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RESEARCH ARTICLE

Export Prices, Imported Inputs, and Domestic Supply Networks

Yusuf Emre Akgündüz[1] · **Salih Fendoğlu**[2]

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Abstract

We study the impact of import intensity in production of exporters and their suppliers on exchange rate pass-through to export prices. For identification, we use rich micro-level databases – domestic firm-to-firm sales and firm-product-level customs – from a large emerging market, Turkey. We find that ignoring suppliers' import reliance misses nearly half of the picture: while exporters' degree of reliance on own imported goods is 24%, this number reaches nearly 40% once their suppliers are taken into account. A higher degree of import reliance by exporters' suppliers significantly increases pass-through to export prices by inducing higher imports-driven marginal costs passing over to downstream exporters. Moreover, exporters with a higher concentration in their domestic supply networks have a higher pass-through.

Keywords Exchange rate pass-through · Exports · Import reliance · Domestic supply networks

JEL Classification D24 · F14 · F31

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✉ Yusuf Emre Akgündüz
emre.akgunduz@sabanciuniv.edu

Salih Fendoğlu
sfendoglu@imf.org

[1] Sabanci University, Istanbul, Turkey

[2] International Monetary Fund, Washington, DC, USA

1 Introduction

Exporters that use imported inputs potentially face higher marginal costs following a domestic currency depreciation, and in turn, their producer-currency export prices tend to move alongside the exchange rate.[1] We show in this paper that the picture is potentially far from complete. Using administrative domestic firm-to-firm sales and rich product-level customs data from a large emerging market, Turkey, we show that (i) the overall import intensity of exporters is in fact much higher when one considers their suppliers' reliance on imported inputs, and (ii) taking into account suppliers' import use unravels a significantly higher exchange rate pass-through into export prices.[2]

It is intuitive to think that import reliance of exporters' suppliers should also matter for the overall sensitivity of export prices to exchange rate movements.[3] Following a domestic currency depreciation, suppliers that rely more on imported inputs would likely pass the increasing costs to the exporter, which in turn would leave the exporter to set higher prices to the extent it relies on such suppliers. Identifying whether such a mechanism is in place is challenging, as it requires having data on firm-to-firm linkages, tracing the whole international trade flows of domestic firms at a micro-level (at a firm, product, imports by source, and exports by destination level) together with firm balance sheets. By studying these datasets from Turkey, we show in a well-identified way how exporters' pricing is driven by their reliance on import-intensive domestic suppliers.

We use an extensive administrative dataset including firm-to-firm sales that cover virtually all inter-firm trade,[4] firm-product-destination country-level exports and firm-product-source country-level imports that cover the whole universe of international trade flows, and complete balance sheet and employment information of the universe of firms operating in Turkey. Our sample runs from 2006 to 2016 on an annual basis. We start by calculating for each exporter its own reliance on imports, which we label as own import intensity, as the ratio of total imports to total cost of sales. We then calculate indirect import intensity for each exporter by weighting the own import intensity of its supplier firms (with weights proportional to by how much the exporter rely on each supplier in its total supplier purchases) and multiplying the resulting number with by much exporter relies on supplier purchases for production, i.e., with the ratio of total supplier purchases to total cost of sales.

[1] For other explanations, see excellent surveys by Goldberg and Hellerstein (2008) and Burstein and Gopinath (2013), and also Amiti et al. (2014) for the role of mark-up channel. See also Gopinath (2015) who shows that exchange rate pass-through into import prices may be substantially high.

[2] Indeed, Amiti et al. (2014) acknowledge for Belgian exporters that some of imports are likely to be made not directly by exporters but through other firms, and they note that they are unable to control for suppliers' imports without more detailed data. Our use of firm-to-firm sales database suggests that a significant portion of exporters' reliance on imports may be due to their suppliers.

[3] No firm exists in a vacuum. On the contrary, economic outcomes of a firm are very likely to arise from and propagate through its supply network (Acemoglu et al. 2016; Barrot and Sauvagnat 2016; Tintelnot et al. 2017; Bernard et al. 2021), including pricing behavior (Duprez and Magerman 2018).

[4] The database covers firm-to-firm transactions above a modest threshold of 5000 TL (which, on average, corresponds to about 2500 US dollars).

We then study how import-intensive exporters, directly by using imported inputs or indirectly by working more with import-intensive suppliers, change their export prices following a domestic currency depreciation, compared to firms that export the same product category at the Combined Nomenclature (CN) 8-digit level to the same destination country at the same year.[5] This identification strategy helps us absorb any demand-side effects or common shocks to marginal costs across these exporters. To shed light on the underlying mechanism, we then use firm-product-source-level imports to measure how direct/indirect reliance on imported inputs entails an increase in production costs following a domestic currency depreciation and finally assess the relevance of marginal cost channel due to exporters' direct or indirect import intensities.

Our results are as follows:

First, almost all exporters use imported inputs, directly or through their suppliers. On average over our sample period, while 61% of exporters import themselves, this figure rises as high as 95%, and exporters' import intensity raises from 24% to 40%, once we also take into account exporters' suppliers' use of imported inputs. These findings underline that focusing on exporters' own import intensity misses an important ingredient of exporters' 'true' import reliance: the degree of their suppliers' reliance on imported inputs.

Second, we find that exporters working with import-intensive suppliers have a significantly higher exchange rate pass-through into producer-currency export prices. Numerically, following a 10% domestic currency depreciation, an exporter at the 90th percentile of indirect import intensity raises its producer-currency (Turkish lira) prices by 3.6 percentage points more compared to an exporter at the 10th percentile that exports the same good to the same destination country at the same year. Exporters' own import intensity matters as well for the pass-through, with a somewhat stronger effect than the indirect effect. Numerically, an exporter at the 90th percentile of the distribution of own import intensity raises its export prices by 4.8 percentage points more compared to an exporter at the 10th percentile.[6] We later show that these results are qualitatively robust to using weighted least squares, to a sub-sample of large exporters or high value exports, and confining interest to exporters' major products. We also find that these results hold particularly for wholesale traders – who in part intermediates exports in Turkey.

Third, we investigate the underlying mechanism. In particular, for each firm (an exporter or its suppliers) importing a product from a source country, we first calculate change in import costs as a result of exchange rate movements. We label the sum of changes (for a given firm summing across different import products and source countries) as the marginal increase in costs due to using imported inputs.

[5] The Turkish customs database follows EUROSTAT and uses the Combined Nomenclature (CN) classification for classifying exported or imported goods. The CN coincides with the Harmonized System (HS) classification up to the sixth digit.

[6] Summing up the direct and indirect import intensities, one can also obtain an aggregate measure of import intensity for exporters. When we do so, we find that exporters with higher aggregate import intensity raise their export prices by 6.2% more.

We find that, facing a higher import bill following a domestic currency depreciation, exporters do shift away from source countries – currencies of which get more valued against the domestic currency – or goods – that happen to be more expensive in domestic currency terms. This adjustment, however, appears insufficient to avoid passing a portion of increases in costs to their export prices. A one-percentage-point increase in production costs due to imports leads to a 0.17% increase in export prices. We find a milder impact on export prices due to marginal increase in exporters' suppliers' imports-driven costs (0.11%). Having a finer measure of marginal costs, these results hold for both wholesale and non-wholesale trader exporters.

Lastly, we explore the role of exporters' market power in domestic supply networks for the exchange rate pass-through. Intuitively, an exporter relying on only a few suppliers may have lower bargaining power over its suppliers and in turn find it harder to vary its mark-ups. Eventually, such exporters may reflect an exchange rate depreciation more onto its product prices. In line with this intuition (Kikkawa et al. 2019), we find that exporters with higher concentration in their domestic supply networks raise their export prices significantly more following a domestic currency depreciation. Moreover, our previous findings on how direct or indirect marginal cost channel affect the pass-through continue to hold.

Our study adds to the recent literature that links exchange rate pass-through to imported inputs, market structure, productivity, or quality of exports (Amiti et al. 2014; Berman et al. 2012; Auer and Schoenle 2016; Garetto 2016; Bernini and Tomasi 2015; Lewis 2017). Most relatedly, Amiti et al. (2014) develop a theoretical framework on how exporters' pricing of their export goods is linked to their import intensity and destination market shares, and show that exporters that rely more on imports raise their export prices significantly more following an exchange rate depreciation, with the marginal cost and mark-up channels contributing to the pass-through with similar strengths.[7] Our results unravel that exporters' import intensity can in fact be significantly higher once their suppliers' use of imported inputs is taken into account, and that exporters' indirect import intensity significantly matters for the pass-through.

Another strand of literature that our work relates to is the recently growing production network literature (Acemoglu et al. 2016; Bernard et al. 2015; Dhyne et al. 2015; Barrot and Sauvagnat 2016; Lim 2017; Tintelnot et al. 2017; Duprez and Magerman 2018; Kikkawa et al. 2019; Bernard et al. 2021; and for an in-depth review, Carvalho and Tahbaz-Salehi 2018). Barrot and Sauvagnat (2016), for instance, show that suppliers affected by natural disasters pass substantial output losses on their customers, especially when they produce specific inputs. Using Belgium firm-to-firm sales, Bernard et al. (2021) examine the role of inter-firm linkages for firm size heterogeneity, and Tintelnot et al. (2017) how international trade shocks affect real wages and efficiency of firms, including even those that do not directly export or import. More related to our paper are Duprez and Magerman (2018) and

[7] Amiti et al. (2014) use destination currency pricing and therefore report lower pass-through as a result of higher import intensity. In producer currency pricing, which we use, their results would point to higher pass-through.

Amiti et al. (2019). Duprez and Magerman (2018) study how firms adjust their domestic prices in response to cost shocks and changes in competitors' prices. Amiti et al. (2019) explore an alternative transmission channel for import pass-through into domestic prices by studying the effect of import intensity across competitors.[8]

Our contribution is threefold. First, we show that exporters' suppliers are more import intensive than an average firm in the economy. This suggests that calculating import intensity by using sector-level input–output tables, a route often followed in policy reports, e.g., OECD (2019), is likely to underestimate true import intensity. To our best knowledge, our paper is the first to document the contribution on exchange rate pass-through of exporters' import intensity due to their domestic suppliers. Our network encompassing import intensity measures may have further applications for the wider literature estimating the impact of using imported inputs on firm-level economic outcomes such as productivity and product scope (Goldberg et al. 2010; Halpern et al. 2015).

Second, we extend Amiti et al. (2014) by incorporating a rich database on exporters' domestic supply network (firm-to-firm sales). We show that exporters' indirect reliance on imports (through their reliance on import-intensive suppliers) is economically large, the indirect marginal cost channel is operational, and it increases the exchange rate pass-through significantly and to a sizable degree.

Finally, our findings on how a weaker domestic currency raises production costs of exporters that work with import-intensive suppliers, and how it eventually raises export prices, complement Duprez and Magerman (2018) who study how firms change their prices *within domestic markets*. More recently, Bruno and Shin (2019) study the finance channel of exports. They show that exporters that are more reliant on US dollar funding (via working with banks funded more with US dollars) can expand their exports significantly less following a stronger dollar, underlining that the finance channel may even dominate the competitiveness channel. Our paper also complements Bruno and Shin (2019), by showing that the competitiveness channel, that was previously shown to be weaker due to exporters' reliance on imports, may even be weaker once import use within exporters' supply network is taken into account. In this regard, our results are particularly relevant for emerging markets with high reliance on imported goods for production, as the results also suggest that it is harder for such countries to ameliorate the loss in domestic absorption and eventually grow in the aftermath of domestic currency depreciations.

The paper proceeds as follows. Section 2 presents the theoretical framework. Section 3 discusses the empirical approach and defines the variables of interest. Section 4 presents the databases in detail. Section 5 presents the empirical results. Section 6 discusses the heterogeneity and robustness of the results. Section 7 concludes.

[8] Moreover, while the mechanism in our paper operates through import-intensive *domestic* suppliers, similar spillover effects can further be prevalent in an international setting. For instance, a shock to a supplier abroad may affect their downstream across-the-border firms. For instance, di Giovanni et al. (2018) and Auer et al. (2019) show evidence for how global supply linkages may render comovement of business cycles or prices across countries. Based on French micro-level data, Giovanni et al. (2020) show that firms that import intermediate inputs react significantly more to foreign shocks, and lay out the quantitative importance of large 'granular' firms in transmitting foreign shocks to the French economy.

2 Theoretical Motivation

The channel works through cost pass-through within a production network economy, where in our setting that corresponds to exporters that rely more on import-intensive suppliers facing higher increase in their input costs following a domestic currency depreciation (ceteris paribus). To formally elaborate this, we follow the model in Bernard et al. (2021).

Consider, for instance, a production network economy where an exporter f source inputs from a set of import-intensive domestic suppliers (in addition to labor and own imported inputs) and produces via

$$y_{f,t} = \kappa z_{f,t} l_{f,t}^{\alpha} \left(m_{f,t}^{1-\gamma_f} v_{f,t}^{\gamma_f} \right)^{1-\alpha} \tag{1}$$

where $y_{f,t}$ is the output, $z_{f,t}$ is the productivity, $l_{f,t}$ is the amount of labor used, α is the share of labor, $m_{f,t}$ is the imported inputs, $\kappa > 0$ a scaling parameter, and t denotes the time. $v_{f,t}$ is a constant elasticity of substitution (CES) bundle of inputs from suppliers $n \in N_{f,t}$ with cost share γ_f, given by

$$v_{f,t} = \left(\sum_{n \in N_{f,t}} \nu_{nf,t}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \tag{2}$$

where $\nu_{nf,t}$ is the input purchased from supplier n. The corresponding unit cost for exporter f of buying this input bundle is given by $P_{f,t} = \left(\sum_{n \in N_{f,t}} p_{nf,t}^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$, where $p_{nf,t}$ is the unit price charged by supplier n to exporter f. The marginal cost of production for exporter f is then proportional to the cost of buying this input bundle and is given by

$$MC_{f,t} = \frac{w_{f,t}^{\alpha} \left(z_{f,t}^{1-\gamma_f} P_{f,t}^{\gamma_f} \right)^{1-\alpha}}{z_{f,t}} \tag{3}$$

where $w_{f,t}$ is the unit labor cost (wage) and $z_{f,t}$ is the cost of imported inputs. Assuming a symmetric production technology for suppliers and a monopolistically competitive market, $p_{nf,t} = \mu MC_{n,t}$ where μ is a constant mark-up and $MC_{n,t}$ (marginal cost) is proportional to the weighted average bilateral exchange rates that supplier n faces over its import source countries. Assuming costly switching across suppliers, equation (3) then reflects the sensitivity of marginal production costs for exporter f to changes in the exchange rate.

While the model is stylized, it reflects key features of the mechanism. First, suppliers' reliance on imported goods passes on their downstream (exporter) firms ($MC_{f,t} \propto P_{f,t}$). Second, to the extent the set of suppliers is sticky (e.g., $N_{f,t} \approx N_f$ assuming switching across suppliers infinitely costly), exporters face a higher $P_{f,t}$ following a domestic currency depreciation against the currency of countries its

suppliers' source their imports from.[9] Third, in principle, the cost pass-through occurs as we move further down the production network (suppliers' marginal cost of production, $mc_{n,t}$, also depends on suppliers' suppliers' marginal production costs). The extent to which the set of suppliers of suppliers are sticky will then determine the extent of cost pass-through at each level of the production network. The second-order effect appears not empirically relevant as we study below.

Consider further the demand an exporter faces in its destination markets. Here, we draw upon Amiti et al. (2014) who show that import intensity (proxying for the sensitivity of marginal costs to the exchange rate) and export market share (proxying for elasticity of markups to prices) constitute a sufficient statistic for the exchange rate pass-through within sector-destination markets. In particular, exporter f's market share in the destination market k for a given sector at a given time is given by

$$S_{k,f} = \xi_{k,f}\left(\frac{P^x_{k,f}}{P^x_k}\right)^{1-\rho} \in [0,1] \tag{4}$$

given a nested CES demand over a variety of products, where $\xi_{k,f}$ is a firm-destination specific preference parameter, ρ is the elasticity of substitution across the varieties within sectors, $P^x_{k,f}$ is the exporter's price, and P^x_k is the sectoral price index. Given monopolistic competition in sector-destination markets, exporters set a markup, $\mu^x_{k,f} = \rho_{k,f}/(\rho_{k,f} - 1)$, over their costs, where $\rho_{k,f} \equiv \rho(1 - S_{k,f}) + \nu S_{k,f}$ is the effective demand elasticity and ν the elasticity of substitution across sectoral aggregates (satisfying $\rho > \eta \geq 1$). Amiti et al. (2014) show that the markup (as well as the elasticity of markup to prices) is increasing in the market share of the exporter. In equilibrium, optimal price set by exporter f for destination market k is a function of markup and marginal costs, i.e., $P^{x*}_{k,f} = \mu^x_{k,f} MC^*_{f,t}$, for which export market shares and overall import intensity form sufficient statistics.

3 Empirical Framework

3.1 Measuring Import Intensity

We define import intensity of a firm as the ratio of its total imports to the total cost of sales. Starting with exporters' own import intensity, $\varphi^{own}_{f,t}$, we calculate

$$\varphi^{own}_{f,t} \equiv \frac{\sum_{c \in C_{f,t}} \sum_{i \in I_{f,t}} \text{Import Value}_{f,i,c,t}}{\text{Cost of Sales}_{f,t}} = \frac{\text{Import Value}_{f,t}}{\text{Cost of Sales}_{f,t}} \tag{5}$$

[9] As we show in Section 4, change in import intensity of suppliers (change in indirect import intensity) is on average close to zero, implying that exporters cannot easily switch to suppliers with lower import intensities.

where the numerator is the total imports of an exporter f at year t (the sum of the value of exporter f's all imported goods indexed by i from source countries indexed by c at year t). We use total imports for the baseline estimations, and the total intermediate goods imports for robustness. The denominator, Cost of Sales$_{f,t}$, is the sum of total labor costs and material costs of exporter f at year t.

To estimate the import intensity of an exporter due to its direct suppliers' imports, which we call indirect import-intensity for the rest of the paper, we use the formula shown in equation (6). First, we define $w_{f,n,t}$, the weight of a given supplier firm n among all $N_{f,t}$ firms that supply to the exporter f at year t. The import intensity of supplier firms is calculated similar to equation (5) (by dividing total imports of supplier n to its total cost of sales for each $n \in N_{f,t}$), and then, are weighted according to $w_{f,n,t}$, to construct a weighted average import intensities of the supplier firms for the exporter f. Afterward, we multiply this measure with the exporter f's reliance on suppliers (namely, the ratio of purchases from suppliers to the cost of sales). Therefore, we reach the following indirect import intensity measure:

$$\varphi_{f,t}^{indirect} \equiv \frac{\text{Supplier Purchases}_{f,t}}{\text{Cost of Sales}_{f,t}} \sum_{n=1}^{N_{f,t}} w_{f,n,t} \frac{\text{Import Value}_{n,f,t}}{\text{Cost of Sales}_{n,f,t}} \tag{6}$$

Alternatively, we define an aggregate measure of import intensity of exporters, $\varphi_{f,t}^{agg}$, as the sum of own and indirect import intensity measures:

$$\varphi_{f,t}^{agg} \equiv \varphi_{f,t}^{own} + \varphi_{f,t}^{indirect} < 1 \tag{7}$$

Since the import intensity measures, $\varphi_{f,t}^{own}$ and $\varphi_{f,t}^{indirect}$, are normalized by total cost of sales, their sum never exceeds 1. Since one would expect own and indirect import intensities to affect the pass-through with different strengths, using the aggregate import intensity naturally loses some information. On the positive side, it is a complete measure of import intensity of inputs in the final product of a given exporter. Later for robustness, we also study higher-order indirect import intensities (for instance, an exporter's reliance on imports due to its suppliers' suppliers' use of imports) and re-define the aggregate measure of import intensity accordingly.[10]

3.2 Identification Strategy

Our identification is based on cross-sectional variation in import intensities, own or indirect, of exporters selling products in the same CN-8 category to the same destination country in the same year. In particular, we estimate

[10] To include all imported inputs in a firm's supply network, the Leontief inverse of import intensity could be calculated as $\varphi_{f,t} = [I - \Omega]^{-}1M = \sum_{k=0}^{\infty} \Omega^k M$, where $w_{i,j,t} \in \Omega$ is the share of inputs from firm i in j, and M is a vector of own import intensities of direct importers. The Leontief inverse of import intensity takes into account all imports within a firm's supply chain and does not differentiate between different orders of suppliers. As we show later, the majority of supplier import intensity is from first order suppliers.

$$\begin{aligned}\Delta p_{f,i,k,t} = &\left(\beta_1 \varphi_{f,t-1}^{own} + \beta_2 \varphi_{f,t-1}^{indirect} + \alpha S_{f,i,k,t-1}\right)\Delta e_{k,t} + \dots \\ &\cdots + b_1 \varphi_{f,t-1}^{own} + b_2 \varphi_{f,t-1}^{indirect} + a S_{f,i,k,t-1} + \mu_{i,k,t} + \epsilon_{f,i,k,t}\end{aligned} \tag{8}$$

The dependent variable, $\Delta p_{f,i,k,t}$, is the (log) change in the producer currency (Turkish lira) price of the exported good i of firm f to destination country k from year $t-1$ to t. Goods (is) are defined at the CN 8-digit level. The price is proxied by its unit value, namely, the ratio of export values to export volume, given by $\Delta p_{f,i,k,t} \equiv \Delta log\left(\frac{\text{Export value}_{f,i,k,t}}{\text{Export volume}_{f,i,k,t}}\right)$, where volume corresponds to volume, amount, quantity, or weight. $\Delta e_{k,t}$ denotes the (log) change in the nominal exchange rate of domestic currency vis-a-vis the destination country k's currency. Thus defined, a positive $\Delta e_{k,t}$ implies a depreciation in the domestic currency.

Our identification is based on the variation in the import intensity, own or indirect, of exporters that export 'same' goods to the same destination country at the same year. To do so, we saturate the model with good×destination×year fixed effects ($\mu_{i,k,t}$).[11] $\mu_{i,k,t}$ further absorb any effects from common shocks to marginal costs across exporters of good i at year t to destination country k as well as the level of change in the exchange rate.

We are primarily interested in the interactions of $\Delta e_{k,t}$ with $\varphi_{f,t-1}^{own}$ and $\varphi_{f,t-1}^{indirect}$. Positive estimated values for β_1 or β_2 imply that an exporter with higher import intensity, through its own reliance on imports (β_1) or through its reliance on import-intensive suppliers (β_2), raises its export prices more following a domestic currency depreciation, compared to exporters exporting to the same good to the same destination country at the same year. Moreover, we cluster standard errors at the destination country level, to take into account possible dependence in residuals for a given destination country across goods and years, which appears to provide more conservative standard errors than simple heteroskedasticity robust or firm- or product-level clustered standard errors.

To control for the mark-up channel in pricing, we proxy for the (ex-ante) market share of each exporter at a destination-good market, $S_{f,i,k,t-1}$. It is defined as the export share of firm f in total exports of Turkish firms to a given destination-good market in year $t-1$. Defining market shares based on a broader good category, e.g., the CN 4-digit level, yields very similar results. The mark-up channel, under certain conditions, suggests that the larger the market share, the lower the elasticity of demand facing the firm (see, e.g., Goldberg and Hellerstein 2008), which in our setting, corresponds to testing for whether α attains a positive value.

Note also that exporters' import intensities might be correlated with their destination-good market shares. In particular, exporters with a higher degree of reliance on imports may systematically have higher market shares within their destination-good markets. We later show that this is indeed the case in our data set (Table 2). Hence, excluding export market share would cause omitted variable bias.

[11] As we show in the Robustness section, we find virtually the same results if we were to exploit variation within the CN 4-digit good level.

We use firm-level averages of import intensities over the sample period to avoid potential noise in the import intensity measure caused by temporary shifts or responses to the exchange rate. Supporting our use of sample averages, we find that a firm's degree of reliance on imports is by and large an underlying characteristic of the firm. Our auxiliary regressions of $\varphi_{f,t}^{own}$ or $\varphi_{f,t}^{agg}$ on firm fixed effects yield an R^2 of 0.91 and 0.90, respectively.[12] We later show that using lagged and contemporary values of import intensities in the regressions does not significantly alter the results.

We extend our baseline specification on two fronts. First, we directly estimate the impact of the marginal change in import costs due to exchange rate variations on export prices. Second, we include proxies in our baseline specifications for exporter market shares within the domestic supply network.

Marginal Cost Channel. We assess whether the marginal cost channel due to reliance on imports is operational. Intuitively, due to imported goods becoming more expensive in domestic currency terms following a domestic currency depreciation, exporters' with higher direct/indirect reliance on imported goods potentially face a greater upward pressure on overall production costs. Along these lines and using firm-product-source country-year-level imports database, we incorporate a measure of imports-driven marginal costs in our baseline specification.

We start with calculating imports-driven marginal costs, by aggregating changes in import costs across goods and source countries for a given firm and year, and normalizing the resulting number with total cost of sales:

$$\Delta\widehat{MC_{f,t}}^{own} \equiv \frac{\sum_{c\in C_{f,t}}\left(\sum_{i\in I_{f,t}}\Delta e_{c,t}\text{Import Value}_{f,i,c,t}\right)}{\text{Cost of Sales}_{f,t}} \tag{9}$$

In equation (10) below, we further introduce the exposure of an exporter to suppliers' imports-driven marginal costs. Similar as above, we calculate imports-driven increase in production costs for each supplier. We then take weighted average of these cost changes – using each supplier's share in exporter's total supplier purchases as weights, and finally, adjust the resulting number with by how much the exporter relies on supplier purchases for production:

$$\Delta\widehat{MC_{f,t}}^{indirect} \equiv \frac{\text{Supplier Purchases}_{f,t}}{\text{Cost of Sales}_{f,t}}\sum_{n=1}^{N_{f,t}} w_{f,n,t}\Delta\widehat{MC_{f,n,t}} \tag{10}$$

where $\Delta\widehat{MC_{f,n,t}}$ denotes imports-driven increase in production costs for supplier n of exporter f.

[12] A potential reason for why exporters have their import intensities largely unchanged following changes in the exchange rate might be due to costly adjustment in changing the production structure or buyer-supplier linkages (e.g., exporters may not easily switch to suppliers with low import use after a domestic currency depreciation). For evidence that inter-firm linkages are in general costly to adjust, see Huneeus (2018).

Along these lines, we modify our baseline specification by including $\Delta\widehat{MC_{f,t}}^{own}$ and $\Delta\widehat{MC_{f,t}}^{indirect}$ as our focus variables, given by

$$\Delta p_{f,i,k,t} = \alpha_1 \Delta\widehat{MC_{f,t}}^{own} + \alpha_2 \Delta\widehat{MC_{f,t}}^{indirect} + OTHERS + \mu_{i,k,t} + \varepsilon_{f,i,k,t} \quad (11)$$

where *OTHERS* include all the variables in our baseline specification (own and indirect import intensities as well as export market shares – in levels and in interaction with changes in the exchange rate). If, for instance, indirect import intensity operates through the marginal cost channel, we would expect indirect import intensity losing its predictive power once indirect marginal cost is included.

Exporters' Domestic Market Power. Second, motivated by Kikkawa et al. (2019) who show that market power within the domestic supply network can lead to significant mark-ups, we extend our baseline specification with exporters' market concentration within their domestic supply networks. In particular, we define a Herfindahl-Hirschman concentration index within the domestic supply market of each exporter at each year, given by

$$\mathcal{C}_{f,t} = \sqrt{\sum_{n=1}^{N_{f,t}} \left(\frac{\text{Purchased Value}_{n,f,t}}{\text{Supplier Purchases}_{f,t}} \right)^2} \quad (12)$$

where higher values of $\mathcal{C}_{f,t}$ imply a higher domestic supplier market concentration for the exporting firm f.[13] Not controlling for domestic market concentration may also be introducing omitted variable bias to the estimation if it is correlated with import intensities. We use the lagged value of $\mathcal{C}$ in the estimations to account for the possibility that exporters may dynamically adjust their supplier composition.

To this end, our most saturated specification is given by:

$$\begin{aligned} \Delta p_{f,i,k,t} = &\left(\beta_1 \varphi^{own}_{f,t-1} + \beta_2 \varphi^{indirect}_{f,t-1} + \alpha S_{f,i,k,t-1} + \gamma \mathcal{C}_{f,t-1} \right) \Delta e_{k,t} + \alpha_1 \Delta\widehat{MC_{f,t}}^{own} \\ &+ \alpha_2 \Delta\widehat{MC_{f,t}}^{indirect} + \dots \\ &\cdots + b_1 \varphi^{own}_{f,t-1} + b_2 \varphi^{indirect}_{f,t-1} + a S_{f,i,k,t-1} + g \mathcal{C}_{f,t-1} + \mu_{i,k,t} + \varepsilon_{f,i,k,t} \end{aligned} \quad (13)$$

4 Data

We use several large-scale administrative databases. The first database is the customs data for the universe of firms in Turkey that export and/or import, with details including the value, amount, destination/source country and product code at the CN

[13] Alternatively, as a proxy for an exporter's market power within its suppliers, we also calculate the share of the largest supplier in an exporter's total supplier purchases. When we use this measure in our regressions – to be presented below, our results remain strongly robust.

12-digit level for each customs transaction.[14] This database is provided by the Turkish Ministry of Customs. The second database, provided by Turkish Ministry of Treasury and Finance, provides complete balance sheets and income statements for virtually all the firms.[15] Third, we use Social Security Institute records of employment (from December of each year) to construct firm labor costs. The final database is firm-to-firm sales. It is provided by the Turkish Ministry of Treasury and Finance, is based on the invoices for value-added tax purposes. It provides all firm-to-firm transactions above a relatively small threshold, 5,000 TL (which on average corresponds to about 2,500 US dollars based on average exchange rate over our sample period) together with buying and selling firm identifiers. All databases are matched at the Entrepreneurship Information System (EIS) of the Turkish Ministry of Industry and Technology. Our sample period runs from 2006 to 2016 on an annual basis.

We supplement our administrative supervisory datasets with exchange rate data. A recent literature has documented that movements in the currency of invoicing determines exchange rate pass through. Unfortunately, our data do not include the currency of invoicing at the transaction level. We can, however, use aggregate-level data to proxy for the currency of invoicing in Turkey (Amiti et al. 2020a; Chen et al. 2019). A large majority of Turkish exports are invoiced in USD or Euros (47% in Euros and 46% in US dollars).[16] For the baseline or unless otherwise noted, we use the TRY against Euro exchange rate for exports to European Monetary Union (EMU) countries and the TRY against the USD exchange rate for the remaining countries. The same pattern persists for imports (33% in Euros and 61% in US dollars) and we use the same proxy for invoice currency of imports when we estimate changes in import marginal costs. We further use bilateral exchange rates of Turkish lira against source and destination country currencies as a robustness test.

We limit the sample to exports where the absolute value of the change in export price does not exceed 100%, since changes in the prices of goods defined at a CN 8-digit level, however, highly disaggregate it is, may still reflect compositional changes or measurement errors. In order to rule out outliers or potential measurement errors, we exclude very small exports which we define as below 100 US dollars. Finally, since our dependent variable is in terms of changes, an exporter-good-destination-level transaction is included in our sample if it is observed consecutively for two years.

Our final sample consists 64,387 exporting firms, which export to 215 countries (including special administrative units, e.g., Gibraltar, Marshall Islands, French

[14] Classification of goods at a CN 8-digit level follows an international standard, and we use this level of disaggregation in our estimations. More disaggregated classifications, e.g., CN 12-digit level as reported by the Turkish Ministry of Customs, may be used, but would be too restrictive since our dependent variable is in terms of changes (i.e., we would then include only those that export the same CN 12-digit level good for two consecutive years). The results are strongly robust, though, to using CN 12-digit classification (available upon request).

[15] Firms with annual gross sales above a relatively modest threshold of around 200,000 Turkish liras (c.a. 100,000 US dollars) report their balance sheets. Since exporters are on average larger than the rest of the firms, we have balance sheet and income statements for almost all the exporters.

[16] See https://www.ticaret.gov.tr/istatistikler/dis-ticaret-istatistikleri for details.

Guiana, Dutch Antilles). There are 739,091 firms that directly supply to exporters, implying on average that there are more than 11 suppliers for each exporter (Table 1). In sum, a significant number of firms in the economy eventually contributes to the exporting activity.

Consistent with the literature that documents for a wide range of countries how exporting firms in general differ from the rest of the firms (see, e.g., Melitz 2003; Mayer and Ottaviano 2007; Amiti et al. 2014), we find that exporters are more likely to import. We also find that exporting firms are on average larger (they have more than three times as many employees as supplier firms or other firms in the firm-to-firm trade), have higher sales and are more productive – higher sales per employee (Table 1).

Importantly, suppliers' use of imports counts for exporters' overall degree of reliance on imports. For instance, an exporter's probability of being also an importer is 61%, but once their suppliers are taken into account, this figure raises as high as 95% (Table 1). Moreover, the distribution of exporters' import intensity shifts right and become considerably flatter (Fig. 1).[17]

Finally, we check how exporters' import intensity has evolved over time (Fig. 2). We plot exporters' own, indirect as well as aggregate import intensities, weighted by export values to have a time-aggregate figure. Exporters' own intensity fluctuates around 25%. Once their reliance on import-intensive supplies is taken into account, the aggregate import intensity reaches close to 40%. We observe a mild decline in aggregate import intensity after 2013 and particularly after 2008 (during which Turkish lira depreciated sharply).

In sum, the key message is that focusing on exporters' own import intensity misses an important ingredient of their 'true' import reliance: the degree of their suppliers' reliance on imports. Once suppliers are taken into account, exporters' reliance on imports almost doubles, and the cross-sectional variation in the degree of exporters' reliance on imports increases strongly.

Market concentration within exporters' domestic supply networks ($\mathcal{C}$) may also matter for the pass-through, not only due to reflecting a potential mark-up channel but also ignorance of which may entail an omitted variable bias if it is correlated with import intensities. Indeed, as Table 2 shows, exporters with a higher degree of own or aggregate import intensity have a lower degree of concentration in their domestic supplier markets. For exporters with higher indirect import intensity, we observe a higher supplier market concentration.

Table 3 presents the summary statistics of the variables used in the main regression analyses. When evaluating economic impacts, we will refer to the 10th and the 90th percentiles of the variable of interest. The table further shows that the average annual change in both own import intensity and indirect import intensity are close to 0, which support the suggestion that changing suppliers is costly.

[17] An increase in the cross-sectional variation in exporters' import intensity also helps for better identification.

Table 1 Summary Statistics: Exporters, Suppliers, and Other Firms in the Supply Network

	Exporters	Suppliers	Non-Exporters
Prob. of being an importer	0.61	0.17	0.06
Prob. of being an importer (agg)	0.95	–	–
Employment	43.61	12.66	6.64
Net sales (log)	14.93	13.51	12.74
Sales per employment (000s, TL)	924.06	661.55	548.78
N	64,387	739,091	1,302,840

Suppliers are firms that supply to at least one exporting firm (regardless of whether the supplier itself is an exporter or not). Non-exporters include all firms that do not export in any year (but may supply an exporting firm)

5 Empirical Results

5.1 Import Intensity Results

Table 4 presents the baseline results for import intensity. We start with a modest specification that includes exporters' own import intensity and export market shares, and saturate the model with good×destination and year fixed effects (column 1). Good×destination fixed effects absorb time-invariant destination country demand for a given product, and year fixed effects any demand or marginal cost shocks common to all exporters. The aggregate pass-through estimate, evaluated at the means of own import intensity and export market share, is 22%. That is, following a 10% domestic currency depreciation, firms raise their producer-currency export prices by 2.2%. The estimated pass-through is low compared to short-run exchange rate pass-through estimates in Turkey, but is in line with the estimate of Bussière et al. (2014), who find a long-run exchange rate pass-through of 28% for Turkish exports. Since our data are on an annual basis, we expect our pass-through estimate to be closer to long-run estimates. Moreover, as given by the estimated coefficient for the interaction of own import intensity with the change in the exchange rate, exporters that rely more on imports raise their export prices significantly more following an exchange rate depreciation. Lastly, having a larger share at a destination×good market has an increasing effect on the exchange rate pass-through.

Our preferred specification controls for any time-varying common demand-side effects or marginal costs across exporters within the same good-destination market, by including good×destination×time fixed effects (columns 2 to 5). Column (2) confirms previous literature, in that exporters with greater reliance on imported inputs raise their producer-currency export prices significantly more. Numerically, and using the percentile values reported in Table 1, we estimate that moving an exporter from the 10th to the 90th percentile of own import intensity would raise the estimated pass-through by 3.5 percentage points.

In column (3), we include indirect import intensity into the picture. We find that exporters relying more on import-intensive suppliers have significantly higher

Table 2 Summary Statistics: Pairwise Correlations of Import Intensity with Export Market Share and Supplier Concentration

	Own import intensity	Indirect import intensity	Aggregate import intensity	Export market share	Supplier concentration
Own import intensity	1				
Indirect import intensity	-0.1351	1			
Aggregate import intensity	0.8654	0.3797	1		
Export market share	0.106	0.0879	0.1434	1	
Supplier concentration	−0.2699	0.1838	−0.159	−0.0005	1

All pairwise correlations are statistically significant at the 1% level

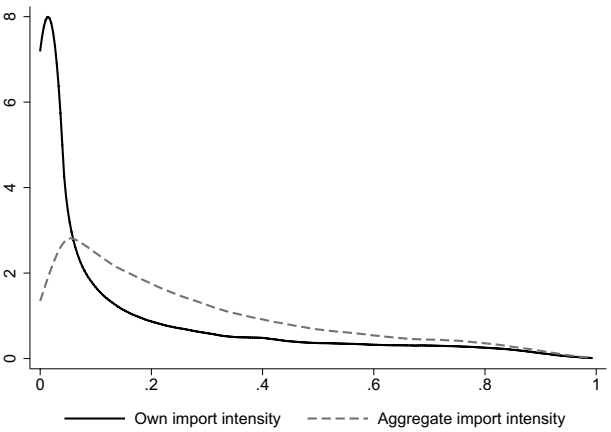

Fig. 1 Import intensity of exporters. *Notes:* The figure plots the density estimates of exporters' own (solid line) and aggregate (dashed line) import intensities. Aggregate import intensity is the summation of own and indirect import intensities. Own import intensity for an exporter is defined as the ratio of its total imports to the total cost of sales (the sum of total labor costs and material costs). Indirect import intensity of an exporter is defined as supplier purchases-to-total cost sales ratio multiplied by weighted average of own import intensities of its suppliers

pass-through. Numerically, evaluated at the respective percentiles, exporters with higher indirect import intensity have an estimated degree of pass-through by 3.6 percentage points higher (whereas the effect of own import intensity on the pass-through is 4.7 percentage points). The economic significance of indirect import intensity is lower than that of first-order intensity, indicating that the supplier can absorb some of the change in costs due to the exchange rate or the exporters' ability to switch suppliers.

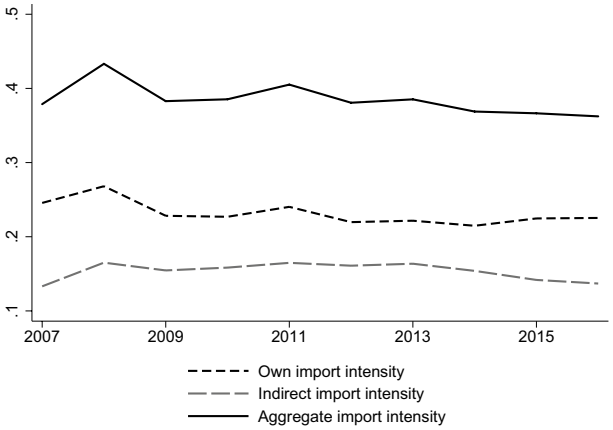

Fig. 2 Exporters' Import Intensity over Time. *Notes:* The figure plots how exporters' own, indirect or aggregate import intensities have evolved over time. In aggregating these import intensity measures, we weight the intensity of each exporter by its total export volume at a given year

The fourth and the final columns of Table 4 use aggregate import intensity of exporters, obtained by adding up exporters' own and indirect import intensity measures. As we move an exporter from the 10th to the 90th percentile of the aggregate import intensity measure, the exchange rate pass-through gets higher by 6.2 percentage points. Comparing this estimated magnitude with column (2) (which includes only the own import intensity of exporters) clearly demonstrates that the effect of import intensity on exchange rate pass-through is underestimated if the indirect import intensity is not accounted for.

5.2 Alternative Measurements of Import Intensity

There are alternative ways to measure import intensity. In this section, we conduct several robustness tests to ensure that our results reflect the impact of direct or indirect import intensities on the exchange rate pass-through (Table 5). Column (0) reports the baseline estimates for ease of comparison.

5.2.1 Third-Order Indirect Import Intensity

So far, we show that within a product-destination market at a given year, exporters working more with import-intensive suppliers raise their prices significantly more following a domestic currency depreciation. Adding another layer of suppliers, we now construct third-order import intensity (where the first corresponding to own import intensity, and the second corresponding to indirect import intensity).

In particular, for each supplier n, we calculate the import intensity of its suppliers, i.e., for all suppliers $m \in M_{n,t}$ of a supplier n to an exporter firm f, and then weight these intensities with the volume of supplied amount (namely, $w_{n,m,t}$,

Table 3 Summary Statistics: Regression Variables

Variables	Symbol	Definition	Mean	Median	SD	10%	90%	N
Δ log(Price)	$\Delta P_{f,i,k,t}$	Log change in producer-currency (TL) price of export good *i* (defined at the CN-8 digit) by exporter*f* to destination country *k*, from year *t-1* to *t*	0.0646	0.0782	0.3575	-0.3981	0.5090	2646190
Own import intensity	$\vartheta_{f,t}^{own}$	Total Imports / Cost of Sales of firm *f*	0.1323	0.0269	0.1929	0.0000	0.4385	2646190
Δ Own import intensity	$\Delta\ \vartheta_{f,t}^{own}$	Annual change in own import intensity	-0.0022	0.0000	0.0645	-0.0526	0.0450	1311394
Indirect import intensity	$\vartheta_{f,t}^{indirect}$	Weighted average "Imports / Cost of Sales" of firm *f*'s suppliers multiplied by "Supplier Purchases / Cost of Sales"	0.1152	0.0868	0.1045	0.0198	0.2462	2646190
Δ Indirect import intensity	$\Delta\ \vartheta_{f,t}^{indirect}$	Annual change in indirect import intensity	-0.0029	-0.0009	0.0545	-0.0515	0.0439	1311394
Aggregate import intensity	$\vartheta_{f,t}^{agg}$	The sum of own and indirect import intensities ($\vartheta_{f,t}^{own} + \vartheta_{f,t}^{indirect}$)	0.2474	0.1862	0.2066	0.0337	0.5689	2646190
Third-order import intensity	$\vartheta_{f,t}^{Third-Order}$	Weighted average aggregate import intensity of suppliers of exporter *f*, multiplied with "Total Supplier Purchases / Cost of Sales" of exporter *f*	0.0890	0.0791	0.0582	0.0311	0.1565	2646190
Δ Own marginal cost	$\Delta MC_{f,t}^{own}$	Change in marginal costs due to imports and foreign exchange rate movements, as a fraction of total cost of sales.	0.0095	0.0002	0.0226	0.0000	0.0370	2290315
Δ Indirect marginal cost	$\Delta MC_{f,t}^{indirect}$	Weighted average Δ Own Marginal Cost of suppliers of exporter *f*, multiplied with "Total Supplier Purchases / Cost of Sales" of exporter *f*	0.0075	0.0043	0.0132	-0.0005	0.0208	2290315
Export market share	$S_{f,i,k,t}$	Share of exports of good *i* by firm *f* for destination country *k*	0.1319	0.0290	0.2180	0.0009	0.4485	2646190
Supplier concentration	$\boldsymbol{C}_{f,t}$	Herfindahl–Hirschman concentration index within domestic supplier markets of exporters	0.4447	0.3542	0.2679	0.1720	0.9475	2617299
Source country share	–	Share of a source country in total imports of CN-4 product category by firm *f*	0.3287	0.2427	0.28185	0.02765	0.7882	2642226
Imports	–	Total Imports of CN-4 product category by a firm *f*	0.0417	0.0038	0.1121	0.0001	0.1062	2646190
Number of source countries	$\mathbf{N}_{f,s,t}$	Total number of source countries for imports of CN-4 product category by a firm *f*	0.3773	0.2755	0.2789	0.1109	0.9118	2642226

Table 4 Baseline Results

Dependent variable: Log-change in export price ($\Delta P_{f,i,k,t}$)	(1)	(2)	(3)	(4)
Δ $ER_{k,t}$ * Own Import Intensity	**0.0162**	**0.0801*** **	**0.1084*** **	
	(0.0279)	(0.0250)	(0.0265)	
Δ $ER_{k,t}$ * Indirect Import Intensity			**0.1607*** **	
			(0.0387)	
Δ $ER_{k,t}$ * Aggregate Import Intensity				**0.1157*** **
				(0.0252)
Δ $ER_{k,t}$ * Export Market Share	**0.0554*** **	**0.0688*** **	**0.0654*** **	**0.0659*** **
	(0.0166)	(0.0212)	(0.0210)	(0.0211)
Δ $ER_{k,t}$	**0.2209*** **			
	(0.0178)			
Good x Destination *and* Year FE	Yes	–	–	–
Good x Destination x Year FE	No	Yes	Yes	Yes
Observations	2,646,190	2,646,190	2,646,190	2,646,190
R-squared	0.056	0.208	0.209	0.209

Standard errors are clustered at the destination level, and given in parentheses. In all columns, the levels of interacted variables are also included (not reported for brevity). ***Significant at 1%, **Significant at 5%, and *Significant at 10%

the weight of a firm m among all $M_{n,t}$ firms that supply to the supplier $n \in N_{f,t}$ at year t). We, therefore, obtain the indirect import intensity of supplier n. The indirect import intensity of the supplier is then weighted by the share of purchases from suppliers in the cost of sales of the supplier firm n, and the resulting weighted import intensity measure are summed using the supplier weights $w_{f,n,t}$ and the share of purchases from suppliers in the cost of sales of the main exporting firm f. The resulting formula, similar in intuition to equation (6), reads as

$$\varphi_{f,t}^{\text{Third-Order}} \equiv \frac{\text{Supplier Purchases}_{f,t}}{\text{Cost of Sales}_{f,t}} \sum_{n=1}^{N_{f,t}} w_{f,n,t} \left[\frac{\text{Supplier Purchases}_{n,t}}{\text{Cost of Sales}_{n,t}} \left(\sum_{m=1}^{M_{n,t}} w_{n,m,t} \frac{\text{Import Value}_{n,m,t}}{\text{Cost of Sales}_{n,m,t}} \right) \right] \tag{14}$$

Columns (1) and (2) show the effects of third-order indirect import intensity on exchange rate pass-through to export prices. Column (3) reports a positive yet insignificant effect of third-order import intensity on the pass-through, suggesting that the effect of import intensity wanes as we move further down the supply chain. In column (2), we re-define aggregate import intensity, by summing up own, indirect *and* third-order import intensities. The estimated effect is only slightly higher compared to baseline estimated effect.

Table 5 Robustness

Specification:	Baseline	Third-order import intensity	Aggregate import intensity (including third-order)	Lagged time-varying import intensity ($\vartheta f \equiv \vartheta f,t-1$)	Contemp. Time-varying import intensity ($\vartheta f \equiv \vartheta f,t$)	Sector-level import intensity	Bilateral exchange rates	Intermediate imports	CN 4-digit
Dependent variable: Log-change in export price ($\Delta P_{f,i,k,t}$)	(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta ER_{k,t}$ * Own import intensity	**0.1084*** **	**0.1155*** **		**0.0707*** **	**0.0990*** **	**0.0167**	**0.0238**	**0.1119*** **	**0.1006*** **
	(0.0265)	(0.0301)		(0.0223)	(0.0228)	(0.0767)	(0.0243)	(0.0235)	(0.0193)
$\Delta ER_{k,t}$ * Indirect import intensity	**0.1607*** **	**0.1622*** **		**0.0680***	**0.1054*** **	**0.5847*** **	**0.0973*** **	**0.1872*** **	**0.0726***
	(0.0387)	(0.0395)		(0.0354)	(0.0353)	(0.2066)	(0.0342)	(0.0357)	(0.0383)
$\Delta ER_{k,t}$ * Export market share	**0.0654*** **	**0.0654*** **	**0.0660*** **	**0.0681*** **	**0.0668*** **	**0.0609*** **	**0.0876** **	**0.0644*** **	**0.0664*** **
	(0.0210)	(0.0210)	(0.0211)	(0.0209)	(0.0211)	(0.0010)	(0.0338)	(0.0250)	(0.0314)
$\Delta ER_{k,t}$ * Third-order import intensity		**0.0540**							
		(0.0969)							
$\Delta ER_{k,t}$ * Aggregate import intensity			**0.1255*** **						
			(0.0280)						
Good x Destination x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,646,190	2,646,190	2,646,190	2,646,190	2,646,190	2,624,239	2,646,190	2,646,190	2,182,599
R-squared	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.132

Standard errors are clustered at the destination level, and given in parentheses. ***Significant at 1%, **Significant at 5%, and *Significant at 10%

5.2.2 Time-Varying Import Intensities

As we have discussed previously, so far we take the sample average of import intensity mainly to avoid noise in the estimations. To show that our results are robust to this assumption, we now use lagged (or contemporaneous) values of import intensities (columns 3 and 4, respectively). The results are qualitatively robust – with stronger results when we use contemporaneous import intensities, possibly due to our using low frequency (annual) data.

5.2.3 Sector-Level Import Intensities

In the absence of micro-level data, the standard approach to estimating import intensity of production is to use sector-level input–output and import values. We use the estimates of Ozcan Tok and Sevinc (2019) who estimate the import intensity of production using Turkish Statistical Institute data to measure import intensity at the sector level.[18] They calculate both direct import intensity using the ratio of sector-level imports to output and indirect import intensity using the Leontief inverse of sector-level input–output tables from 2012. They find that the aggregate import intensity of production to be around 19.3% in Turkey. 10.6% of this figure is from direct imports of the sector and 8.7% is from indirect supply linkages. The results in column (4) suggest that sector-level import intensity is too noisy to accurately capture the effect on exchange rate pass-through. Direct import intensity has a positive, though statistically insignificant effect. Indirect import intensity is positive and statistically significant but nearly 4 times as large as the baseline micro-level estimate. The larger coefficient estimate is likely due to the systematic underestimation of import intensity at the sector level since both exporters and their suppliers are more likely to import than other firms.

5.2.4 Bilateral Exchange Rates

So far, we have assumed that exports to the EMU countries are invoiced in Euros (a natural assumption), and to other countries in US dollars. This assumption is not as restrictive as it may seem since for exports to non-EMU countries, 87% are invoiced in US dollars. For completeness, we now use the bilateral exchange rates of Turkish lira against the currency of each destination country (column 6).

While we continue to find a positive impact of exporters' own import intensity on the pass-through, it loses its statistical significance. For indirect import intensity, we find significant yet weaker estimates than the baseline. These results are inline with the fact that US dollar or Euro exchange rates are important drivers of Turkish firms' import costs,[19] and in turn, potentially has a bearing on their pricing of exports to third-party countries.

[18] In Ozcan Tok and Sevinc (2019), the level of aggregation is close to the 2-digit NACE level, but some sectors are aggregated by Turkish Statistical Institute to the 1-digit level.

[19] Turkish Statistical Institute reports that 61% of Turkish imports (of exporters and non-exporters) are invoiced in US dollars, and 33% in Euros (on average over our sample period).

5.2.5 Intermediate Import Goods

The key mechanism behind our results is that, following an exchange rate depreciation, exporters with a higher degree of direct or indirect reliance on imports face higher cost of production and in turn are left to raise their export prices more. Before we study this mechanism in the next section in more detail, we would like provide further evidence. We now exclude imports classified as a final good (using Broad Economic Categories, BEC, Rev.4), and use only the intermediate import goods when calculating the import intensities of exporters or their suppliers (column 7). The results are strongly robust. Exporters that rely more on imported intermediate goods, directly or through their suppliers, raise their prices significantly more following an exchange rate depreciation.

5.2.6 Estimates at the CN 4-digit Good Level

So far we have been using export goods defined at a CN 8-digit level, the highest level of disaggregation that complies with the international standards. An alternative would be to use a coarse definition for goods, which on the one hand, provides more observations per goods per destination country, and thus, may help us reach better inferences, but on the other, entails the risk of having weakly comparable goods. In case this trade-off is resolved in favor of the former, we now study export goods defined at the CN 4-digit (column 8). The own and indirect import intensity continue to have a positive impact on the pass-through, with weaker estimates for the latter.[20]

5.3 Marginal Costs and Domestic Market Power

The mechanism, as we also argued above, for why exporters with higher degrees of direct or indirect import intensities set higher prices following a domestic currency depreciation is the marginal cost channel. By using firm-product-source country-year-level imports database, we modify our baseline specification by including firm-level imports-driven change in costs (of the exporter due to own imports, $\widehat{MC}_{f,t}^{own}$, or indirectly through its suppliers' imports, $\widehat{MC}_{f,t}^{indirect}$) and evaluate whether our import intensity measures continue to matter (see equation 11).

We start Table 6 with a modest specification that includes $\widehat{MC}_{f,t}^{own}$ and $\mu_{i,k,t}$ (column 1). Among exporters exporting the same good i to the same destination country k at year t, exporters with a higher increase in production costs raises its export prices significantly more – due to its importing goods from countries, currencies of which on average got more valued against the domestic currency–. Numerically, the estimated coefficient implies that a one-percentage-point

[20] Our results are also strongly robust to exploiting the cross-sectional variation in import intensities of exporters that export the same – but wider – product category to the same destination country at the same year. When we replaced good×destination×year fixed effects, $\mu_{i,k,t}$, in our baseline regression (equation 8) with sector×destination×year fixed effects, where sectors are defined more broadly than goods (CN 4-digit-level sectors vs. CN 8-digit-level goods), our results remained similar.

increase in marginal costs due to to imports raises export prices by around 0.13%. Alternatively, moving an exporter from the 10th percentile to the 90th percentile of $\widehat{MC}_{f,t}^{own}$ implies an increase in export prices by 0.49%. In column (2), we include own import intensity and export market share. We observe that own import intensity loses its predictive power, implying that the marginal cost channel is operational.

In columns (3) and (4), we then include indirect marginal costs. We find that exporters with higher indirect marginal costs, too, raise their export prices more. Economically, the estimated coefficients imply that a one-percentage-point increase in indirect (direct) marginal costs raises export prices by 0.156% (0.152%). Evaluated at respective percentiles, the effect of indirect marginal costs is smaller than that of direct marginal costs. Moving an exporter from the 10th to the 90th percentile of indirect marginal costs raises export prices by 0.23% more, whereas for direct marginal costs that estimate corresponds to 0.63%. Indirect import intensity remains statistically significant in column (4), where the coefficients for both the indirect marginal cost and import intensity are smaller than the baseline estimates. This likely reflects the multicollinearity between these two variables.

In remaining columns, we conduct a few additional tests. In column (5), we use bilateral exchange rates with destination country currencies. Our result is largely robust: own or indirect marginal cost significantly matters (with the former playing a larger role), and own or indirect import intensities losing their predictive power or getting weaker.

In columns (6) and (7), we further include supplier concentration (the market concentration of suppliers for a given exporter) to reflect the domestic mark-up channel. Intuitively, if the mechanism, suppliers' passing on increasing costs to their downstream exporters, is in place, we would expect exporters with lower bargaining power within their supply network to set higher prices after a depreciation in the exchange rate. Moreover, controlling for supplier concentration may also be important for our estimations since it is correlated with import intensity measures. Inline with this intuition, we find supportive evidence that exporters with a higher concentration within their domestic supplier markets have higher pass-through into export prices (statistically significant in column (6), though not in column (7)).

We conduct a similar analysis in Table 7, except that here we calculate own and indirect marginal costs using changes in EUR/TRY exchange rate for imports from EMU countries and changes in USD/TRY exchange rate for imports from the rest of the economies. The results suggest a stronger role for the marginal cost channel (particularly for the indirect reliance on imports). Indirect import intensity is no longer significant once indirect marginal costs are included, which suggests that simplifying the exchange rate currencies to match invoice currencies more precisely

Table 6 Exploring the Mechanism

Specification:	Baseline	Own marginal costs	Own marginal costs and Own import intensity	Own&Indirect marginal costs	Own&Indirect marginal costs and Own&Indirect import intensity	Column (4) with Δ $ER_{k,t}$ taken bilateral	Column (4) with Supplier Concentration	Column (4) with Δ $ER_{k,t}$ taken bilateral and Supplier Concentration
Dependent variable: Log-change in export price (Δ $P_{f,i,k,t}$)	(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δ Own marginal cost		**0.1344*** **	**0.1625*** **	**0.1524*** **	**0.1699*** **	**0.1853*** **	**0.1693*** **	**0.1873*** **
		(0.0273)	(0.0285)	(0.0292)	(0.0297)	(0.0271)	(0.0292)	(0.0269)
Δ Indirect marginal cost				**0.1568*** **	**0.1072*** **	**0.1257*** **	**0.0975*** **	**0.1222*** **
				(0.0262)	(0.0336)	(0.0307)	(0.0328)	(0.0299)
Δ $ER_{k,t}$ * Own import intensity	**0.1084*** **		**-0.0035**		**0.0211**	**-0.0253**	**0.0769** **	**-0.0106**
	(0.0265)		(0.0272)		(0.0291)	(0.0258)	(0.0315)	(0.0262)
Δ $ER_{k,t}$ * Indirect import intensity	**0.1607*** **				**0.1138*** **	**0.0716** **	**0.0993** **	**0.0592***
	(0.0387)				(0.0424)	(0.0322)	(0.0406)	(0.0322)
Δ $ER_{k,t}$ * Export market share	**0.0654*** **		**0.0698*** **		**0.0668*** **	**0.0889*** **	**0.0635*** **	**0.0864** **
	(0.0210)		(0.0211)		(0.0208)	(0.0333)	(0.0214)	(0.0334)
Δ $ER_{k,t}$ * Supplier concentration							**0.1086*** **	**0.0280**
							(0.0169)	(0.0190)
Good x Destination x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 6 (continued)

Specification:	Baseline	Own marginal costs	Own marginal costs and Own import intensity	Own&Indirect marginal costs	Own&Indirect marginal costs and Own&Indirect import intensity	Column (4) with Δ $ER_{k,t}$ taken bilateral	Column (4) with Supplier Concentration	Column (4) with Δ $ER_{k,t}$ taken bilateral and Supplier Concentration
Dependent variable: Log-change in export price (Δ $P_{f,i,k,t}$)	(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Observations	2,646,190	2,646,190	2,646,190	2,646,190	2,646,190	2,646,190	2,617,299	2,617,299
R-squared	0.209	0.208	0.209	0.209	0.209	0.209	0.210	0.210

Standard errors are clustered at the destination level, and given in parantheses. All columns include the levels of variables that appear in interaction terms. ***Significant at 1%, **Significant at 5%, and *Significant at 10%

captures the change in import costs. Moreover, we find more robust results for the domestic market concentration: a higher degree of price pass-through for exporters with a higher concentration within their domestic supplier markets.

If the domestic currency depreciates against the currency of a source country, exporters may choose to lower their imports from the source country and switch to other countries, or rely less on that imported good. Figure 3 confirms this intuition, where we plot the distribution of ex-ante and realized changes in imports-driven production costs. We calculate ex-ante changes in imports-driven production costs at t by assuming that costs of sales and the country and good composition of imports at $t-1$ had remained unchanged. The figure shows a clear shift to the left for the realized changes in costs, suggesting that exporters are adjusting their imports to limit the likely increase in costs due to reliance on imports. In Appendix, we formally test to what extent exporters' adjustments of imported inputs by shifting away from source countries and goods when the domestic currency depreciates against the source country currency.

6 Robustness and Heterogeneity

In this section, we provide several tests on the robustness and heterogeneity of the effects. We present the results for the specification with import intensity and change in marginal costs in Tables 8 and 9, respectively. Column (0) reports the baseline estimates for ease of comparison.

6.1 Weighted Estimates

So far, we treated each observation as equally relevant for the estimates. Consider, however, the possibility that import-intensive exporters may be exporting disproportionately more variety of goods to various destination countries but constitute only a small fraction of overall exports. In this case, our previous estimates would imply an upper bound for the effect of import intensities on the pass-through. We therefore re-estimate our baseline specification by assigning higher weights to higher export values. In particular, we use the log of export value at $t-1$ as the weight for each observation, and employ weighted least squares. The estimates, reported in column (1), are similar in magnitude to the baseline results (column (0)) for both import intensity and marginal costs.

6.2 Large Exporters

We next test whether there is an heterogeneity in the impact of import intensity on exchange rate pass through based on firm size. In column (2), we present the results for a limited sample of product-destination-level transactions with a value exceeding 10,000 USD.[21] In column (3), we limit our sample to exporters with more than 49 employees of which there are 11,694. Limiting the sample to high value transactions

[21] As evident from the number of observations, 10,000 USD is close to the sample median.

Table 7 Exploring the Mechanism (Marginal Costs calculated using USD and EUR)

Specification:	Baseline	Own marginal costs	Own marginal costs and Own import intensity	Own&Indirect marginal costs	Own&Indirect marginal costs and Own&Indirect import intensity	Column (4) with Δ $ER_{k,t}$ taken bilateral	Column (4) with Supplier concentration	Column (4) with Δ $ER_{k,t}$ taken bilateral and Supplier concentration
Dependent variable: Log-change in export price (Δ $P_{f,i,k,t}$)	(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δ Own marginal cost		**0.1235*** **	**0.2187*** **	**0.1517*** **	**0.2382*** **	**0.2069*** **	**0.2401*** **	**0.2139*** **
(based on USD and EUR)		(0.0254)	(0.0338)	(0.0284)	(0.0360)	(0.0272)	(0.0349)	(0.0272)
Δ Indirect marginal cost				**0.1753*** **	**0.1626*** **	**0.1787*** **	**0.1502*** **	**0.1792*** **
(based on USD and EUR)				(0.0289)	(0.0460)	(0.0320)	(0.0446)	(0.0312)
Δ $ER_{k,t}$ * Own import intensity	**0.1084*** **		**− 0.0740** **		**− 0.0593***	**− 0.0272**	**− 0.0050**	**− 0.0125**
	(0.0265)		(0.0286)		(0.0316)	(0.0265)	(0.0338)	(0.0247)
Δ $ER_{k,t}$ * Indirect import intensity	**0.1607*** **				**0.0484**	**0.0523***	**0.0387**	**0.0388**
	(0.0387)				(0.0535)	(0.0287)	(0.0514)	(0.0294)
Δ $ER_{k,t}$ * Export market share	**0.0654*** **		**0.0692*** **		**0.0657*** **	**0.0876** **	**0.0623*** **	**0.0850** **
	(0.0210)		(0.0211)		(0.0209)	(0.0337)	(0.0215)	(0.0338)
Δ $ER_{k,t}$ * Supplier concentration							**0.1085*** **	**0.0305***
							(0.0169)	(0.0184)

Table 7 (continued)

Specification:	Baseline	Own marginal costs	Own marginal costs and Own import intensity	Own&Indirect marginal costs	Own&Indirect marginal costs and Own&Indirect import intensity	Column (4) with Δ $ER_{k,t}$ taken bilateral	Column (4) with Supplier concentration	Column (4) with Δ $ER_{k,t}$ taken bilateral and Supplier concentration
Dependent variable: Log-change in export price (Δ $P_{f,i,k,t}$)	(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Good x Destination x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,646,190	2,646,190	2,646,190	2,646,190	2,646,190	2,646,190	2,617,299	2,617,299
R-squared	0.209	0.208	0.209	0.209	0.209	0.209	0.210	0.210

Standard errors are clustered at the destination level, and given in parantheses. All columns include the levels of variables that appear in interaction terms. ***Significant at 1%, **Significant at 5%, and *Significant at 10%

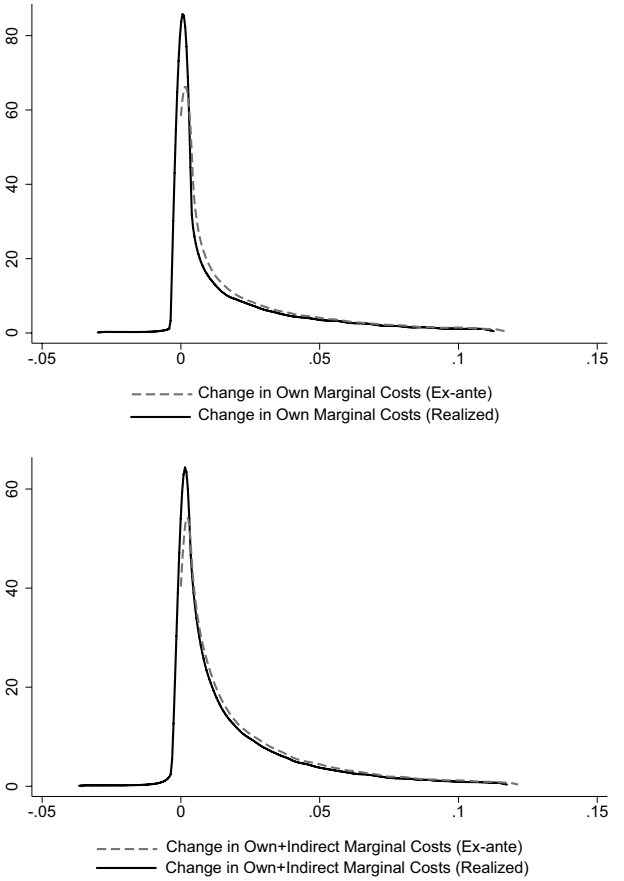

Fig. 3 Ex-ante vs. Realized Change in Import Costs. *Notes:* The figure plots the density estimates of ex-ante or realized change in own import costs (upper panel) or of own+indirect import costs (lower panel). We restrict the sample to those where ex-ante change in import costs (own or own+indirect) is positive, and plot the density of realized and ex-ante changes for this sample, to essentially show that import-intensive exporters are only partially able to limit the resulting increase in production costs following domestic currency depreciations

change the results little. On the other hand, for large firms, the estimated effects differ from the baseline. Direct import intensity does not have a statistically significant effect for the large firm sample and the change in the indirect marginal cost has an effect that is nearly twice as large as effect of the change in own marginal cost. One explanation might be that large firms are able to absorb shocks to own import costs by adjusting their cost structure but cannot adjust for cost shocks to their suppliers.

Focusing on large firms has the added advantage of serving as a robustness test for a potential bias due to a correlation between the pass-through of import costs to prices and currency denomination of exports. Even though 93% of Turkish exports are made in US dollars or Euros, currency choice may still affect the results. If firms

Table 8 Heterogeneity – Import Intensity

Specification:	Baseline	Weighted	High value	Large firms	Wholesale	Non-Wholesale	Main products
Dependent variable: Log-change in export price ($\Delta P_{f,i,k,t}$)	(0)	(1)	(2)	(3)	(4)	(5)	(6)
Δ $ER_{k,t}$ * Own import intensity	**0.1084*****	**0.1046*****	**0.1011*****	**0.0452**	**0.2905*****	**0.0037**	**0.0884*****
	(0.0265)	(0.0250)	(0.0322)	(0.0517)	(0.0390)	(0.0326)	(0.0306)
Δ $ER_{k,t}$ * Indirect import intensity	**0.1607*****	**0.1505*****	**0.1218****	**0.1749*****	**0.3233*****	**-0.0257**	**0.1193****
	(0.0387)	(0.0380)	(0.0555)	(0.0575)	(0.0611)	(0.0602)	(0.0496)
Δ $ER_{k,t}$ * Export market share	**0.0654*****	**0.0545****	**0.0312**	**0.0235**	**0.0493**	**0.0694*****	**0.0599*****
	(0.0210)	(0.0211)	(0.0216)	(0.0331)	(0.0362)	(0.0249)	(0.0219)
Good x Destination x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,646,190	2,646,190	1,396,663	938,617	941,134	1,434,654	1,943,870
R-squared	0.209	0.212	0.253	0.290	0.263	0.241	0.226

Standard errors are clustered at the destination level, and given in parentheses. ***significant at 1%, **significant at 5%, and *significant at 10%

Table 9 Heterogeneity – Marginal Costs

Specification:	Baseline	Weighted	High value	Large firms	Wholesale	Non-Wholesale	Main products
Dependent variable: Log-change in export price ($\Delta P_{f,i,k,t}$)	(0)	(1)	(2)	(3)	(4)	(5)	(6)
A – Bilateral							
Δ Own marginal cost	**0.1524*****	**0.1148*****	**0.1086*****	**0.1422*****	**0.2420*****	**0.0911*****	**0.1133*****
	(0.0292)	(0.0292)	(0.0159)	(0.0461)	(0.0259)	(0.0338)	(0.0230)
Δ Indirect marginal cost	**0.1568*****	**0.1322*****	**0.0700*****	**0.2483*****	**0.1881*****	**0.1101****	**0.0913*****
	(0.0262)	(0.0259)	(0.0226)	(0.0658)	(0.0481)	(0.0511)	(0.0267)
Good x Destination x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,646,190	1,254,615	1,396,663	938,617	941,134	1,434,654	1,924,788
R-squared	0.209	0.252	0.253	0.290	0.263	0.241	0.226
B – USD / EUR							
Δ Own marginal cost	**0.1517*****	**0.1054*****	**0.0882*****	**0.1147****	**0.2679*****	**0.0722****	**0.1064*****
(based on USD and EUR)	(0.0284)	(0.0278)	(0.0184)	(0.0458)	(0.0266)	(0.0314)	(0.0229)
Δ Indirect marginal cost	**0.1753*****	**0.1238*****	**0.0693****	**0.2255*****	**0.2243*****	**0.1142****	**0.1155*****
(based on USD and EUR)	(0.0289)	(0.0302)	(0.0288)	(0.0591)	(0.0459)	(0.0452)	(0.0285)
Good x Destination x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,646,190	1,254,615	1,396,663	938,617	941,134	1,434,654	1,924,788
R-squared	0.209	0.252	0.253	0.290	0.263	0.241	0.226

Standard errors are clustered at the destination level, and given in parentheses. ***Significant at 1%, **Significant at 5%, and *Significant at 10%

that use destination country currencies are more likely to have high import intensity and exchange rate pass-through, our results may be upward biased. Amiti et al. (2020b) find that large firms are more likely to use US dollars in exports from Belgium. If a similar trend holds for Turkey, we would expect the sample of firms with more than 49 employees to pre-dominantly use US dollars or Euros for their exports. While the effects are in fact smaller for own import intensity, the results remain robust for own and indirect marginal costs and indirect import intensity.

6.3 Wholesale Exporters

A natural test for whether import intensities matter for the pass-through is to focus on a subset of firms which are less able to shift increasing marginal costs to other inputs like labor following a cost shock, and assess whether our key results hold. Wholesale traders can serve this purpose. In particular, we define wholesale exporters as those exporters in the NACE-2.46 industry ("Wholesale trade, except of motor vehicles and motorcycles"). Columns (4) and (5) show the results are for wholesale and non-wholesale exporters separately. It is worth noting that wholesale traders make-up a third of the export transactions in Turkey during our sample period.

For a given increase in direct or indirect import intensity, the estimated effects for wholesale traders on the pass-through are at least twice as high as the baseline estimates. This increase is observed for the change in own marginal costs as well, where the coefficient increases by around 50%. On the other hand, the effect of import intensity measures are insignificant for non-wholesale trade exporters. The effect of the change in marginal costs are also smaller (though still statistically significant and positive) for the non-wholesale exporter sample. Results imply that wholesale traders are more likely to pass through changes in their import costs and that the measure for the change in the marginal cost is more likely to capture smaller effects on exchange rate pass-through.

It is also important to understand the role wholesale traders play for Turkish exports. The own import intensity of wholesale trader exporters is much lower than that for the rest of the exporters (0.3% vs 9.9%, comparing the medians). This suggests that they are not merely re-exporting imported products. Moreover, wholesale trader exporters make more than 60% of their firm-to-firm purchases from the manufacturing sector -a key source of export products in Turkey. This suggests that wholesale trader exporters act as an intermediary for the manufacturing exporters in Turkey. In fact, the manufacturing sector as a whole makes nearly 45% of their firm-to-firm sales to wholesale traders, which further confirms the wholesale traders' intermediary role.

6.4 Major Export Products

Firms generally produce not only a single product but many, and the production technology for each good may differ (Eckel and Neary 2010; Chatterjee et al. 2013). Exporters should be no exception. For example, a firm in our sample exports an average of 3 unique CN-2-level varieties.[22] Since there are no data on the use of imported goods or cost of production for each variety produced by a firm, it is practically not feasible to differentiate the role of import intensity across varieties within an exporter. As a remedy, we make a plausible assumption that import use is particularly relevant for the main products of an exporter. We define main products of an exporter as those product categories (defined at the CN 2-digit level) that make-up at least 10% of its total exports during the sample period.[23] We then re-estimate our baseline specification for only the main products.

Column (6) shows that our results remain qualitatively robust. Own and indirect import intensities and changes in marginal costs are estimated to increase the pass-through significantly.

Moreover, following Eckel and Neary (2010) and Chatterjee et al. (2013), we may hypothesize that the pricing behavior of exporters would be more dependent on import intensity and its effect on the marginal cost of a product if they are less competitive outside of their main products. Indeed, we find somewhat smaller estimated effects than the baseline estimates, implying that import intensity has a greater impact on pass-through for products outside of an exporter's main product categories.

7 Conclusion

There is growing acknowledgment that behavior of individual firms is closely related to the supply chains they are a part of. With increasing data availability, we are able to better map out how supply chains affect final pricing behavior of firms. In this paper, we apply this idea to exchange rate pass through to export prices for an emerging market economy, Turkey. For identification, we study rich administrative databases, the universe of domestic firm-to-firm sales, firm-product-level exports and imports – with destination and source countries, and firm balance sheets. We explore whether – and if so, to what extent – exporters' import use through their domestic supply network matters for the exchange rate pass-through to export prices.

We show that exporters' direct use of imports is half of the picture. Once exporters' suppliers are taken into account, almost all exporters import and exporters' import intensities nearly double. We then provide robust evidence that exporters that rely more on import-intensive suppliers raise their export prices significantly more following a domestic currency depreciation. The effect of exporters' indirect import

[22] The precise average number of unique CN-2-level varieties per exporter is 3.089.

[23] When we construct the distribution of export shares by product category for each firm, the 10% cutoff coincides with the 25th percentile of the product share in exports distribution. That is, by focusing on main products, we loose about 25% of observations.

intensities on the pass-through is quantitatively similar in size compared to own import intensity. These effects are confirmed by a large battery of robustness tests.

We confirm that own and indirect import intensity influences exchange rate pass-through into export prices through their effect on the marginal cost of importing exporters. Firms try to avoid these costs by switching away from source countries and even reducing imports, but their adjustment remains limited. We further show that similar to market share in the export market, market concentration within the supplier network has consequences for exchange rate pass-through. Firms with greater supplier concentration experience higher exchange rate pass-through.

Our results are likely to be applicable to all exporting countries but may be particularly relevant for countries where there is a large domestic production network and indirect import intensities are prevalent. Along these lines, a key insight is that policies that miss exporters' production network may not be able to accurately predict the impact of an exchange rate depreciation on export prices. Future research on how import intensity within production networks of exporters affect other outcomes like productivity or product scope is likely to lead to further insights.

Appendix A1 – Exporters' Dynamic Adjustments of Imports

We test exporters' adjustments in imported goods on two dimensions: a shift away from source countries or from goods when the domestic currency depreciates against the source country currency. In doing so, we first aggregate the firm-product-source-year-level imports database at the firm, CN 4-digit-level product category, source country and year level. We use a wider definition of goods (CN 4-digit instead of CN 8-digit) to account for the possibility that exporters may switch within CN 4-digit products from a given source country.[24] In particular, we estimate

$$\Delta Y_{f,j|s,t} = \left(\theta + \kappa \mathcal{N}_{f,j,t-1}\right) \text{Imports}_{f,s,t-1} \Delta e_{s,t} + \mu_f + \mu_s + \mu_{j,t} + \varepsilon_{f,j|s,t} \qquad (15)$$

where the dependent variable is (i) the change in the share of a source country s in total imports of a product category j of exporter f from $t-1$ to t ($\Delta Y_{f,j,s,t}$), or (ii) the change in the value of total imports of j by exporter f from $t-1$ to t ($\Delta Y_{f,j,t}$), where ΔY is defined as $(Y_t - Y_{t-1})/((1/2) * (Y_t + Y_{t-1}))$, to account for the extensive margin. $\mathcal{N}_{f,j,t-1}$ is the total number of source countries for imports of j in $t-1$ by exporter f. μ_f, μ_s, and $\mu_{j,t}$ stand for firm, source country, and CN-4 product category×year fixed effects, respectively.

Table 10 presents the results. Column (1) indicates that an exporter facing an increase in import bill due to importing from a particular source country reduces the share of that source country in its imports of CN-4 products. Numerically, a one percent ex-ante increase in production costs due to domestic currency losing its

[24] To give an example, an exporter importing *"17021100.Lactose or lactose syrup containing by weight 99% or more lactose"* may switch to importing *"17023010.Glucose and glucose syrup, not containing fructose or containing in the dry state less than 20% by weight of fructose"*. By having a wider definition of goods – for the sake of this example, using *"1702.Other sugars, including chemically pure lactose, maltose, glucose, and fructose, in solid form"*– accounts for this possibility.

Table 10 Exporters' Shifting Away from Source Countries or Goods

Dependent variable:	Δ Source country share (in imports of CN-4 products)	Δ Total imports (of CN-4 products)	Δ Source country share (in imports of CN-4 products)	Δ Total imports (of CN-4 products)
	(1)	(2)	(3)	(4)
$\Delta ER_{s,t} * Imports_{f,s,t-1}$	**− 5.0773*****	**− 8.6935*****	**− 0.2548**	**− 11.2284*****
	(0.1141)	(0.1232)	(0.1669)	(0.1801)
$\Delta ER_{s,t} * Imports_{f,s,t-1} *$ Number of source $countries_{f,j,t-1}$			**− 2.2298*****	**1.2780*****
			(0.0530)	(0.0571)
Firm FE	Yes	Yes	Yes	Yes
Source country FE	Yes	Yes	Yes	Yes
Product category (CN4) x Year FE	Yes	Yes	Yes	Yes
Observations	2,058,941	2,058,941	2,058,941	2,058,941
R-squared	0.043	0.015	0.063	0.019

Δ Source Country Share is the change in the share of a source country in total imports of a CN-4 product category of an exporter. Δ Total Imports is the change in the value of total imports of the 4-digit product category of an exporter. Number of Source Countries is the total number of source countries for imports of CN-4 product category by an exporter. Standard errors are clustered at the source country level, and given in parentheses. *** significant at 1%, ** significant at 5%, and * significant at 10%

value against the source country currency is estimated to reduce the share of imports from that country by 13%. Column (2) further shows when a product becomes more expensive to import due to borrowing from a source country for which the domestic currency gets less valued against, the exporter reduces its total imports of that product. A 1% increase in costs is now associated with a 5% reduction in imports of that good.

In columns (3) and (4), we further shed light on whether exporters' shifting away from source countries or goods entail frictions. This essentially serves as a verification test for the data since shifting sources of imports or goods should be costly as it requires looking for alternative foreign/domestic suppliers or changing the production structure, a friction one could expect to hold in the data. We look into a particular aspect of such frictions: whether having higher number of source countries for a particular imported product ameliorates such frictions. If shifting entails frictions, than exporters that work with a wider range of source countries should be better positioned. Indeed, as columns (3) and (4) show, exporters that ex-ante import the same product category from a higher number of countries reduce the source country share more strongly and decrease their reliance on importing such product category less mildly.

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Yusuf Emre Akgündüz is an Assistant Professor of Economics at the Faculty of Arts and Social Sciences of Sabanci University. Prior to joining Sabanci University, he worked as a research economist at the Central Bank of the Republic of Turkey and researcher at the CPB Netherlands Bureau for Economic Policy Analysis. He holds a PhD from Utrecht University. His main research interests are labor economics, international economics, firm dynamics and applied microeconometrics.

Salih Fendoğlu is a Financial Sector Expert at the International Monetary Fund (IMF). Prior to joining the IMF, he worked as a research economist at the Central Bank of the Republic of Turkey, and held visiting positions at the Bank for International Settlements and Bogazici University. He holds a PhD from the University of Maryland - College Park. His main research interests are international economics, and monetary and macro-financial policies.