higher input prices, as two separate variables in our analysis. The main VAR model has 4 variables which include sectoral import price index denominated in USD, the USD/TL exchange rate, sectoral output gap and the sectoral D-PPI (sectoral CPI for the services sectors).

The ordering of the variables and the identification of shocks in the impulse-response analysis are based on Cholesky decomposition. Accordingly, import prices are assumed to be the most exogenous variable, which is followed by the USD/TL exchange rate, the output gap and the price indicator, respectively[9]. The shock for the variable at a particular stage is the part of that variable that cannot be explained by shocks of previous stages and information at period t-1. In the model, the variables do not affect the preceding variables contemporaneously, where their lagged values affect all variables. The shocks are assumed to be serially uncorrelated and orthogonal across equations. The model can be estimated by VAR after replacing expected values of each variable with the linear projections of the lagged values of all variables.

Against this background the model for industrial sectors can be estimated as follows:

Model 1: $(\pi_{I,t}^{IMP}, \Delta EXC_t, GAP_{I,t}, \pi_{I,t}^{PPI})$

$$\pi_{i,t}^{IMP} = E_{i,t-1}\left(\pi_{i,t}^{IMP}\right) + \varepsilon_{i,t}^{IMP}$$

$$\Delta EXC_t = E_{i,t-1}(\Delta EXC_t) + \alpha_{1,i}\varepsilon_{i,t}^{IMP} + \varepsilon_{i,t}^{EXC}$$

$$GAP_{i,t} = E_{i,t-1}\left(GAP_{i,t}\right) + \beta_{1,i}\varepsilon_{i,t}^{IMP} + \beta_{2,i}\varepsilon_{i,t}^{EXC} + \varepsilon_{i,t}^{GAP}$$

$$\pi_{i,t}^{PPI} = E_{i,t-1}\left(\pi_{i,t}^{PPI}\right) + \delta_{1,i}\varepsilon_{t}^{IMP} + \delta_{2,i}\varepsilon_{t}^{EXC} + \delta_{3,i}\varepsilon_{t}^{GAP} + \varepsilon_{i,t}^{PPI}$$

[9] We apply a different ordering than McCarthy (2007). We take the import prices as the most exogeneous variable since Turkey is a small open economy and is not able to affect the import prices in the world market.

where, π^{IMP} denotes the monthly percent change of import price in USD; ΔEXC is the monthly change of USD/TL rate; GAP represents the sectoral output gap and π^{PPI} stands for the sectoral D-PPI inflation. E_{t-1} (.) refers to the expectation of the variable based on the information set available at the end of period t-1. $\varepsilon_{i,t}^{IMP}$, $\varepsilon_{i,t}^{EXC}$, $\varepsilon_{i,t}^{GAP}$ and $\varepsilon_{i,t}^{PPI}$ represent shocks to import price index, the exchange rate, output gap and D-PPI, respectively. Finally, i stands for the industrial sectors and t denotes time.

Similarly, the model for Services sectors can be stated as follows:

Model 2: $(\pi_{I,t}^{IMP},\ \Delta EXC_t, GAP_{I,t}, \pi_{I,t}^{CPI})$

$$\pi_{i,t}^{IMP} = E_{i,t-1}(\pi_{i,t}^{IMP}) + \varepsilon_{i,t}^{IMP}$$

$$\Delta EXC_t = E_{i,t-1}(\Delta EXC_t) + \alpha_{1,i}\varepsilon_{i,t}^{IMP} + \varepsilon_{i,t}^{EXC}$$

$$GAP_{i,t} = E_{i,t-1}(GAP_{i,t}) + \beta_{1,i}\varepsilon_{i,t}^{IMP} + \beta_{2,i}\varepsilon_{i,t}^{EXC} + \varepsilon_{i,t}^{GAP}$$

$$\pi_{I,t}^{CPI} = E_{i,t-1}(\pi_{I,t}^{CPI})) + \delta_{1,i}\varepsilon_{t}^{IMP} + \delta_{2,i}\varepsilon_{t}^{EXC} + \delta_{3,i}\varepsilon_{t}^{GAP} + \varepsilon_{i,t}^{CPI}$$

The only difference from the model for industrial sectors is that we use the sectoral consumer price indices we construct, where $\pi_{i,t}^{CPI}$ denotes sector level consumer price inflation in the model instead of the sectoral producer price inflation.

Although we have introduced the main models for the pass-through analysis above, we have also estimated alternative VAR models in order to analyze the effects of using sectoral data instead of the aggregate. Other alternative VAR models estimated in this context are as follows.

Alternate Models for Industrial Sectors:

Alternate Model 1.1: $(\pi_t^{IMP\_TL}, \pi_{i,t}^{PPI})$

Alternate Model 1.2: $(\pi_{i,t}^{IMP\_TL}, \pi_{i,t}^{PPI})$

Alternate Model 1.3: $(\pi_{i,t}^{IMP\_TL}, GAP_t,\ \pi_{i,t}^{PPI})$

Alternate Model 1.4: $(\pi_{i,t}^{IMP\_TL}, GAP_{i,t},\ \pi_{i,t}^{PPI})$

where, $\pi_t^{IMP\_TL}$ refers to aggregate import price inflation in Turkish lira; $\pi_{i,t}^{IMP\_TL}$ represents the sector level import price inflation in Turkish lira. Correspondingly, GAP_t is the output gap for total industry and $GAP_{i,t}$ is the sector level output gap. $\pi_{i,t}^{PPI}$ denotes sectoral producer price inflation.

In Alternate Model 1.1, we estimate the pass-through effect of TL-denominated aggregate import prices, i.e. the compound effect of import prices and exchange rate. In Alternate Model 1.2, we investigate the effect of using sectoral import prices instead of general import prices on pass-through estimations. In Alternate Model 1.3 and 1.4, we include output gap measures in aggregate and sectoral level to understand how the pass-through estimates change after accounting for demand pressures.

The same alternative models are estimated for the services sectors, where consumer prices for services are used instead of producer prices[10].

Alternate Models for Services Sectors:

Alternate Model 2.1: $(\pi_t^{IMP\_TL}, \pi_{i,t}^{CPI})$

Alternate Model 2.2: $(\pi_{i,t}^{IMP\_TL}, \pi_{i,t}^{CPI})$

Alternate Model 2.3: $(\pi_{i,t}^{IMP\_TL}, GAP_t,\ \pi_{i,t}^{CPI})$

Alternate Model 2.4: $(\pi_{i,t}^{IMP\_TL}, GAP_{i,t},\ \pi_{i,t}^{CPI})$

The lag length selection for each VAR is made by the combined evaluation of various lag length selection criteria (FPE, AIC, SC and HQ). The selected lag lengths usually range between 1 and 3. The series are seasonally adjusted where necessary. In the VAR models the stationary forms of the variables are used. Except the output gap, all the variables are in monthly percentage changes.

5. Empirical Results

5.1. Pass-through Coefficient Estimations of Alternative VAR Models

5.1.1. Results for Industrial Sector

Table 2 reports the pass-through estimation results for industrial sectors. The pass-through coefficients show the response of sectoral domestic producer prices in percentage terms to 1 percent shock to indicated import price (IMPPT) and exchange rate (ERPT). We start the analysis with two variable VAR models (Alternate Model 1.1 and 1.2). Accordingly, we find that the use of sectoral import prices instead of aggregate import prices leads to different and more reasonable pass-through coefficients. In the next step, we observe that adding output gap indicator changes the TL-denominated import price

[10] Since the service group is a labor intensive sector, it is expected that wages should be included in the VAR analysis. However, since the real unit wage series are calculated on a quarterly basis, we couldn't include them in our monthly models.

pass-through estimates for some sectors (Alternate Model 1.3). In order to better cover the specific dynamics of each sector, the analysis next includes the sectoral output gaps (Alternate Model 1.4). Finally, the two components of import prices in TL, namely; import prices in USD and USD/TL exchange rate are captured separately in the model.

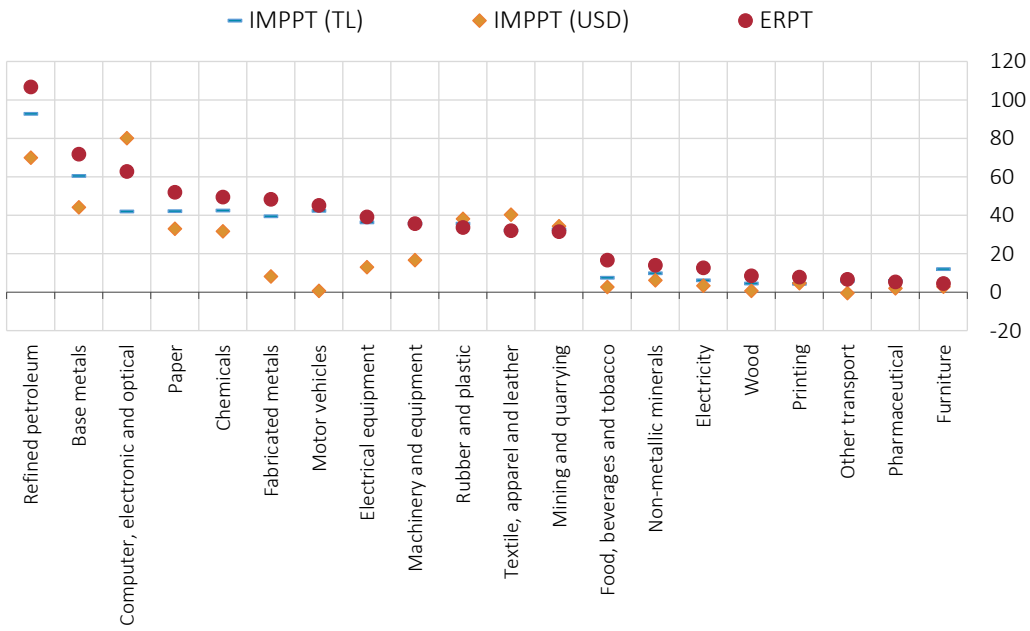
Table 2: Pass-through Estimates for Industrial Sectors (2010-2017) and Import Dependency

Variables in the VAR:	IMP (TL)	Sectoral IMP (TL)	Sectoral IMP (TL)	Sectoral IMP (TL)	Sectoral IMP (USD)		
	Sectoral PPI	Sectoral PPI	Output Gap	Sectoral Output Gap	USD/TL Exchange rate		
	-	-	Sectoral PPI	Sectoral PPI	Sectoral Output Gap		
	-	-	-	-	Sectoral PPI		
	(1.1)	(1.2)	(1.3)	1.(4)	(1.4a)	(1.4b)	
	IMPPT (%)	IMPPT (%)	IMPPT (%)	IMPPT (%)	IMPPT (%)	ERPT (%)	Import Dependency Ratio (%)
Refined petroleum	152.9	92.1	93.5	92.7	70.0	106.8	72.1
Chemicals	51.2	42.8	43.0	42.5	31.8	49.5	41.4
Base metals	84.2	60.6	60.2	60.4	44.3	71.8	35.3
Motor vehicles	35.2	41.8	42.8	42.4	0.7	45.2	32.6
Rubber and plastic	39.7	35.9	36.4	35.8	38.2	33.7	33.6
Paper	39.7	40.9	39.5	42.2	33.0	52.0	33.9
Computer, electronic and optical	46.5	50.9	42.5	42.1	80.2	62.8	34.5
Electrical equipment	34.8	36.4	36.4	36.3	13.0	39.1	26.6
Electricity	10.6	6.6	5.8	6.2	3.5	12.8	26.3
Pharmaceutical	11.8	13.0	4.1	5.9	2.0	5.3	25.5
Machinery and equipment	29.7	35.6	36.5	35.6	16.7	35.6	25.5
Other transport	4.2	5.3	2.7	5.8	-0.4	6.7	22.4
Printing	-2.5	3.1	2.9	4.4	4.8	7.9	22.1
Fabricated metals	41.3	39.7	40.0	39.5	8.3	48.4	18.9
Wood	5.5	5.5	6.7	4.5	0.7	8.6	18.2
Furniture	6.9	13.3	15.2	12.1	2.8	4.5	17.5
Textile, apparel and leather	31.8	31.8	32.1	32.2	40.3	32.1	15.2
Food, beverages and tobacco	9.2	7.4	7.9	7.6	2.7	16.7	13.3
Non-metallic minerals	22.1	14.8	8.8	9.9	6.1	14.0	13.0
Mining and quarrying	43.2	32.7	32.6	32.7	34.4	31.5	12.1

Notes: The pass-through coefficients show the cumulative response of sectoral domestic producer prices to a unit shock to indicated import prices (IMPT) or exchange rate (ERPT) at the end of 12 months.

The difference between exchange rate (ERPT) and USD-denominated import price pass-through (IMPPT) justifies our choice of disaggregating the effect of import prices and exchange rates (Figure 9). We see that they can differ to a large extent even in the same sector, and in general, the ERPT is higher than IMPPT.

Figure 9: Pass-through Coefficients (%) for Industrial Sectors (2010-2017)*



Notes: The figures are from columns 1.4, 1.4a and 1.4b of Table 2. Sectors are sorted from higher pass-through to lower pass through based on ERPT.

5.1.2. Results for Services Sector

Next we progress to the estimation results of the VAR analysis for services sectors (Table 3).

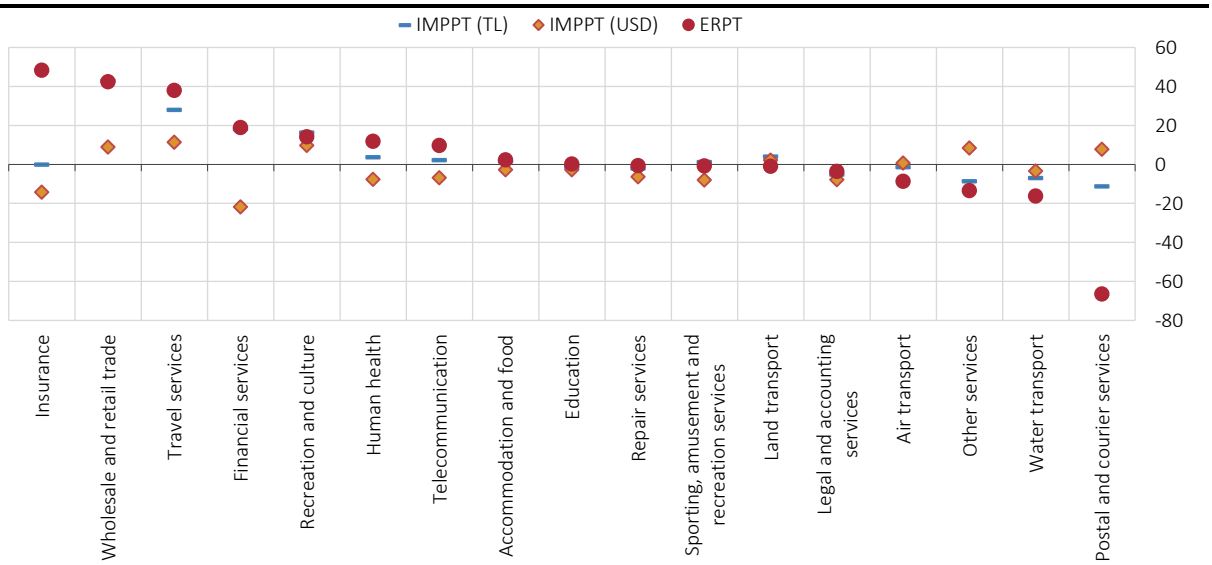
In the analysis, pass-through coefficients show the response of sectoral consumer prices in percentage terms to 1 percent shock to indicated import price (IMPT) and exchange rate (ERPT). The use of imported intermediate goods in services sector is less than industrial sectors, so pass-through effects are expected to be lower. While estimation results confirm this, regulated services prices may also distort pass-through estimations. The difference between exchange rate (ERPT) and USD-denominated import price pass-through (IMPPT(USD)) reveals the importance of disaggregation of external factors for services sector as well (Figure 10).

Table 3: Pass-through Estimates for Services Sectors (2010-2017)

Variables in the VAR:	IMP (TL)	Sectoral IMP (TL)	Sectoral IMP (TL)	Sectoral IMP (USD)		
	Sectoral Consumer Prices	Sectoral Consumer Prices	Sectoral Output Gap	USD/TL Exchange rate		
	-	-	Sectoral Consumer Prices	Sectoral Output Gap		
	-	-	-	Sectoral Consumer Prices		
	(2.1)	(2.2)	(2.4)	(2.4a)	(2.4b)	
	IMPPT (%)	IMPPT (%)	IMPPT (%)	IMPPT (%)	ERPT (%)	Import Dependency Ratio (%)
Repair services	0.4	0.6	-2.0	-6.3	-0.5	18.4
Other services*	-5.5	-8.6	-8.6	8.5	-13.4	12.7
Travel services	31.4	25.2	28.0	11.4	38.0	10.9
Financial services	8.5	11.2	18.1	-21.8	19.0	2.3
Education	-0.4	-1.0	-1.2	-2.6	0.3	1.2
Wholesale and retail trade,repair	35.1	41.3	42.9	8.9	42.5	13.1
Land transport	0.9	2.5	4.0	2.3	-0.9	12.5
Legal and accounting services*	-1.6	-3.7	-5.2	-7.8	-3.5	3.9
Accommodation and food	0.9	0.9	1.5	-2.6	2.3	6.6
Water transport*	-7.2	-9.3	-7.0	-3.4	-16.2	13.6
Telecommunication	3.8	0.6	2.2	-6.8	9.8	3.7
Air transport	0.8	8.3	-1.3	0.7	-8.7	17.6
Human health	8.7	3.6	3.8	-7.6	11.9	6.5
Recreation and culture	9.5	12.1	16.3	9.8	14.2	3.0
Postal and courier services*	-25.9	-10.4	-11.2	7.8	-66.4	5.1
Sporting, amusement and rec. ser.	0.7	1.7	1.2	-7.9	-0.8	4.8
Insurance	-7.6	-35.8	4.7	-14.2	48.4	12.7

Notes: The pass-through coefficients show the cumulative response of sectoral domestic consumer prices to 1 percent shock to indicated import price or exchange rate at the end of 12 months.
*Sectors having low frequency of price change or rather prices are regulated.

Figure 10: Pass-through Coefficients (%) for Services Sectors (2010-2017)



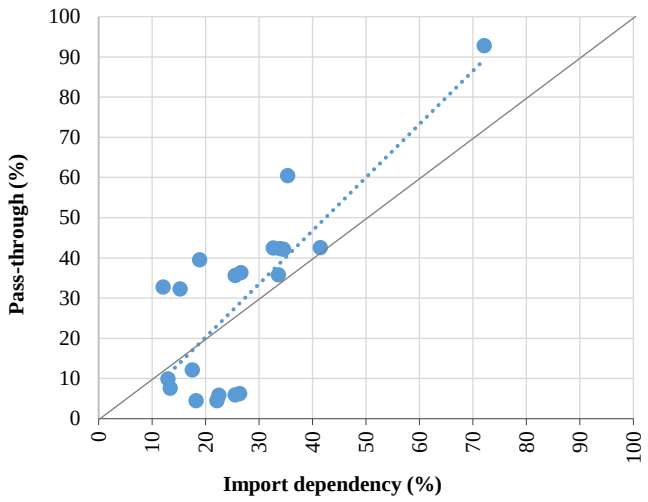
Notes: The figures are from columns 2.4, 2.4a and 2.4b of Table 3. Sectors are sorted from higher to lower pass through based on ERPT.

5.2. Does Imported Input Use Help Explain the Heterogeneity in Pass-through Coefficients?

5.2.1. Industrial Sectors

We first compare the import dependency ratios[11] with the pass-through coefficients estimated for the import prices in domestic currency in a 3-variable VAR setting for the post-2010 period depicted in Figure 11. The first observation is that there is sectoral heterogeneity in terms of import price pass-through in parallel to heterogeneity in import dependence, where the pass-through rate ranges from 4.4 % to 92.7 % in this sample period. A priori, the pass-through coefficients are expected to be similar to the share of import dependency across sectors. However, according to Figure 11, this expectation holds for only a few sectors and for majority of the sectors the import price (in TL) pass-through rates are different than the share of import dependency. Moreover, for some sectors, the pass-through is considerably higher than the share of imported costs. The linear trend (dashed line) shown in the scatter plot also implies that on average, the pass-through of import prices in TL to domestic prices is higher than the share of imported inputs.[12]

Figure 11. Import Dependency Ratio and Pass-through of Import Prices in TL (2010-2017)



Notes: The pass-through is the cumulative percentage increase at the end of 12 months in response to a 1 percent shock to import prices in domestic currency. The dashed line is the linear trend line meanwhile solid line is the 45-degree line. The figure shows the results of Table 2, column 1.4.

[11] The import dependency measure in the figure is the ratio of imported inputs to the sum of total intermediate consumption and compensation of employees.

[12] Especially the refined petroleum products sector stand out (top-right data point). On the other extreme, some sectors have lower pass-through than the share of import content. Among those is the electricity production. It should be remembered that the fact that the electricity prices are administered, it may not be detectable in simple VAR settings.

As already discussed in the introduction, the pass-through rates of the two components of the import prices in domestic currency (the exchange rate and the import price in USD) have different impacts on the transmission of cost shocks to domestic prices. Thus, we move to the results of the 4-variable VAR analysis where we separately estimate the exchange rate pass-through and the pass-through of import prices in USD to domestic prices (Figure 12 and 13). The first scatter plot (Figure 12) depicts the exchange rate pass-through and the import dependency ratio. Apart from the sectoral-wide heterogeneity, the exchange rate pass-through is significantly higher than the import dependence. In contrast, the pass-through of import prices in USD is less apart from the import dependency, on average (Figure 13). The linear trends in the scatter plots reveal that on average, the import price pass-through is close to the share of import dependency, meanwhile the exchange rate pass-through is, on average, sizeably higher than the import dependency ratio. Hence, these figures suggest that the divergence from the import dependency observed for the pass-through of import prices in TL in Figure 11, largely stems from the divergence in the pass-through of the exchange rate shocks.

Figure 12. Import Dependency and Exchange Rate Pass-through (2010-2017)

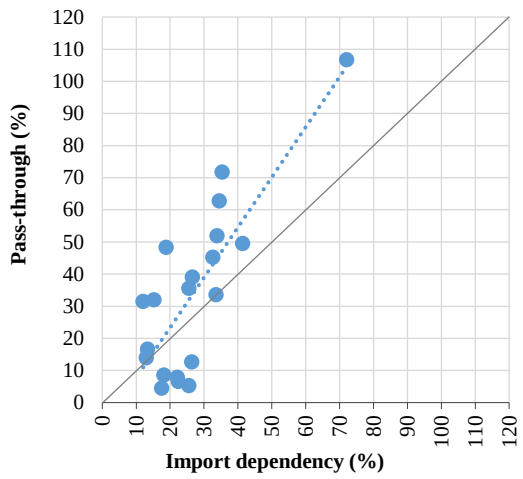
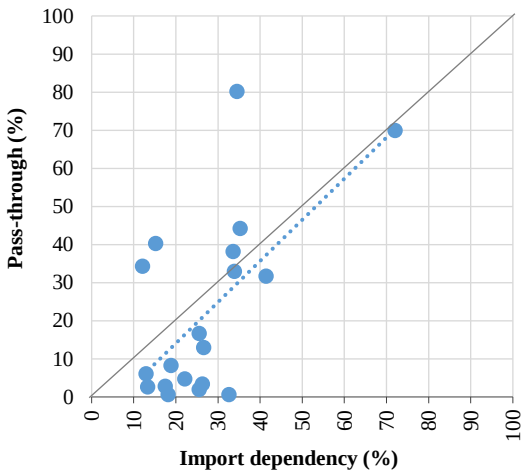


Figure 13. Import Dependency and Pass-through of Import Prices in USD (2010-2017)



Notes: The pass-through is the cumulative percentage increase at the end of 12 months in response to a 1 percent shock to exchange rate (left) and import prices in USD (right). The dashed line is the linear trend line meanwhile solid line is the 45-degree line. The figure shows the results of Table 2, columns 1.4a-1.4b.

A slightly different picture emerges when pre-2010 period, where the import dependency ratios are calculated from 2002 I-O tables, is considered. In that period, divergence of exchange rate pass-through from import dependency ratio is at a relatively smaller scale (Figure 14 and 15).

Figure 14. Import Dependency Ratio and Exchange Rate Pass-through (2005-2009)

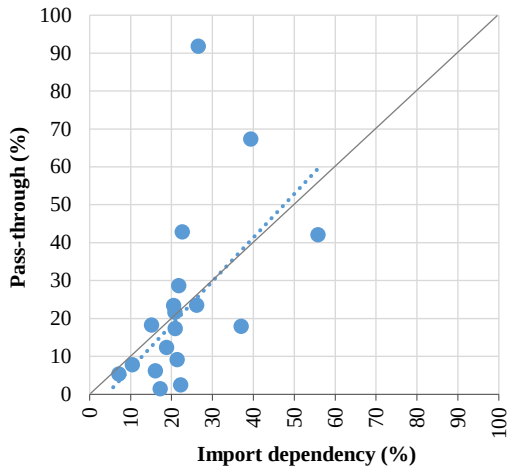
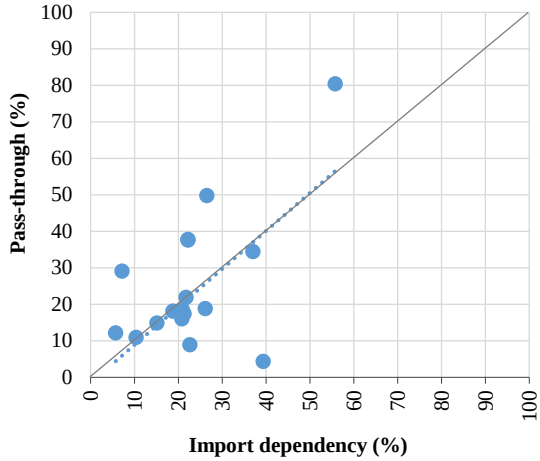


Figure 15. Import Dependency Ratio and Pass-through of Import Prices in USD (2005-2009)



Notes: The pass-through is the cumulative percentage increase at the end of 12 months in response to a 1 percent shock to exchange rate (left) and import prices in USD (right). The dashed line is the linear trend line meanwhile solid line is the 45-degree line. The figure shows the results of Model 1 for pre-2010 period (Table 2, columns 1.4a-1.4b estimated for pre-2010 period).

So far, we focused on the visual relationship between pass-through and the import dependency. Next, we run a set of pooled panel regressions of the pass-through coefficients on the import dependency. The results, shown in Table 4, reveal that in the full sample, the import dependency explains about half (one third) of the variation in exchange rate (import price) pass-through across sectors.

Table 4. Pass-through and Import Dependence

	2005-2017		2010-2017	
Dependent variable:	Exchange Rate PT	Import Price in USD PT	Exchange Rate PT	Import Price in USD PT
Import dependence	1.513***	1.064***	1.590***	1.038***
	(0.225)	(0.227)	(0.170)	(0.208)
Constant	-3.552	-0.229	-1.406	-1.635
	(4.861)	(4.956)	(6.280)	(6.839)
Observations	40	40	20	20
R-squared	0.470	0.341	0.628	0.330
Test beta(imp_dep)=1				
F-value	5.23	0.08	12.07	0.03
p-value	0.028	0.779	0.003	0.856

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Sample includes manufacturing and mining sectors. Full sample combines pre and post 2010 observations.

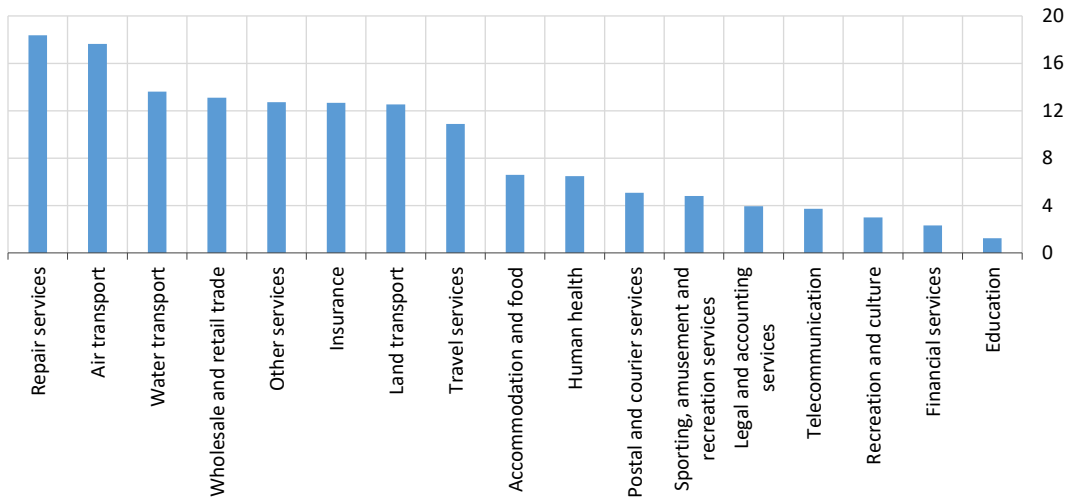
The F-test results (F-value and p-value) given in the last two rows of Table 4 show whether the coefficients estimated for import dependence in import price pass-through equations are statistically different than 1. Accordingly, it suggests that, on average, the

pass-through from import prices in USD to domestic prices is not different than the share of imported costs in total costs over the sample period. Meanwhile, these coefficients are statistically different (and higher) than 1 for exchange rate pass-through, suggesting that the exchange rate pass-through is on average much higher than the share of imported costs. This confirms the observation that the overshooting observed in first scatter plot (Figure 11) is due to the behaviour of the exchange rates. In Table 4, we also report the same set of regression results for the post-2010 sample period. The findings point to even higher coefficients on the exchange rate pass-through, with a much higher model fit. The import dependency by itself explains around two-thirds of the sectoral variation in exchange rate pass-through. In this sample period, even though the impact on exchange rate is higher, the correlation between the pass-through of import prices and import dependency is still one-to-one. The findings clearly reveal the divergent behavior of exchange rate pass-through to domestic prices.

5.2.2. Services Sector

Although mostly dependent on domestic inputs, some services sectors are also have a non-negligible share of imported input use in production costs. Figure 16 shows the imported input shares across services in the 2012 I-O tables.

Figure 16. The Intensity of Imported Input Use in Domestic Production of Services Sectors in Turkey (%)



Notes: The intensity of imported input use in domestic service (import dependency ratio) is calculated by dividing the value of imported inputs in the domestic use table by the sum of total intermediate consumption and compensation of employees.

Almost half of the sectors considered have at least 10% of imported inputs in their service provision, with repair services and airport transport being the highest. Figure 17a implies that the relation between import dependency and exchange rate pass-through is not strong. However, the VAR analyses reveal only a small number of sectors with significant pass-through. Figure 17b shows the services sectors which are subject to considerably high exchange rate pass-through. Overall, the exchange rate is not only an important element of pricing of industrial goods, but it is an important determinant of prices in some service sectors as well.

We could not repeat the same analysis regarding the import dependency and pass-through coefficients for services sector for pre-2010 period due to lack of monthly turnover data before 2009.

Figure 17a. Import Dependency and Exchange Rate Pass-through in Total Services (2010-2017)

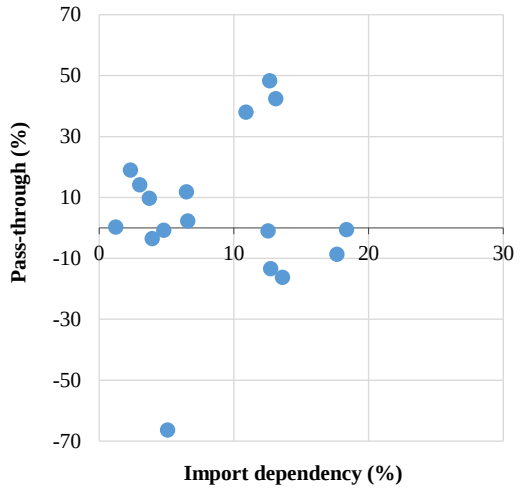


Figure 17b. Import Dependency and Exchange Rate Pass-through in Certain Services (2010-2017)

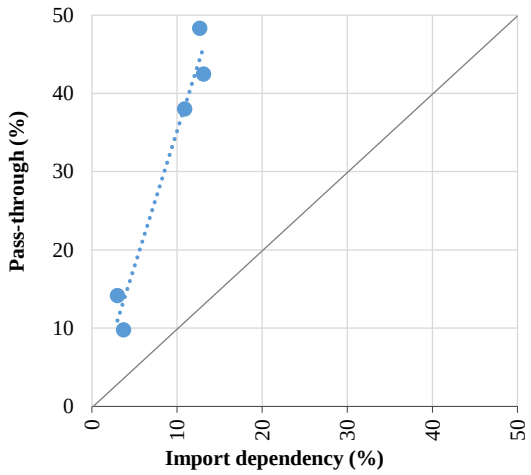


Figure 17a shows the results of Table 3, column 2.4a. Figure 17b instead covers only five sectors (insurance, wholesale and retail trade, travel services, recreation and culture and telecommunication) which are clearly sensitive to exchange rate where we observe significant exchange rate pass through.

5.3. Can Foreign Exchange Borrowing Help Explain the Sectoral Differences in Excess Exchange Rate Pass-Through?

Over the last decade a significant rise in the foreign currency borrowing across sectors has been witnessed. Given favorable international conditions, opportunities for lower cost borrowing and the scarcity of long-term borrowing opportunities in Turkish lira has motivated, in particular, industrial firms to borrow in foreign currency in order to finance investments. Given that their sales prices in the domestic market are in Turkish lira and debts being in largely in foreign currency, the pricing strategies of the sectors

may be affected especially in the periods of increased uncertainty regarding the exchange rate. In such periods, firms with a high share of foreign currency debt may wish to extend the size of the exchange rate pass-through compared to firms with less foreign debt in order to repay their debts. This motivation may even be stronger if the foreign currency debt is of short term.

To this end, we analyze whether there is an association between the excess exchange rate pass-through and the share of foreign currency debt (both in short term and total) in total assets of the firms across sectors. We define the excess exchange rate pass-through as the exchange rate pass-through minus the share of imported input use in production costs.[13] The data on sectoral foreign currency liability ratios are retrieved from The Banks Association of Turkey and Risk Center. The estimation results are given in Table 5. The cross-section evidence across sectors reveals that there is a statistically significant association between the share of foreign currency (FX) liabilities in total assets and the excess exchange rate pass-through. The impact is stronger with the short term liabilities. Also, when the share of total FX liability and the share of short-term FX liability are considered together, it appears that short-term liability share matters more. Accordingly, considering the last column of the estimations, a one percentage point increase in the share of short-term liability is associated with 2.3 percentage points rise in the excess exchange rate pass-through.

Table 5. Excess Exchange Rate Pass-through and the Share of FX liability (2005-2017)

Dependent variable:	Excess exchange rate pass-through					
FX liability (% of assets)	1.256***	1.214***			0.517	0.422
	(0.329)	(0.310)			(0.386)	(0.366)
Short term FX liability (% of assets)			2.999***	2.972***	2.145**	2.276**
			(0.886)	(0.779)	(1.012)	(0.892)
Import dependence		0.418		0.535*		0.490*
		(0.246)		(0.268)		(0.257)
Constant	-33.55***	-42.21***	-26.65***	-38.83***	-32.44***	-42.53***
	(7.757)	(9.594)	(6.007)	(7.501)	(8.557)	(9.179)
Observations	30	30	30	30	30	30
R-squared	0.295	0.320	0.351	0.392	0.372	0.406

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

[13] We assume that an exchange rate shock can only be transmitted into producer prices through the imported input use. Accordingly and theoretically, the share of imported input in total inputs should determine the size of the change in the total cost of production, given that exchange rate rise is fully passed-through to imported input cost in TL terms. This is why we are looking at the difference between exchange rate pass-through and imported input use as excess exchange rate pass-through. This measure can be considered as the difference between actual pass-through and theoretical pass-through.

The results point to the presence of an association between the foreign currency indebtedness and excess exchange rate pass-through. The FX liability data is available for 15 sectors and therefore we have 30 observations in total (15 sectors and two periods). Thus, the results reported in Table 5 should be considered as an indication of an association between the FX liability ratio and the excess exchange rate pass-through, rather than implying causality. Nonetheless, there is some evidence that deserves further investigation.

6. Conclusion

Over the last decades, increased integration of local economies to the global value chains, has led to a considerable rise in the share of imported inputs in domestic production. As a byproduct, the elevated use of imported inputs has also served as a factor increasing the responsiveness of an economy to import price and exchange rate shocks. In this framework, this study investigates to what extent the use of imported inputs weigh on exchange rate and import price pass-through to domestic prices in Turkey. To better understand the dynamics, we build on a sectoral level analysis incorporating manufacturing and services sub-sectors. We construct sector level imported input use, output gap, import price and domestic price indicators, which constitute an important contribution to the study. Later, we estimate sectoral level import price and exchange rate pass through coefficients using several VAR specifications.

Our first set of results, which focus on industry, reveals that there is a considerable amount of heterogeneity across sectors in terms of the size of the pass-through and that the pass-through of exchange rate shocks are in general higher than the pass-through of import price shocks in USD. More importantly, we find that while the extent of import price pass through is in line with the share of imported inputs use across sectors, the exchange rate pass-through is higher than the share of imported inputs in most occasions. Furthermore, the excess amount of exchange rate pass-through over imported input use has strengthened in the recent period. Results regarding the services point to several sectors with substantial level of exchange rate pass-through as well.

As discussed in the literature, although the use of imported inputs is the main source of exchange rate and import price pass-through, there are factors that can affect the extent to which foreign prices and exchange rates transmit into domestic producer

prices. In our analysis, we highlight the foreign currency debt as a channel that might have driven the excess exchange rate pass-through observed in the recent period in Turkey. Our empirical results suggest that the excess exchange rate pass-through (difference between the exchange rate pass-through and the the share of imported imputs) is associated with the high share of foreign currency debt in total assets, especially the short-term debt. Even though this finding comes from a limited number of observations due to data availability, the results deserve further investigation.

Overall, our results suggest that the intensive use of imported inputs *per se* help explain the heterogeneity in the pass-through of import prices to a large extent. However, its relation with the exchange rate pass-through is not one to one, suggesting that other factors also weigh on exchange rate pass-through. Considering the possible impact of foreign currency debtedness, the management of foreign exchange liability turns out to be critical to enhance the effectiveness of monetary policy and to create room for maneuver to fight against inflation by reducing the excess exchange rate pass-through.

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Appendix:

Table A1. Input-Output Tables in Turkey

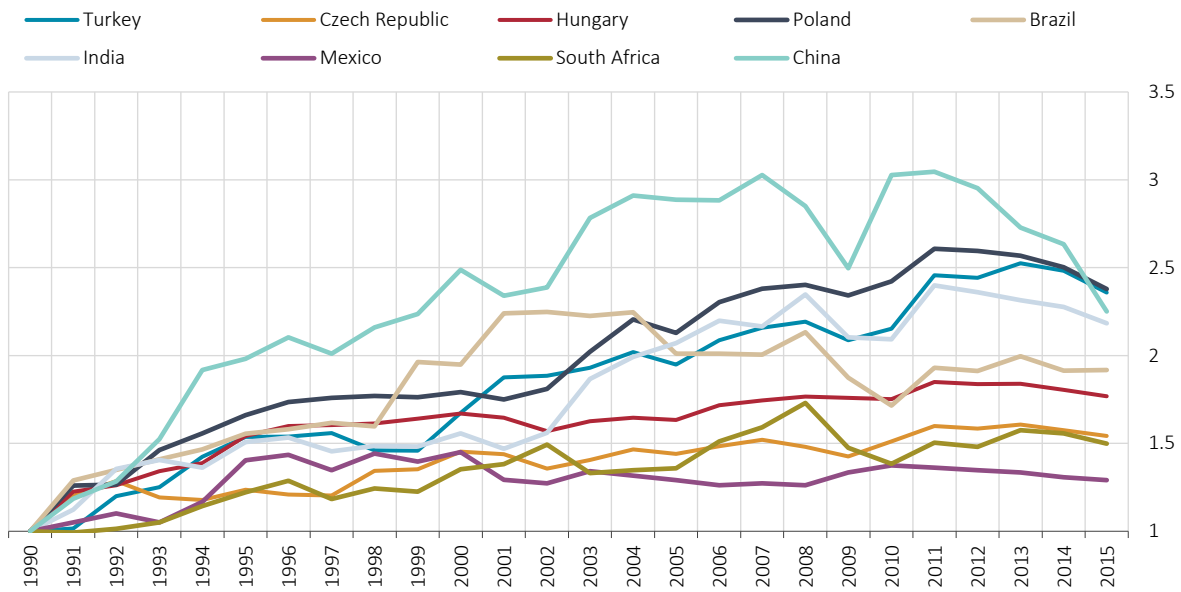
Stylized Input Output Table

		Products				Total	Final Use			Total Use
	Sectors	Agriculture	Industry	Construction	Services		Consumption	Investment	Exports	
Products	Agriculture	Intermediate Domestic Input Use (1)					Final Demand (2)			
	Industry									
	Construction									
	Services									
	Total Intermediate Domestic Input	(1)								
Primary Inputs	Imports	Imported Input Use (3)								
	Total Intermediate Input Use	(1) + (3)								
	Compensation of Employees	(4)								
	Other Taxes and Subsidies	(5)								
	Value Added	(6)								
	Total Production	(1) + (3) + (4) + (5) + (6)								

Table A2: Data Definitions and Sources

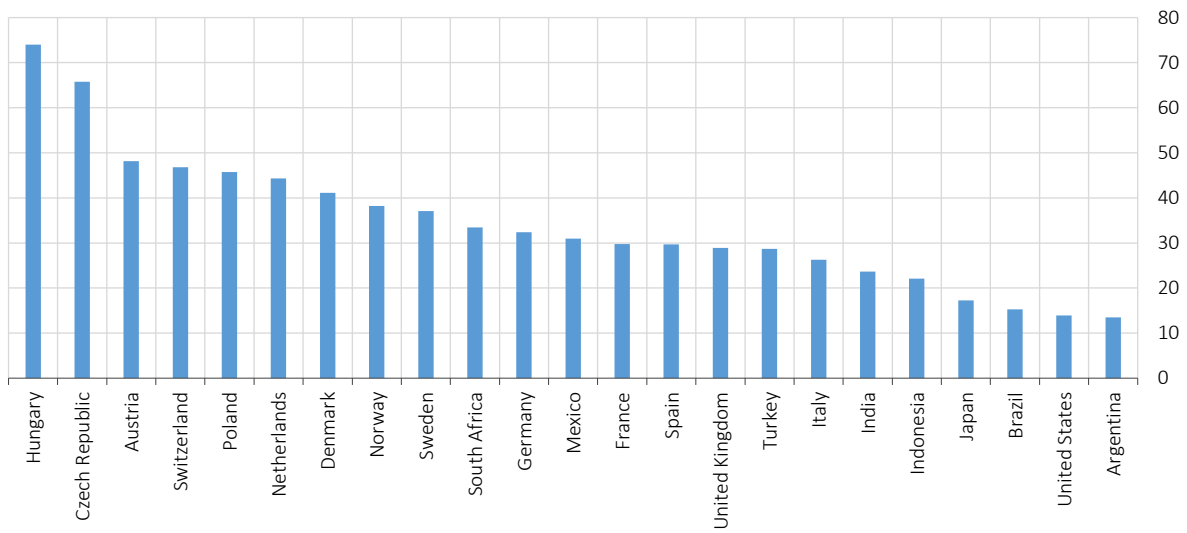
Variable	Description	Source
Inflation	Monthly percentage change of seasonally adjusted domestic producers price indices (D-PPI) and services prices in CPI.	TURKSTAT
Inflation (sectoral)	Monthly percentage change of seasonally adjusted sectoral price indices	TURKSTAT, Authors' calculations.
Import Prices (aggregate)	Monthly percentage change of the import price index, in TL and USD	TURKSTAT
Import Prices (sectoral)	Monthly percentage change of the sectoral import price index for(in TL and USD)	TURKSTAT, Authors' calculations.
Output Gap (aggregate)	Logarithmic difference of seasonal and calendar adjusted industrial production index from the Hodrick-Prescott filtered trend.	TURKSTAT
Output Gap (sectoral)	Logarithmic difference of seasonal and calendar adjusted sectoral production/turnover index from the odrick-Prescott filtered trend	TURKSTAT, Authors' calculations.
Exchange Rate	Monthly percentage change of the monthly average value of nominal TL/USD.	TURKSTAT
Import Dependency Ratio	The value of imported inputs in the domestic use table is divided by the sum of total intermediate consumption and compensation of employees	TURKSTAT, Authors' calculations.
FX Liability	Total Bank Loans in Foreign Currency	The Banks Association of Turkey and Risk Center

Figure A1: Share of Foreign Value Added in Value Added of Exports (%) (1990=1)



Source: UNCTAD-EORA database

Figure A2: Foreign Value Added in Final Demand (2015) (%)



Source: OECD, TIVA (Trade in Value Added) database, 2018 and author's calculations.

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