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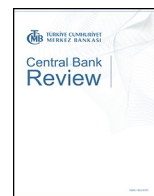
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Import Content of Turkish Production and Exports: A sectoral analysis¹

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ABSTRACT

This study investigates the evolution of the import content of production and exports in Turkey for the 2002–2018 period. Based on 2002 and 2012 input-output tables and a large data set of production and foreign trade, we estimate the production and imported input use for 20 sectors, mainly from the manufacturing industry. We calculate import requirement ratios, comprising both direct and indirect effects, for each sector using the Leontief inverse matrix. Our findings indicate that import dependency increases for exports, but stays relatively stable for production over time. In general, the import content of production is lower than that of exports. This difference is mainly attributable to the services sector, which has low import dependency, yet a large share in production. Sectors with the highest import requirements are those with higher capital and technology intensity, such as petroleum products, basic metals, and motor vehicles. Agriculture, forestry and fishery; services and mining sectors have the lowest import requirements.

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1. Introduction

Imported intermediate goods constitute roughly three fourths of Turkey's total imports, indicating a widespread use of imported inputs in domestic production. This can partly be explained by the globalization and integration trends to the global value chains in recent decades. As a matter of fact, Turkey has attracted a considerable amount of foreign direct investment in the past two decades.

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¹ The views expressed in this paper are only those of the authors and should not be interpreted as reflecting the views of the Central Bank of the Republic of Turkey or its staff.

² Foreign direct investments (FDI) to Turkey increased sevenfold between 2000 and 2018. The manufacturing and services sectors constituted around 53 and 36 percent of total FDI in the early 2000s, respectively. This composition has changed in favour of the services sector over time. Between 2015 and 2018, the average share of the manufacturing sector in total FDI was 30 percent, while that of the services sector was 59 percent. Thus, the argument for the role of FDI in promoting the use of imported inputs is more valid for the earlier period. We provide the sectoral breakdown of FDI in Appendix Table A1.

The entrance of large multinational and foreign-owned firms contributed to the strengthening of trade ties with global suppliers and increased the imports of intermediate goods in the industrial sector.¹ Another explanation is that, over the years, necessary inputs for production in Turkey either were not produced in sufficient amounts domestically or necessitated certain skills and technologies that were not acquired by local firms.² Price and quality advantages were additional factors that fed the upward trend in imported inputs, which in turn led import dependency to become a structural characteristic of the Turkish economy.

The degree of import dependency and its evolution over time are important issues for developing countries, especially for those that run current account deficits. From a macroeconomic perspective, extensive use of imported inputs in production has a

² The automotive industry serves as a good example for both cases. As one of the main exporting sectors, Turkey's automotive industry started with assembly-based production and gravitated towards technological development, gradually evolving as an industry with design capability and high added value.

direct influence on several economic relations. Some important ones among these are exchange rate elasticities of exports and imports, pass-through of import prices to domestic prices³ and trade gains from changes in foreign demand.⁴ In this context, Turkey's current account experience in the past two decades serves as an example. Import dependency contributes to deterioration in the current account balance especially during high growth periods,⁵ and limits the price gains from currency depreciation. Moreover, it lengthens out the rebalancing of the current account during TL's depreciation periods.⁶ Despite these dynamics, we observe an improvement in the current account balance in recent years on the back of more competitive real exchange rates.⁷

Input-output analysis is a practical approach to examine the import content of production and exports. Input-output tables (IOTs) provide information on the structure of production through the linkages between different sectors within an economy and with the rest of the world. Ideally, the availability of IOTs on a regular basis would make it easier to trace the changes in the degree of import dependency over time. But in practice, many countries publish them irregularly and even if they do, with low frequency.⁸ Hence, in empirical studies, the analysis of import content either provides a snap-shot of the situation in those years that IOTs are available; or involves their estimation based on different techniques and other available data for the remaining years.

In this study, we aim to examine how the import contents of production and exports change in Turkey from 2002 to 2018. Using the most recent IOTs for 2002 and 2012, we estimate the production and imported input use for the remaining years based on a large data set of production and foreign trade for 20 selected sectors, most of which operate in the manufacturing industry. We then calculate the import requirement ratios for each sector.⁹ We define the import requirement ratio as the ratio of imported inputs in total inputs and we consider both direct and indirect reliance on imported inputs in our calculations. In other words, we also take into

account the imported content of domestic inputs involved in the former stages of their production. We use the Leontief inverse matrix to approximate these higher degree import dependency effects. We estimate the import dependency of production in Turkey as the weighted average of the import requirement ratios of each sector weighted by the sector shares in total production for each year. Similarly, we use the share of each sector in total exports as the weighting factor while estimating the import dependency of Turkish exports.¹⁰

Our findings indicate that the import content of exports follows an upward trend during the examined period, major increases occurring between 2002–2007 and 2016–2017, and recording a downturn during the global financial crisis. The import content of production, on the other hand, stays relatively stable for the Turkish economy. There is also a level difference between the two, import content of production being considerably lower. We attribute this difference to the services sector, which has relatively low import dependency, but a significant share in production. On the other hand, there exists a significant heterogeneity among sectors in terms of the import content. Sectors with the highest import requirements are the ones with higher capital and technology intensity, such as coke and refined petroleum products, basic metals, and motor vehicles. Agriculture, forestry and fishery; services and mining sectors are found to have the lowest import requirements.

The first contribution of our paper is that we propose a unique methodology to approximate imported input use for any given year, based on the previously published official IOTs and a wide range of micro and macro level statistics. Our methodology in estimating these figures exploits some practical assumptions that we describe in Section 3. In that respect, it serves as a useful guide for extracting economic indicators from IOTs such as import dependency even when there is no officially published table, and for applying a similar analysis to other country cases. The second contribution of our paper is that it fills a large gap in the related literature by shedding some light on the evolution of import dependency in the Turkish economy during the more recent years. Our quantitative findings between 2002 and 2018 provide new insights at both sectoral and aggregate levels for not only researchers interested in the field, but also for policymakers in the decision making process.

The rest of the paper is organized as follows. Section 2 provides a brief literature review. Section 3 presents the data and methodology. Section 4 provides the findings, and Section 5 concludes.

2. Literature review

What we know about import content of production is largely based on empirical studies that examine the import dependency at the firm and sectoral levels. Some recent studies provide evidence regarding the benefits and costs of outsourcing inputs from abroad. Price and quality advantages and productivity gains are the main benefits highlighted in the literature (See Halpern et al. (2015) for Hungarian firms, Feng et al. (2016) for Chinese firms, Imbruno and Ketterer (2018) for Indonesian firms). On the contrary, several other studies emphasize the costs of using imported inputs, which mainly translate to loss in domestic innovation and labor market distortions, such as a decline in employment (See Liu and Qiu (2016) for Chinese firms and Boehm et al. (2017) for US firms).

³ A higher import content of production is associated with higher pass-through from import prices to domestic prices. See Akgündüz and Fendoğlu (2019) and Ertuğ et al. (2020) for recent evidence.

⁴ A higher import dependency of production decreases net trade gains from a rise in foreign demand. Conventionally, we would expect a decline in the trade deficit due to an increase in exports when foreign demand is strong. However, if the import requirement ratio is high, imports of additional intermediate goods stimulated by foreign demand would likely lower potential trade gains.

⁵ Imported intermediate goods is the main component of the foreign trade deficit in Turkey, which drives the current account deficit. Excluding the intermediate goods, in fact, there is a trade surplus. In general, the imports of intermediate goods are positively related to economic activity. The correlation coefficient for imports of intermediate goods and gross domestic product (both in seasonally-adjusted volumes and as deviations from trends) is 0.68. See Appendix Fig. A1 for plots of the series.

⁶ Although we mainly mention the negative impacts of import dependency, there is also evidence in the literature that suggests higher import content is associated with higher productivity and innovation, such as Halpern et al. (2015) and Bloom et al. (2016).

⁷ Even in 2020, current account balance follows a more moderate course compared to its dynamics in the past, despite the disruption in exports and the sharp decline in tourism revenues due to the coronavirus outbreak.

⁸ See Erduman et al. (2012) for a large coverage of IOT country practices.

⁹ The terms and definitions we adopt in this study are as follows. First, the direct import requirement ratio is the ratio of the value of imported inputs (in nominal TL) that are directly used in the production process to the value of total production (in nominal TL). Second, the indirect import requirement ratio is the value of imported inputs that are used in the former stages of production of domestic inputs as a ratio of the value of total production in nominal TL. (All domestically-produced inputs may have some degree of import content since their production may also involve the use of imported inputs.) The import requirement ratio for a given sector is defined as the sum of these direct and indirect import contents. Finally, the import dependency is the weighted average of sectoral import requirement ratios and is calculated for production and for exports separately.

¹⁰ With regards to the estimation of import dependency of exports, there is arguably the issue of re-exports. These are the final consumption or capital goods that are imported to Turkey and exported without any added-value. Unfortunately the currently available data does not enable us to quantify re-exports, although we believe they are fairly low. Hence, re-exports are beyond the scope of this study. However, it is worth mentioning that our estimates for import dependency of exports can be regarded as a lower bound if re-exports were to be considered.

The empirical literature regarding the estimation of import content follows two main approaches. The first approach, which we also employ, uses input-output analysis and matrix algebra to derive the direct and indirect use of imported inputs in production through the Leontief Inverse matrix.¹¹ The second approach, which is less common, uses the aggregate level statistics to calculate some indicators with regards to import dependency. While the former approach is advantageous to the latter by also taking into account the linkages among sectors, it has a limitation. Calculations cannot be undertaken if an official IOT is not available for a given year. Thus, it requires the estimation of an approximate IOT for a given year in which an official IOT is not published. Rueda-Cantuche et al. (2017) state that using the IOT structures of previous years usually performs better than any other approach for the estimation of IOTs from a statistical perspective. This is mostly because IOTs gather detailed country specific information that is not expected to change in the short term. We employ a similar approach in our analysis to generate the IOTs of Turkey for the missing years.

There is an extensive empirical literature that focuses on import dependency and vertical specialization in trade that uses input-output analysis. Breda et al. (2008) examine the import content of exports for seven European countries and provide estimates for the degree of internationalization, the extent to which firms use inputs from international suppliers. Combining the IOTs with international trade data, Amador and Cabral (2009) develop a vertical specialization measure and test it on a large dataset of 79 countries. Their results suggest a substantial increase in vertical specialization in high-technology products and in East Asia. Anós-Casero and de Astarloa (2010) investigate the degree of vertical specialization in exports in Argentina. Bravo and Álvarez (2012) analyze the import content of industrial sectors in Spain and conclude that the degree of import dependency of Spain's production exceeds that of the main euro area economies.

As for Turkey, most of the literature on import content uses IOTs. The majority of these empirical studies are based on 2002 and/or earlier tables.¹² Şenesen and Şenesen (2003) examine the import dependency of production from the 1970s to the 1990s in the context of economic policies. Using IOTs of 1973, 1985, and 1996, they investigate the structural changes in the economy and provide evidence that import dependency of production increased gradually after abandoning import substitution policies. Their findings suggest that the rise was 33 percent from 1973 to 1985, while it was more limited between 1985 and 1996. They also argue that production is more dependent on intermediate imports in technology and energy intensive sectors and that import dependency increased in leading export sectors like agriculture, textiles, and food in the post-1980 era.

Yükseler and Türkan (2006) provide evidence indicating sector level heterogeneity in terms of import content of production for the Turkish manufacturing industry. They estimate an import dependency of 21.8 percent in manufacturing using the 1998 IOT. Their findings suggest that import requirement ratios are above the industry average for the sectors of basic metals; chemical products; electrical machinery-equipment; plastic-rubber products; furniture; communication and radio-TV devices, and medical, precision and optical devices. In addition to IOTs analysis, they compute several aggregate level indicators such as imports/production,

imports/total supply, exports/production and exports/total supply to examine the structural change in the manufacturing sector and quantify the degree of import dependency.¹³ They report that the Turkish economy became more integrated into the global trade after the Customs Union and more import dependent.

Several other studies draw upon aggregate level statistics. Using survey and interview based data for 145 large-scale manufacturing firms; Saygılı et al. (2014) investigate the factors that lead to an increase in the use of imported intermediate goods. They list three main determinants of imported input use in production as (i) access to intermediate and investment goods of higher quality, (ii) supply of those goods at lower prices, and (ii) existence of multinational firms and foreign capital investments. In an earlier study, Saygılı et al. (2012) use IOTs in addition to survey based data and examine the import dependency in the 1998–2007 period. For the years between 1998 and 2002, they use the official IOTs and find that import content of production in manufacturing increased five points during the period, from 22.2 percent in 1998 to 26.7 in 2002. They make inference for the years between 2002 and 2007 using the survey data. At the sectoral level, their findings indicate that import dependency increased for most of the products. However, they report that the upwards trend of import content of production is not specific to Turkey.

On the other hand, there is limited evidence on how import dependencies in sectors have evolved in the more recent period, or on the current levels they have reached. Özcan-Tok and Sevinç (2019) calculate sectoral import dependency ratios from 2002 to 2012 IOTs and find that the import content of total production increased from 16.1 percent in 2002 to 19.3 percent in 2012. Regarding the extent to which Turkey participates in vertical trade chains, their results indicate a vertical specialization rate of 30.2 percent for 2012. Akgündüz and Fendoğlu (2019) paper is also related to ours as they estimate import dependency, even though they use micro-level datasets instead of the IOT framework. Unlike our definition, they define the import dependency as the ratio of the value of imported inputs to the total cost of production to examine its impact on exchange rate pass-through. They argue that the degree of import reliance reaches nearly 45 percent for exports once firms' domestic supply networks are taken into account and that it remains roughly unchanged between 2007 and 2016, diverging from the common findings of the previous studies. Our paper differs from theirs, since it provides additional insights for the evolution of import content in Turkey, covering a more extensive time period and emphasizing sectoral differentiation.

With regards to Turkey's relative position among other emerging and developing economies (EMDEs) in terms of import dependency, OECD (2020) statistics provides a ground for comparison.¹⁴ According to the OECD estimates for import content of gross exports in 2016, Turkey's import content of exports is below the average of 28 EMDEs in the database. Turkey's import dependency ranks below countries like China, South Africa, Poland, Thailand, Mexico, and Hungary. On the other hand, it is above the import dependency of countries like Saudi Arabia, Peru, Brazil, Russia, Chile, and India. The comparison of Turkey and other EMDEs' positions suggests that net-commodity-importer countries generally have higher import dependency. Turkey, as a net commodity-importer, performs relatively better, with a lower

¹¹ Section 3 provides more details.

¹² The official IOTs published by the Turkish Statistical Institute (TurkStat) are for 1985, 1990, 1998, 2002, and 2012 in chronological order.

¹³ The last two indicators are also used by Aydın et al. (2007). They calculate those ratios for Turkey, Czech Republic, Hungary, Poland and Slovakia to compare the import dependency of exports in each country.

¹⁴ According to the OECD (2010, 2020) methodology, the latest figure for the import content of Turkish exports is estimated as 16.5 percent for 2016. However it is worth noting that the OECD's definition for the import content of exports is different from ours. While we use sector shares in total exports as the weighting factor in calculating the import dependency of exports, OECD uses sector shares in production. In this respect, OECD's definition is more comparable to our calculations for the import content of the production.

import dependency, when we only consider the commodity-importer EMDEs. In addition, statistics indicate that Turkey's import content of gross exports has stayed relatively stable since 2006, while the average import dependency of the EMDEs has decreased in the same period.

In a nutshell, empirical studies on the import content of the Turkish economy broadly agree on two main conclusions. The first is that the average import content of production is around one-fourth in the manufacturing sector. The second is that import dependency has increased since the 1980s but stayed relatively stable in the past decade. Frankly, all previous studies that use official IOTs calculate import dependency only for the years that the data is available. Given that the latest IOT was published in 2012 and the previous one was a decade earlier, we have limited information on the evolution of import content in Turkey in-between period. Our knowledge is even less when more recent period is considered, since there is no data for those years after 2012. In the next chapter, we propose a methodology to calculate the import content for all years between 2002 and 2018. In this sense, our paper is distinguished among the others.

3. Data and methodology

The foundation of our paper rests on input-output analysis. Originated by Leontief, the input-output analysis reveals the production-related interdependencies between different sectors within an economy and with the rest of the world. An input-output table includes a series of rows and columns of data that quantify the supply chain for all sectors of an economy. Product groups corresponding to specific sectors of the economy are listed in the headers of each row and each column. The data in each column gives the levels of input use by that sector from other sectors.

The two most recent IOTs for the Turkish economy published by the Turkish Statistical Institute (TurkStat) are available for 2002 and 2012. Our analysis covers between 2002 and 2018, based on these two tables. We estimate the figures for the other years in the period according to the methodology we describe in this section. First, we calculate the estimates of output for production at current prices for each year. Then, the value of imported inputs is obtained by using the relevant trade statistics. Finally, we calculate the direct and indirect import requirement ratios of each sector.

In the IOTs, the product categories are related to activities as defined by the statistical classification of economic activities in the European Community (NACE). To begin with, we identify 20 sector categories from the NACE Economic Activity classification. These sectors can mainly be classified under three groups; (i) agriculture, forestry and fishery (ii) manufacturing industry and (iii) services. The selection is made based on the sector categories corresponding to the product groups (CPA - Classification of Products by Activity) in the 2012 IOT. Since the classification in 2002 and 2012 are different, and the 2002 IOT presents a more detailed classification in manufacturing sectors, some product groups are merged to ensure the compatibility of the IOTs, as shown in Table 1.¹⁵

To estimate the production values for the 20 selected product groups (hereafter referred to as sector) in each year, we first get the production values for each sector from the 2002 and the 2012 IOTs. Then, for the manufacturing industry and the services sectors, we calculate the production values between 2003 and 2018 based on the annual growth rate of production of each corresponding sector

in TurkStat's Industry and Service statistics. Since TurkStat's Industry and Services statistics do not cover agriculture, forestry and fishery, we estimate the production values of these sectors based on Gross Domestic Product (GDP) data. The National Accounts framework classifies these three sectors under one item. Accordingly, we use the nominal annual GDP growth rate of this item to estimate the current production value of these three sectors combined.

The second stage of the procedure deals with the estimation of imported input usage. The imported input values for 2002 and 2012 are taken from import IOTs. For the remaining years, we follow a four-step methodology as described below:

- In the first step, from the 2002 and 2012 IOTs, we calculate the sectoral usages and corresponding distributions of imported intermediate goods for each of the 20 product groups separately. This shows the sectoral breakdown of inputs that a given sector provides to other sectors. For example, in 2012, 25.7 percent of the total imported intermediate goods of the chemicals sector was used by the chemicals sector itself. It provided 20.9 percent of the imported intermediate goods to the rubber and plastic products sector, 13.1 percent to the textiles, apparel and leather products sector, and the rest went to other sectors.
- In the second step, we use linear interpolation to calculate the sectoral distributions of imported intermediate goods that a given sector provides to other sectors for the years between 2002 and 2012. For the years beyond 2012, we assume that the percentage usages of imported intermediate goods for each sector stay the same. This approach stands on the assumption that the percentage usages of imported intermediate goods by sectors exhibit only a gradual change over the years, as suggested in Rueda-Cantuche et al. (2017).¹⁶ Turning back to the example, the share of imported intermediate goods of the chemicals sector used by the chemical sector itself has increased from 23.2 in 2002, to 25.7 in 2012. Therefore in calculations, the share is assumed to increase by 0.25 points each year.
- The third step involves most of the data mining. From the TurkStat External Trade Statistics, we obtain import data classified according to the Harmonized Commodity Description and Coding Systems (HS) at 6 digit level for each year. Then, we match each product item at HS 6-digit level with its corresponding Broad Economic Categories (BEC) classification to determine which items are intermediate goods. This conversion is made using HS to BEC correspondence tables for over 5000 items each year. The items identified to be imported intermediate goods are selected. Next, they are allocated to the sector categories according to the International Standard Industrial Classification (ISIC) using HS to ISIC conversion tables. The matching of these sectors with the corresponding sectors (provided in Table 1) gives us the value of imported intermediate goods for each sector every year.

¹⁵ In the 2012 table, there are 64 products that are classified according to CPA 2008. 19 of these products belong to the manufacturing industry. In the 2002 table, there are 59 products that are classified according to CPA 2002, of which 22 belong to the manufacturing industry.

¹⁶ Rueda-Cantuche et al. (2017) examine a few methods for the estimation of domestic and import use tables at basic prices in the absence of official IOT data with a selection of auxiliary information from national statistical offices in the European context. For providing an indication of how much their estimates fit the reality, they assess the results against the official Supply, Use, and Input-Output tables of Belgium, Germany, Italy, Netherlands, Finland, Austria, and Slovakia by using matrix difference metrics. Their main conclusion is that using the IOT structures of previous years usually performs better than any other approach, mostly because they gather detailed country-specific information that is not expected to change in the short term. They also note that their analysis is carried out within the EU context because of the availability of additional homogenous data, but it can be used as well in non-EU countries provided the same data are available.

Table 1

Selected sectors according to 2002 and 2012 IOT product group classification.

Product Groups	2012 (CPA 2008)	2002 (CPA 2002)
Agriculture, forestry and fishery	A01 + A02 + A03	1 + 2+3
Mining and quarrying	B	10 + 11+12 + 13+14
Food, beverages and tobacco products	C10 + C11 + C12	15 + 16
Textiles, wearing apparel and leather products	C13 + C14 + C15	17 + 18+19
Wood and wood products	C16	20
Paper and paper products	C17	21
Printing and recording	C18	22
Coke and refined petroleum products	C19	23
Chemicals and chemical products	C20	24
Rubber and plastic products	C22	25
Other non-metallic mineral products	C23	26
Basic metals	C24	27
Fabricated metal products, except machinery and equipment	C25	28
Computer, electronic and optical products	C26	30 + 32+33
Electrical equipment	C27	31
Machinery and equipment	C28	29
Motor vehicles, trailers and semi-trailers	C29	34
Other transport equipment	C30	35
Furniture and other manufactured goods	C31 + C32	36
Services (Other Sectors)	Rest of the above	Rest of the above

Note: This table provides the corresponding Classification of Products by Activity (CPA) codes for each product group in Input-Output Tables.

- In the fourth step, we take the product of the sectoral shares of imported intermediate goods constructed in the second step and the value of imported intermediate goods in the third step for each of the sectors and for every year. This product gives us the values for imported inputs.

In the third and final stage of our analysis, we estimate the direct and indirect import requirement ratios for each sector, as in [Loschky and Ritter \(2006\)](#) and [Saygılı et al. \(2012\)](#). The ratio of the value of imported intermediate goods (in nominal TL) to the value of production (in nominal TL) for a given sector is called the direct import requirement. On the other hand, in addition to imported inputs, all sectors rely on domestically-produced inputs from other sectors, the production of which may also involve the use of imported inputs. Thus, all domestic inputs may have some degree of import content. The indirect import content measures the indirect value of imported inputs that are used in the production of domestic inputs as a ratio of the value of total production in nominal TL. In other words, the indirect import requirement content takes into account the import content of domestic inputs as well, through the imported raw materials involved in the former stages of their production. The import requirement ratios represent the imports required by total production, for both domestic demand (consumption and investment) and foreign demand (exports), as in the “open” Leontief model formulated by [Leontief \(1944\)](#). In other words, it is assumed that the products for domestic use and foreign markets are homogenous and have similar production structures, in terms of the import content.

In the model, the intermediate consumption of sector i from sector j is a certain share of the total production of sector i .

$$X_{ij} = a_{ij}X_j \text{ such that } 0 < a_{ij} < 1 \quad (1)$$

The sectoral production vector (X) is the total of intermediate product consumption and final product consumption (Y) of all sectors.

$$X = AX + Y \quad (2)$$

X can be solved as

$$X = (I - A)^{-1}Y \quad (3)$$

here, X is a 20×1 dimensional vector that comprises the output of 20 sectors. I is a 20×20 dimensional identity matrix. Y is a 20×1 dimensional vector that comprises the final product consumption of 20 sectors. A represents the Leontief technical coefficients matrix that reflects production technologies that determine the unit output-input requirements for each sector. In other words, the elements of matrix A , (a_{ij}) , show the ratio of intermediate consumption of sector i directly used for the production of one unit domestic output of sector j . Accordingly, matrix A reflects the direct intermediate consumption structure within the sectors. On the other hand, $(I - A)^{-1}$ is called the Leontief inverse matrix. The elements of the Leontief inverse matrix contain the production of one unit output for final uses (unit matrix I), the production of domestic intermediate inputs directly used in the production process for final uses (input coefficients A) and the necessary production of domestic intermediate inputs in former stages of the production process. Yet, the sum of the columns of the Leontief inverse matrix comprises all direct and indirect relations for each sector.

The technical coefficient matrix A can be disaggregated into two parts, domestic (A_d) and imported (A_m):

$$A = A_d + A_m \quad (4)$$

In this case, the import inverse matrix can be written as:

$$R = A_m(I - A_d)^{-1} \quad (5)$$

In Equation (5), the elements of the matrix R are the total direct and indirect import requirement coefficients. The sum of each column of the import inverse matrix gives the import requirement ratio for the corresponding sectors.

The direct import requirement ratio ($DIRR_{it}$) for each sector in a given year is calculated by using the formula:

$$DIRR_{it} = IGM_{it} / Y_{it} \quad (6)$$

where, i and t represent sector and time respectively. IGM_{it} is the value of intermediate goods imports that sector i directly uses for production at time t (in nominal TL), and Y_{it} is the value of production for sector i at time t (in nominal TL at current prices).

From the IOTs we estimated, we then construct the technical coefficient matrix A_d for each year. The elements of the matrix A_d for a given year t comprises the direct import requirement ratios ($DIRR_{it}$) of each sector in the corresponding year. We derive the

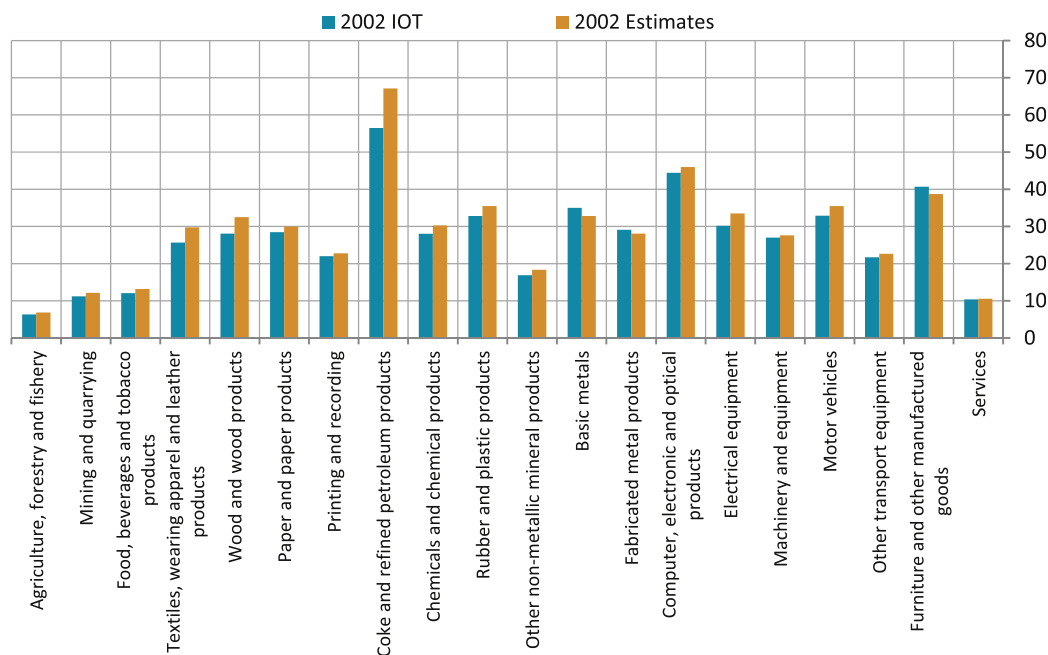


Fig. 1. Import Requirement Ratios from 2002 IOT and the Estimates (By Sector, Percent).

Note: This figure compares the import requirement ratios of each sector calculated based on the official IOT and authors' estimates for 2002.

import inverse matrix R for each year as in Equation (5) and obtain the import requirement ratios for each sector i by taking the sum of each column. Thereby, we get the import requirement ratios for each sector i and for each year t , which we denote as IRR_{it} .

The import content (or dependency) of production in a given year t (ICP_t) is calculated as the weighted average of import requirement ratios of each sector weighted by the sectors' shares in total production for each year:

$$ICP_t = \sum_{i=1}^{20} w_{it} \cdot IRR_{it} \quad \text{for} \quad \sum_{i=1}^{20} w_{it} = 1 \quad (7)$$

where w_{it} is the weighting factor. We use the share of each sector in manufacturing production as the weighting factor, while estimating the import dependency of Turkish manufacturing. In a similar fashion, we compute the import dependency of total exports as the weighted average of import requirement ratios of each sector weighted by the sectors' shares in Turkish exports. We obtain the import dependency of goods exports by excluding the import requirement ratio of the services sector from the calculations and adjusting the weighting factors accordingly.

4. Findings

To show the accuracy of our findings, we first present the import requirement ratios that are calculated from the official IOT of 2002 in comparison to those that are estimated by our methodology. As Fig. 1 depicts, the estimated import contents for the sectors successfully approximate the ones that are obtained from the official table. If we call the calculations from the official tables as the actual import contents, the percentage difference of our estimates from their actual counterparts is the estimation errors from our methodology. In this context, the average percentage error over the industry sectors is found to be 7.8 percent. The errors vary from 1.9 percent to 18.8 percent, with a standard deviation of 4.7 percent. Although there are visually discernable differences between the actual ratios and the estimated ones, our calculations seem to be

fairly consistent proxies, especially when the variety of the data sources used during the calculation process is considered.

Fig. 2 provides import requirement ratios by sector from 2002 to 2012 official IOTs, together with 2018 estimates. The figure portrays the degree of heterogeneity among the sectors in terms of the import requirement ratios. The sectors with the highest import requirements are the ones that are characterized by high capital intensity and advanced technology usage such as coke and refined petroleum products, motor vehicles, and basic metals. The services, agriculture, forestry and fishery, and mining sectors have the lowest import requirements among 20 sectors and at the aggregate level. The lack of official IOTs after 2012 leaves the questions about the current level of import dependency unanswered. Nevertheless, our estimates shed some light on the issue and point out that they have generally gone up slightly as compared to the official 2012 figures. It is also worth noting that the ordering of only a few sectors did change from 2012 to 2018.

To better evaluate how import dependency in each sector has evolved over the examined period, the sectors are separated into three groups with respect to whether their import contents exhibit increasing, decreasing or constant trends. According to our findings, the import content ratio is marked with an increasing trend in 9 out of the 20 sectors. 6 sectors have falling trends while import content ratio remains almost unchanged in the other 5 sectors. Here we present plots of 4 sectors per each category, and the plots of the remaining sectors are provided in the Appendix Fig. A2.

Fig. 3 shows the evolution of the import content of production in the first four sectors that have the highest upward trend over the 2002–2018 period.¹⁷ The amount of increase changes from 8 to 18 percentage points across the sectors. One interesting observation is that these are among the sectors with the highest ratios of import content in the initial year. In other words, these findings indicate that the sectors with the largest import dependency become even

¹⁷ Other sectors where the import requirement ratios have a rising trend are chemicals; other transport equipment; printing and recording; food, beverages, and tobacco; agriculture, forestry and fishery.

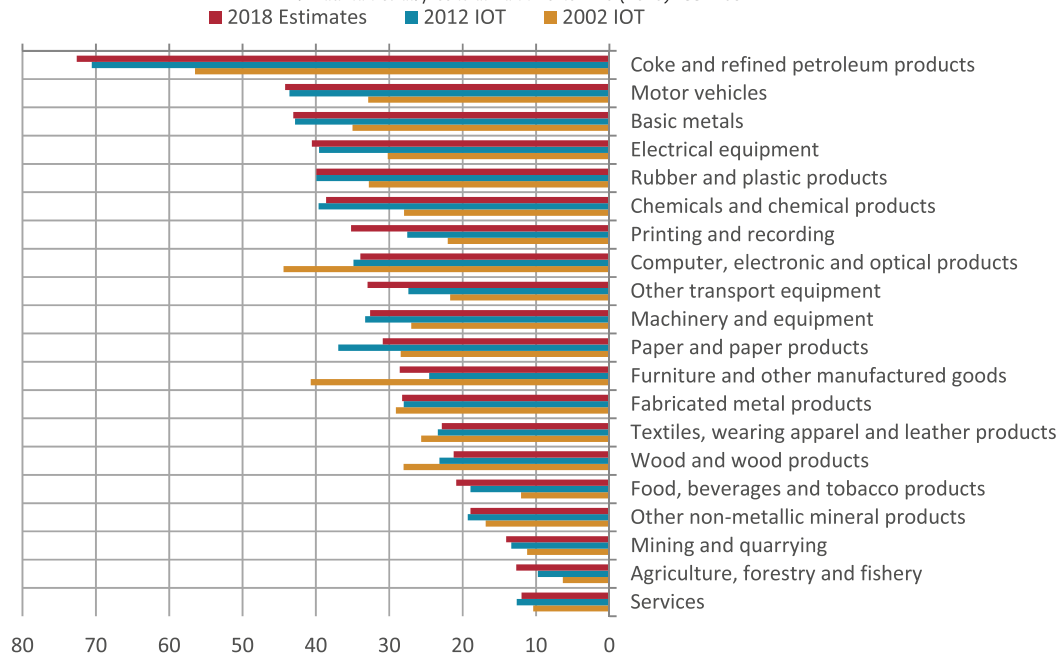


Fig. 2. Import Requirement Ratios from 2002 to 2012 IOTs and the Estimates for 2018 (By Sector, Percent).

Note: This figure compares the import requirement ratios of each sector calculated based on the official IOTs for 2002, 2012, and authors' estimates for 2018.

more reliant on imported intermediate goods over time. Although the reasons behind this transformation are not within the scope of our paper, we may touch on some possible explanations briefly.

One possible explanation would be that some firms may have started to produce entirely new products, which rely on imported inputs at substantially higher rates than the sectoral average. Or,

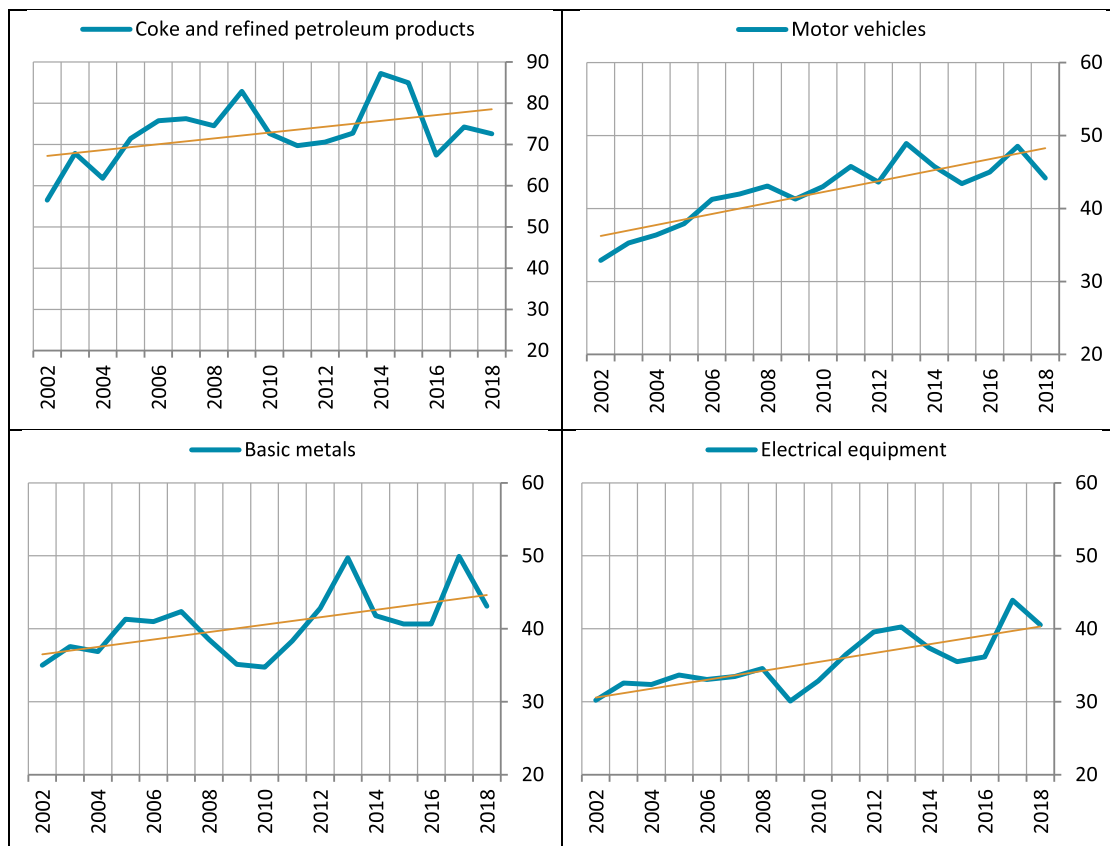


Fig. 3. Sectors with a Rising Trend in Import Requirements (Percent).

Note: This figure presents the evolution of the import requirement ratios in those sectors in which the import content has a rising trend. Yellow lines represent the linear trends of the series.

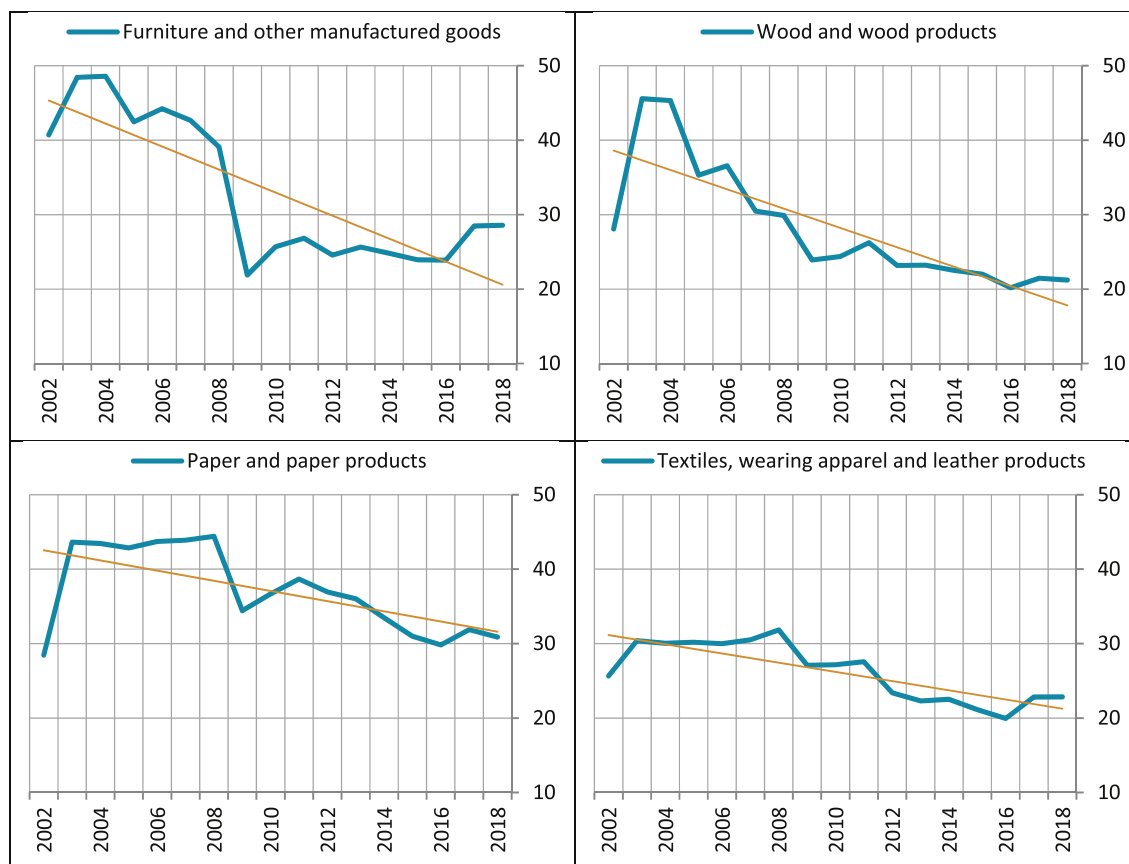


Fig. 4. Sectors with a Declining Trend in Import Requirements (Percent).

Note: This figure presents the evolution of the import requirement ratios in those sectors in which the import content has a declining trend. Yellow lines the represent linear trends of the series.

firms may have upgraded their existing products so that their production required more imported inputs than before. The list of possible factors can easily be extended, but it requires a meticulous analysis to figure out the right answer, which may be the subject of another research paper.

The development of import content is displayed in Fig. 4 for the sectors that have declining imported content requirements.¹⁸ Here, only the four sectors with the strongest downward trend are presented. The furniture sector experiences the most significant decline in import content ratio, amounting to roughly 12 percentage points in sixteen years. It is followed by the wood products sector with a drop of 7 percentage points. The decreasing trend is found to be less pronounced in the remaining two sectors. These findings imply that the firms switched from the imported to locally produced inputs. This shift might be either because those inputs started to be produced locally as the necessary technology and knowledge are adapted, or because domestically produced inputs provided cost advantages throughout the period of analysis.

In total, there are five sectors in which the import content remains almost constant throughout the entire period when their trends are considered. Fig. 5 illustrates the time path of import content for four of those sectors. Rubber and plastics products, and computer and electronic products sectors have trends around 40 percent. In comparison, the trend is placed around 12 and 19 percent in services and other non-metallic products sectors,

respectively. The fact that the share of the imported inputs in the total value of production remains almost unchanged in these sectors implies that imported inputs were not replaced with their domestically-produced inputs or vice versa.

After obtaining sectoral import requirement ratios, we calculate the import contents of production, manufacturing production, total exports and exports of goods. The definition of production includes all goods and services produced in Turkey. So, our definition covers the goods produced for both export and domestic consumption.¹⁹ Then, we obtain the import dependency of production in Turkey as the weighted average of the import requirement ratios of each sector weighted by the sector shares in the total production value for each year. When calculating the import dependency of Turkish exports, instead of the shares of sectors in total production, we use the share of each sector in total value of goods and services exports as the weighting factor. It is worth noting that the share of each sector, or the weighting factor per se, in production and exports can be considerably different. To give an idea on the extent of the divergence, the shares of each sector in 2012 is provided in Table 2. While the services sector constitutes the highest share in total production, the main export sectors are textiles and apparel, basic metal, and motor vehicles in the manufacturing industry.

Fig. 6 displays our calculations under the base scenario in Panel (a), for which we assume the import use ratios and the shares of domestic inputs in each sector to remain at their 2012 levels beyond 2012. We estimate the average import content of

¹⁸ Since we make the classification with respect to their trend movements, the final value of import content may be higher than its starting value in some sectors.

¹⁹ We assume homogenous products for export and domestic markets.

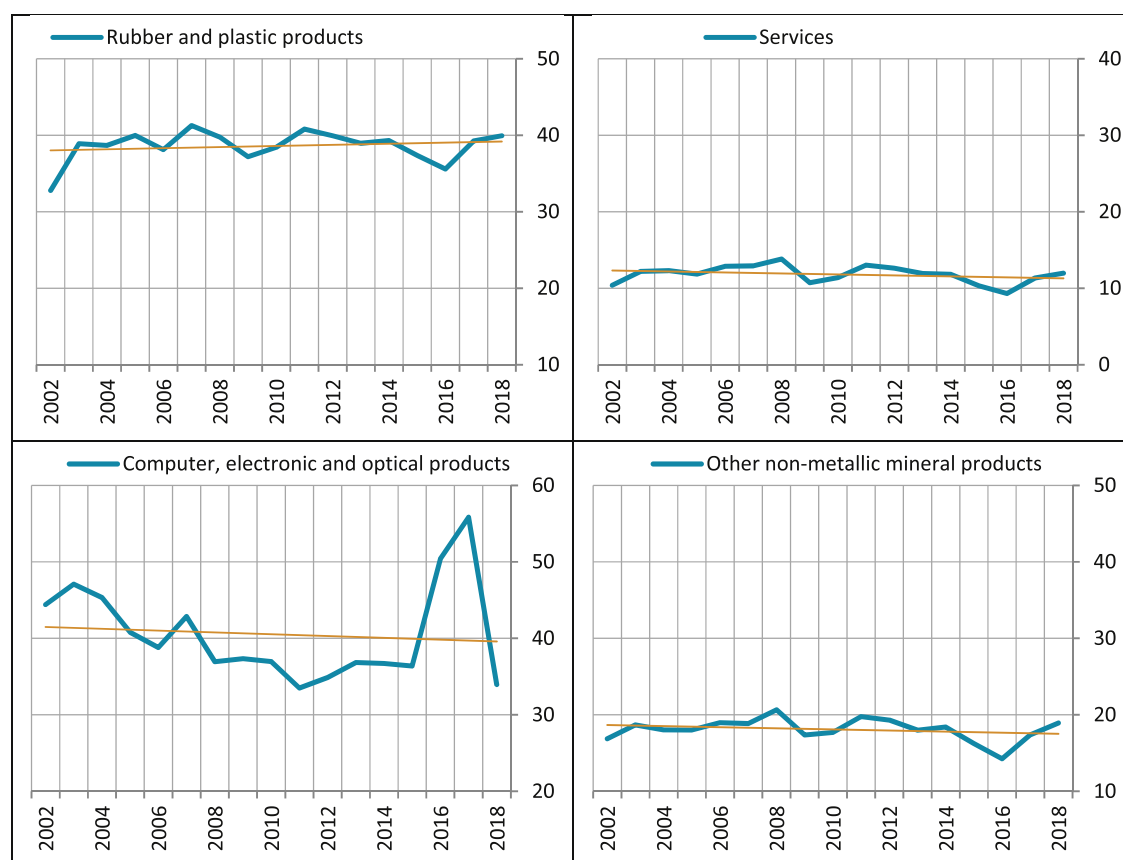


Fig. 5. Sectors with a Constant Trend in Import Requirements (Percent).

Note: This figure presents the evolution of the import requirement ratios in those sectors in which the import content has a fairly constant trend. Yellow lines represent the linear trends of the series.

production and manufacturing production as 17.9 and 31.5, respectively, during the 2002–2018 period. On the other hand, we find the average import content of exports of goods and exports of goods and services as 32.7, and 28.2, respectively. Our findings reveal that the import content of exports is, on average, 10 percentage points higher than the import content of total production,

which reflects both the significant import-content heterogeneity across sectors and different sectoral compositions of exports and total production. The difference is mainly attributed to the services sector, which has relatively low import content and a much larger share in total production than in total exports. Accordingly, when we exclude the services exports from the total exports, the average

Table 2
Sector shares in production and exports in 2012 (percent).

Sectors	Production	Exports
Agriculture, forestry and fishery	6.05	3.13
Mining and quarrying	1.11	1.62
Food, beverages and tobacco products	5.86	5.91
Textiles, wearing apparel, leather, and related products	5.15	17.86
Wood and wood products	0.41	0.38
Paper and paper products	0.63	0.92
Printing and recording services	0.31	0.00
Coke and refined petroleum products	1.48	4.02
Chemicals and chemical products	1.78	4.07
Rubber and plastic products	1.48	3.56
Other non-metallic mineral products	1.73	2.25
Basic metals	4.01	10.55
Fabricated metal products, except machinery and equipment	1.68	3.88
Computer, electronic and optical products	0.40	1.69
Electrical equipment	1.28	5.48
Machinery and equipment	1.19	4.78
Motor vehicles, trailers and semi-trailers	1.85	9.19
Other transport equipment	0.21	0.94
Furniture and other manufactured goods	1.37	2.41
Services (Other Sectors)	62.04	17.35

Note: This table provides the share of each sector in production and in exports for 2012, calculated based on the value of production and exports at current prices.

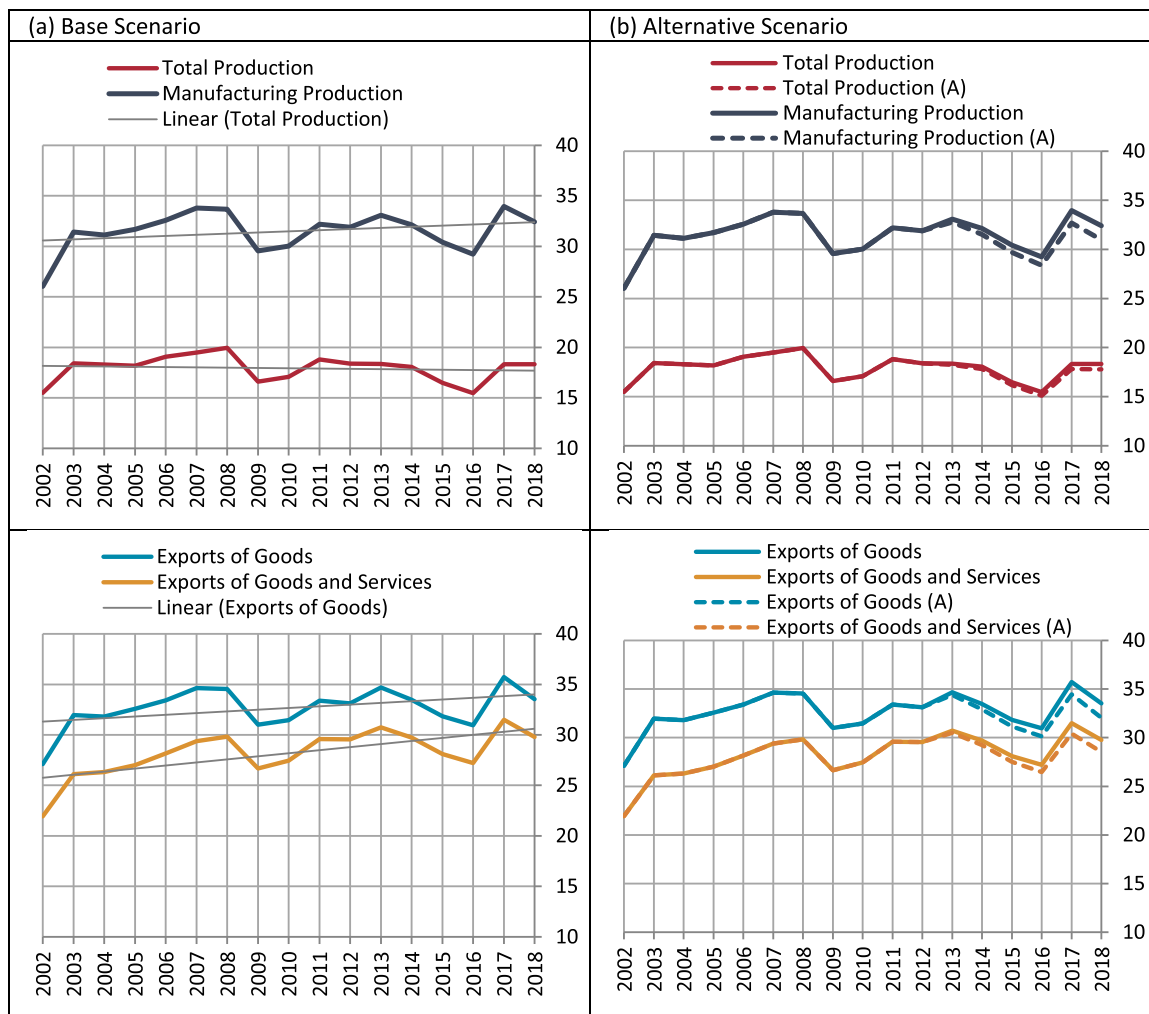


Fig. 6. Import Content of Turkish Production and Exports (Percent).

Note: This figure displays the evolution of import content of production, manufacturing production, exports and good exports under the base and alternative scenarios. In the base scenario (Panel a) the import use ratios and the shares of domestic inputs in each sector are assumed to remain constant after 2012. In the alternative scenario (Panel b), the import use ratios and the shares of domestic inputs in each sector are assumed to maintain their 2002–2012 trend after 2012. Grey lines in Panel (a) represent the linear trends of the series.

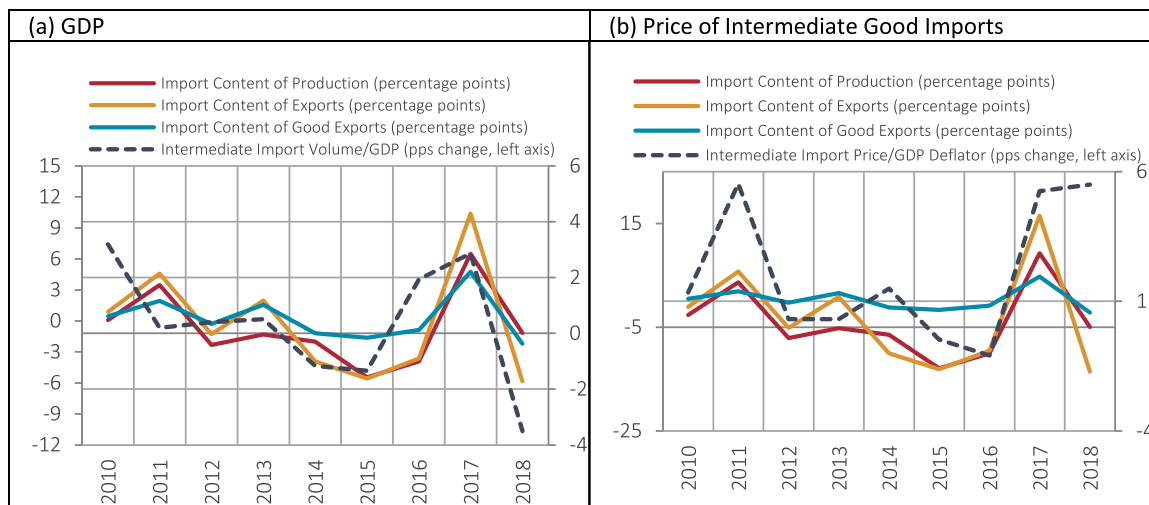


Fig. 7. Import Content Ratios, and Relative Volume and Price Changes in Intermediate Goods Imports (Change from Previous Year).

Note: Panel (a) displays the annual percent changes in import content of production, exports and goods exports with the change in intermediate good imports volume index relative to GDP. Panel (b) displays the annual percent changes in import content of production, exports and goods exports with the change in intermediate good imports price index relative to GDP deflator.

import dependency increases by almost 5 percentage points. Similarly, after ignoring the services production, the average import content of manufacturing sector becomes 31.5 percent, 13 percentage points higher than the import dependency of total production.

Despite the considerable level difference, the four series exhibit very similar movement patterns over the period of analysis. For all series, there are periods of ups and downs, which mostly overlap. The import content shows gradual ascent before the global financial crisis, the major increase taking place between 2002 and 2007. It then makes a downturn in 2009 and returns to its pre-crisis levels in 2011. Afterward, it remains relatively stable until 2014 and sets off a gradual decline, which ends with a relatively significant upturn in 2017. In 2018, we observe a correction in the import content of good exports and total export that bring the figures around their averages in the last five years. Nonetheless, the overall trend of import content for goods and services exports is upwards during the period under investigation, with an increase around 8 percentage points from 2002 to 2018. The import content of total production remains relatively stable, rising only around 3 percentage points for the period. This indicates that Turkey's exports are concentrated in the sectors in which the use of imported inputs has increased during the examined period. In the case of domestic production, those sectors have relatively smaller shares, and their impact is mostly offset by the sectors with a declining trend in import requirements.

One can speculate about the future trends in import content of Turkish production and exports taking the course of the sector shares in both of the two into account. Over the period, the composition of production has become more services-oriented and less manufacturing-intensive. The secular upward trend in the share of the services sector, coupled with its low import dependency, implies that the import content of production may decrease over the horizon. Besides, the import content of exports is likely to decline gradually in the future when the recent trends in the sector-level export shares and the change in the sectors' import requirement ratios are considered.

To check the robustness of our main findings, we create an alternative scenario by altering our assumption that the import use ratios and the shares of domestic inputs in the value of production in sectors remain unchanged after 2012. Instead, we assume that the average course of change between the two official IOTs for those ratios and shares in each sector are maintained in the subsequent years. To save space, we refrain from displaying the change in the import requirement ratios for each sector and comparing them with their benchmark counterparts. Hence, only the aggregate import contents of production, manufacturing production, exports and good exports are plotted in Fig. 6 Panel (b) in comparison to our findings from the base scenario. Under the alternative scenario, the resulting paths of the import content for both production and exports exhibit very slight downside deviations from the patterns of change in the base scenario. Thus, our main findings regarding the gap between import contents of production and exports and their temporal movements remain valid after the alteration of the assumption.

One last point that attracts attention in these results is the hike and sharp decline in import content ratios in 2017 and 2018, respectively. Here, Fig. 7 may provide some insight for this phenomenon. The change in the import content ratios with respect to the previous year seems to be closely related to the annual percentage change in the ratio of intermediate goods imports volume to GDP and the annual percentage change in the ratio of intermediate goods imports price to GDP deflator. According to Panel (a) in Fig. 7, the import content ratios rise in those years in which the annual growth of intermediate goods import volumes exceeds the

annual GDP growth and vice versa. 2011, 2013, and 2017 are the years that the Turkish economy recorded higher growth rates than its average of 6.8 percent after the global financial crisis. Besides, the period in which the real growth of intermediate goods imports realized above the already strong GDP growth also corresponds to the years that the change in the import content ratio was positive. Therefore, it may be inferred that when the economic activity is considerably strong, the need for imported raw materials increases, probably because domestic input suppliers fall short of meeting the excessive demand.

Fig. 7 Panel (b) suggests that the increase in intermediate goods import prices relative to the GDP deflator may be another factor that contributes to the rise in import dependency in the Turkish economy. The rise in the oil and other commodity prices increases the prices of imported raw materials, which in return, expands the share of imported inputs in the production value. Increases in the prices of intermediate goods imports seem to accentuate the rise in import content ratios, especially when coupled with higher than average GDP growth rates, such as in 2011 and 2017.

In addition to these two possible explanations for the evaluation of the import dependency over the recent period, there may be several others. These include sector-level heterogeneity in terms of the integration to global value chains, capital and labour shares of sectors production inputs, shares of each sectors' sales in the country and abroad, sector-specific shocks from the foreign markets, etc. Further quantitative analysis is needed to reveal the sources of variation in the import content among the different sectors of the economy. Since the sector-level determinants of the import dependency is a question beyond our study's scope, we leave this for future research.

5. Conclusion

The degree of import dependency, which has increased on a global scale due to growing integration to global value chains in recent decades, is especially important for developing countries that run current account deficits. High import requirement ratios are among the structural factors that result in excessive current account deficits and limit external trade gains.

In this study we examine the course of the import content of Turkish production and exports over the 2002–2018 period. Based on the 2002 and 2012 input-output tables, we estimate production and imported input use values of 20 main sectors of the economy for the remaining years in our sample by using foreign trade, and industry and services statistics. Import requirement ratios for each sector, comprising both direct and indirect linkages, are calculated using the Leontief inverse matrix. Our findings are broadly in line with former empirical evidence on the import dependency of the Turkish economy. They indicate that the average import content is around 18 percent for production and 28 percent for exports in the examined period. This difference is mainly attributable to the services sector, which has relatively low import content, but a large share in production. There exists considerable heterogeneity among sectors in terms of import content. Sectors with the highest import requirements are found to be those with higher capital and technology intensity such as coke and refined petroleum products, basic metals and motor vehicles. The services, agriculture, forestry and fishery, and mining sectors are found to have the lowest import requirements. The import dependency is found to have an increasing trend in exports, but to remain relatively stable for production over time. Our results are consistent with the intuition that Turkey's exports are concentrated in the sectors where the use of imported inputs has expanded during the past two decades. In the case of production, those sectors have relatively smaller shares and their impact is mostly offset by the sectors with declining

import usage. Although our study provides evidence on the sector-level heterogeneity in import dependency, quantitative analysis on the determinants of this heterogeneity is beyond its scope. Future research should try to deepen our understanding of the factors that lead to sectoral differentiation of import requirements as well as the price and volume effects of intermediate goods imports in shaping the course of import dependencies.

Our analysis contributes to the literature by shedding some new light on how import dependencies in sectors have evolved in the recent period. Identifying the sectors that have higher import requirements and determining the periods during which import dependency escalate can be useful for policy-makers in designing more targeted policies. Two key policy implications that can be

drawn from this study are that sectors with higher import requirements should be given priority in providing incentives to increase the local input content of production, and tailor-made policies that account for sector specific characteristics and capacities should be adopted instead of one-size-fits-all strategies. By implementing structural reforms to increase the local input content of production, the Turkish economy can not only better harness the benefits of foreign trade, but also contribute to price stability through restraining the exchange rate pass-through to domestic prices, and financial stability through decreasing the current account deficit and reducing external financing needs in the medium term.

Appendix

Table A1

Foreign Direct Investments in Turkey - Sectoral Breakdown. (Million US Dollars)

Sectors	2000	2018
Agriculture, forestry and fishery	45	614
Industrial Sectors	11,732	43,315
Mining and quarrying	262	3467
Manufacturing	9777	33,818
Food, beverages and tobacco products	2188	6299
Textiles, leather and related products	288	351
Wood and wood products	21	148
Paper and paper products	303	544
Coke and refined petroleum products	360	4662
Chemicals and chemical products	1278	5279
Rubber and plastic products	665	2382
Other non-metallic mineral products	429	871
Basic metals and Fabricated metal products	349	1921
Machinery and Equipment	699	58
Computers, Electronic-Electrical and Optical Equipment	1130	3138
Transport Equipment	1964	6282
Other manufacturing	103	1883
Electricity, Gas, Steam and Air-conditioning Supply	1693	6005
Water Supply; Sewerage, Waste Management and Remediation	0	25
Services	7035	89,290
TOTAL	18,812	133,219

Source: Central Bank of the Republic of Turkey. International Investment Position Statistics.

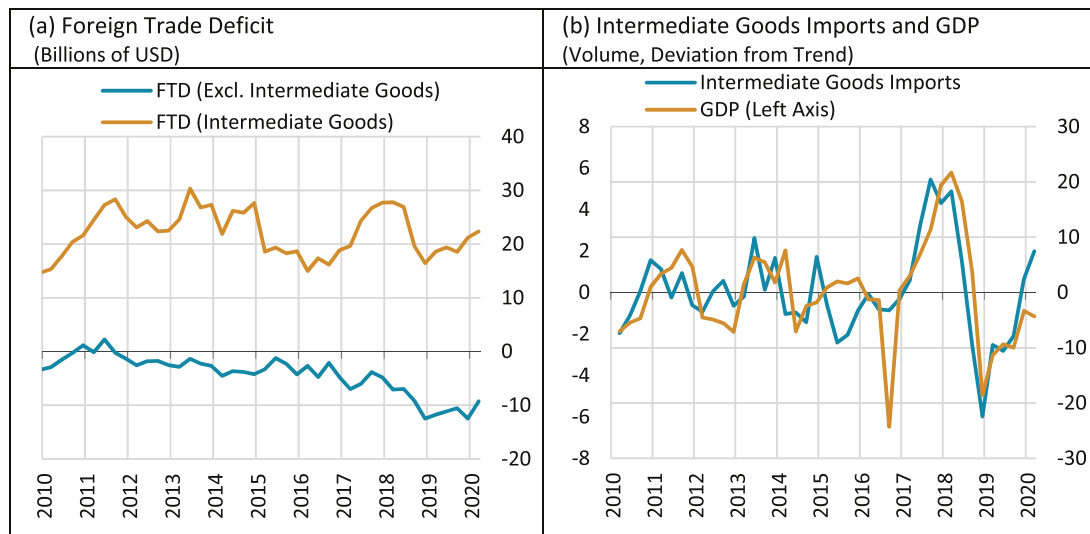


Fig. A1. Intermediate Goods Imports and Economic Activity.

Source: TurkStat and authors' calculations.

Note: Panel (a) shows the foreign trade deficit (FTD) of intermediate goods trade and the FTD excluding intermediate goods. Imports of intermediate goods are the main component of the foreign trade deficit in Turkey. Excluding the intermediate goods, there is a trade surplus. Panel (b) shows imports of intermediate goods and gross domestic product, both in seasonally-adjusted volumes and as deviations from trends. The correlation coefficient between the two series is 0.68.

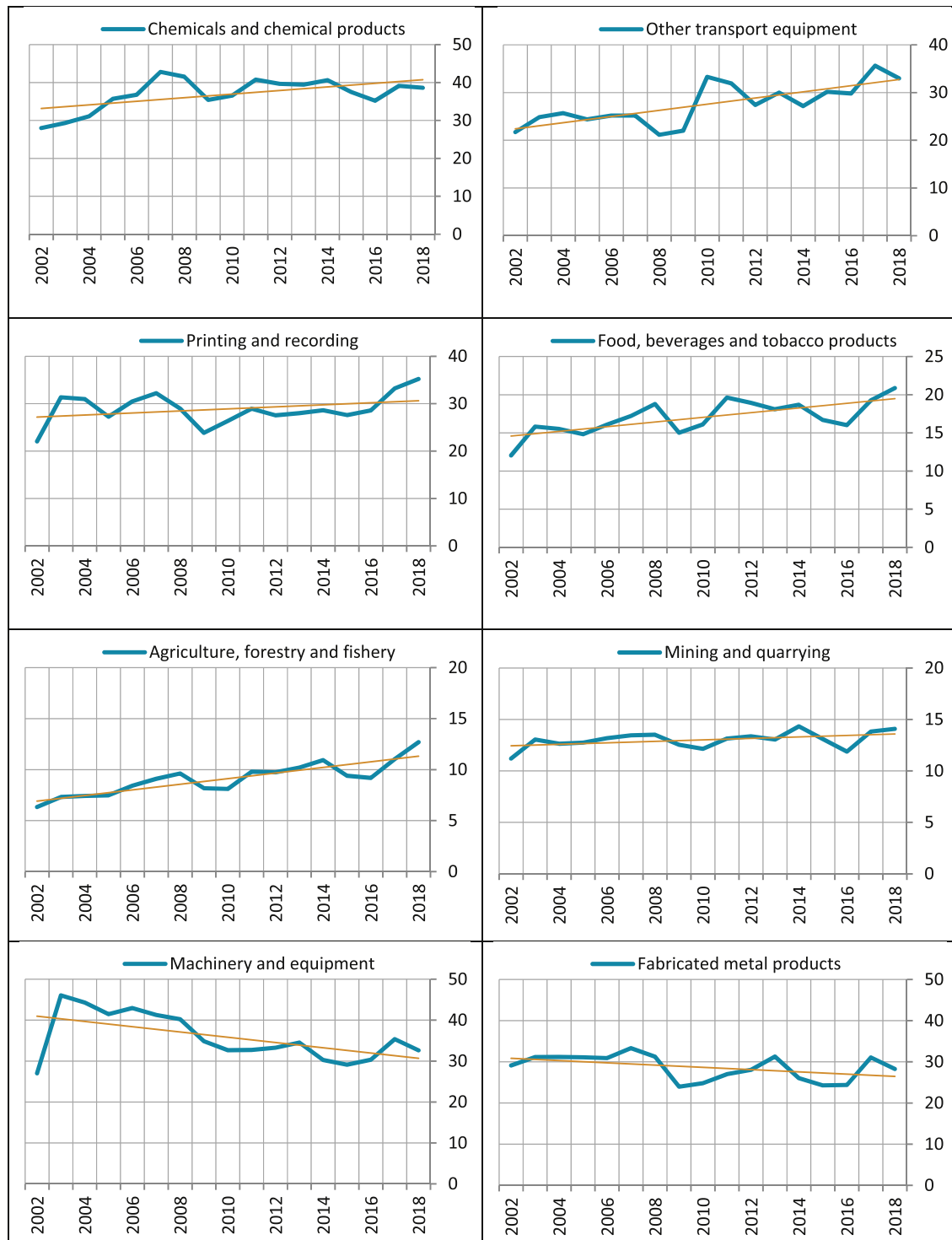


Fig. A2. Import Requirement Ratios of Remaining Sectors (Percent).

Note: This figure presents the evolution of the import requirement ratios in the eight remaining sectors not included in the main discussion. Yellow lines represent the linear trends of the series.

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