Firm Size, and Import Content of Production*

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May 2014
(**Preliminary and Incomplete.**)

Abstract

This paper analyzes the interaction between size, imported intermediate inputs, and exports behavior of heterogeneous firms. Data from Turkish manufacturing firms exhibit some patterns about these interactions which are: 1) the share of imports in total intermediate inputs is, on average, higher for the exporter firms than the non-exporter ones at all size percentiles, 2) the share of imports in total intermediate inputs grows faster with size for the exporters than for the non-exporters, 3) as the number of imported intermediate input varieties goes up, the number of firms importing that many varieties goes down. This paper explains these regularities in a setup where firms decide about importing and exporting simultaneously while adapting each intermediate good into the production process is costly.

*Corresponding author: fatih.ulu@tcmb.gov.tr. We are grateful to Sam Kortum, Thomas Chaney, Chad Syverson, Andrei Levchenko, Nobuhiro Kiyotaki, Juan Pablo Nicolini, Kerem Coşar, Amira El-Haddad and European Summer Symposium on International Macroeconomics (ESSIM) 2013 participants for their very useful comments. All errors are ours.

1 Introduction

One of the common patterns for countries that reduce their trade barriers is the surge in their exports accompanied with an even bigger increase in their imports. At the same time, import content of exports increases in these countries.[1] We also know that two thirds of world trade is in intermediate goods (Hummels et al. (2001)). Beside these, when a production function with three production factors -labor,capital and intermediate goods- is estimated for industries, the biggest share of the total cost of production is spent for intermediate goods.[2] These findings combined suggest that intermediate goods are important in both trade and production processes, and this study analyzes the joint role of intermediate goods in trade and production processes, which has not been explored completely yet.

This paper analyzes the interaction between firm productivity, imported intermediate inputs, and exports behavior of firms. It explains the regularities observed in the data about these interactions in a setup where after receiving their productivity and demand shocks firms decide about importing and exporting simultaneously while adapting each imported intermediate good into the production process is costly and costs grow convexly in the number of imported varieties.

Different aspects of the fragmentation of production processes across countries have been analyzed under different names in several other studies.[3,4] Next to the theoretical studies of the topic some other studies have analyzed and quantified couple channels for the impact of trade in intermediate goods other economic decisions of firms.[5] Goldberg et al. (2010) investigate the impact of trade barrier reductions on intermediate goods imports and consequently firm product scope. They state that in the analyzed period in India, 31% of the new products launched by domestic firms accounted for the lower tariff barriers. Availability of new intermediate inputs which were not available prior to barrier reduction is the main factor that drove this outcome. In Halpern et al. (2011) imported inputs affect TFP, and they find large productivity effects of imported inputs. Kasahara and Rodrigue (2008) also finds evidence from Chilean data that importing intermediate inputs improves productivity. Kasahara and Lapham (2013) analyze the interaction between productivity and decisions to

[1]Trade barrier reductions between EU and Central and Eastern European countries may give us examples of these situations.

[2]In Amiti and Konings (2007) for almost all manufacturing sectors the share of intermediate goods in total production costs is between 60% and 70%.

[3]Some of these names are offshoring, outsourcing, global value chains, global production chains, fragmentation of production.

[4]Grossman and Rossi-Hansberg (2008) has a good list of related references.

[5]Grossman and Rossi-Hansberg (2008) propose a theory of global production processes with tradeable tasks, and analyze the impact changes in offshoring costs on domestic factor prices. Costinot et al. (forthcoming) offer a perspective on how vertical specialization shapes the interdependence of nations.

import and export. They develop a theoretical model and estimate their structural model empirically. Johnson and Noguera (2012) find that variation in aggregate VAX (value added to exports) ratios across countries is, to a large extent, driven by variation in the composition of exports. Bergin et al. (2009) show how global production sharing affects the volatility of economic activity. Feenstra and Hanson (1997) indicate that outsourcing explains significant fractions of the increase in the relative wages of non-production workers at industry level.

As to the motives behind firms' import behaviors, a recent study by Saygl et al. (2010) presents results of their interviews with the big intermediate input importers in Turkey. These interviewed firms produce 35.9% of total manufacturing value added and export 24.8% of manufactured goods. 96.6% of these firms mention lack of domestic supply of the imported input, and 75.2% of them also mention purchasing more quality inputs for cheaper from abroad as their motives for importing. Firms' responses in these interviews also justify our approach which accounts for quality differences between the imported intermediates and the domestic ones.

The mechanism that we propose to explain the interaction between intermediate goods, productivity and the value added content of exports builds on the the approach of Gopinath and Neiman (2014) for modelling the decision of firm about how much imported intermediate input to employ in production. We augment their model by introducing an exports market which is costly to enter (e.g., Melitz (2003)). Firms have incentive to use more imported intermediate inputs due to the quality of intermediate input that can be embedded to the productivity of the firm as well as the love-of-variety in the production technologies.

Halpern et al. (2011) have an idea similar to ours. However, they do not analyze the interaction between firm size, input imports and export behavior of firms which we focus on. Our model diverges from Kasahara and Lapham (2013) in several respects. First, in their set up imported inputs increase productivity only through the channel of love-of-variety in the production function. Instead, we introduce quality differences into intermediate inputs, and these quality differences across intermediate inputs directly affect the productivity of firms. A second difference of our work is that we explicitly model firms' decisions about the number of different varieties to import. This aspect of our model provides an explanation for the fact that is observed in the data that the gap between average intermediate import ratios for exporters and non-exporters grows with the firm size.

Since the marginal productivity gains through importing one more good will be higher for them, more productive firms will be more willing to import more varieties of intermediate inputs. On the other side, the fixed cost of importing will be convex in the number of different varieties imported. Hence, for each firm with an initial productivity, there will be an optimal number of different varieties to be imported. This situation gives more productive firms more room to improve their productivities by importing a more diverse set of intermediate inputs. It is already established in the previous studies that only sufficiently productive firms enter the export markets in the existence of fixed entry costs. Imported intermediate goods give the more productive firms the ability to become even more productive relative to the less productive firms. More productive firms import more, become even more productive, and hence export even more, and their exported goods are on average more import intensive.

For calibrating the model we target a list of moments that includes the intermediate import ratios of exporter and non-exporter firms at all sizes, and the distribution of the number of imported intermediate inputs. Findings from the calibration gives estimates for the deep parameters that govern the interaction between firm productivity and firms' import and export decisions, and allow me to have some counterfactual experiments.

2 Data and Facts

We combine two distinct datasets from the Turkish Statistical Institute (TurkStat), which are the trade transactions and structural business datasets for Turkish firms. We focus our analysis on only the manufacturing firms (NACE 15-37) in 2008. We observe both import and export numbers as well as some balance sheet items of these firms. In this section, we present some regularities about firm size, number of imported varieties, expenditure share of imported intermediate inputs in total intermediate input expenditure and firms' importer and exporter statuses.

Figure 1 plots the average intermediate import ratio for firms in specific size bins by their exporter statuses. In this figure size percentile of a firm is computed with respect to its value of production within the space of all manufacturing firms. Since exporter firms tend to be the larger ones, in this figure, we do not observe many exporter firms at the lower size percentiles. Average intermediate import ratio increases as the size percentile of a firm increases. Exporter firms' average intermediate import ratio is significantly higher than non-exporter firms, and the gap between intermediate import ratios for exporter and non-exporter firms grow in a convex manner as firm size grows.

Figure 2 disaggregates the number of firms in each size bin by their exporter statuses. Only a couple of exporter firms are detected at the lowest size bins whereas non-exporter ones populate these size bins, and as size increases the composition of the split reverses. The higher size bins are populated, mainly, by the exporter firms.

To alleviate the exposition problem in Figure 1, Figure 3 exhibits results for the same exercise once more. However, this time we rank firms within the same exporter status

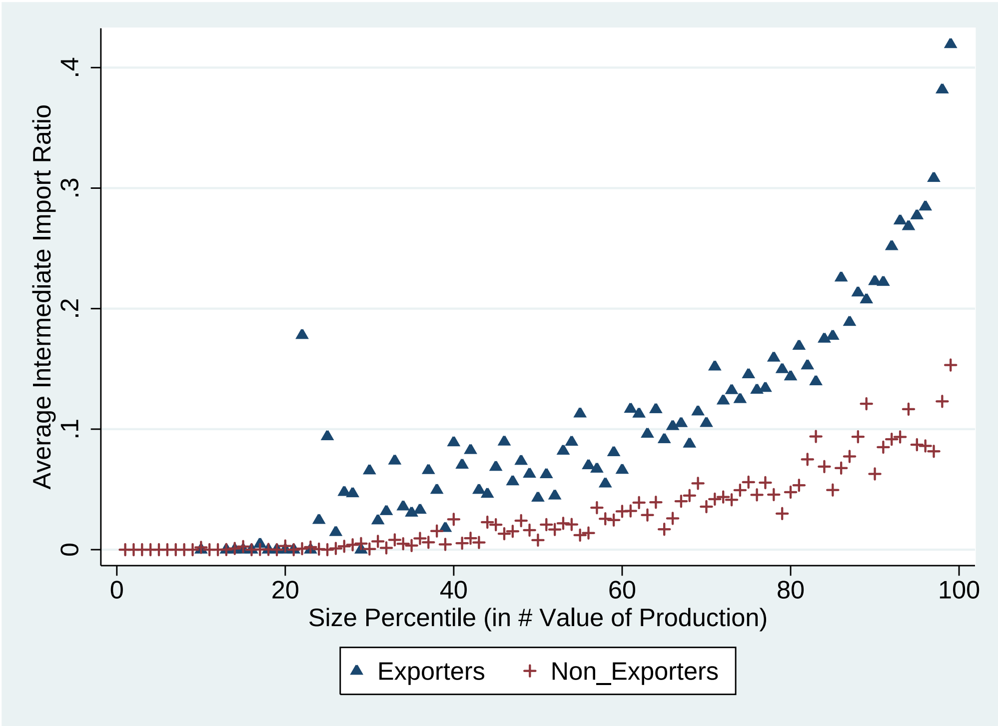


Figure 1: Intermediate Import Ratio By Exporter Status

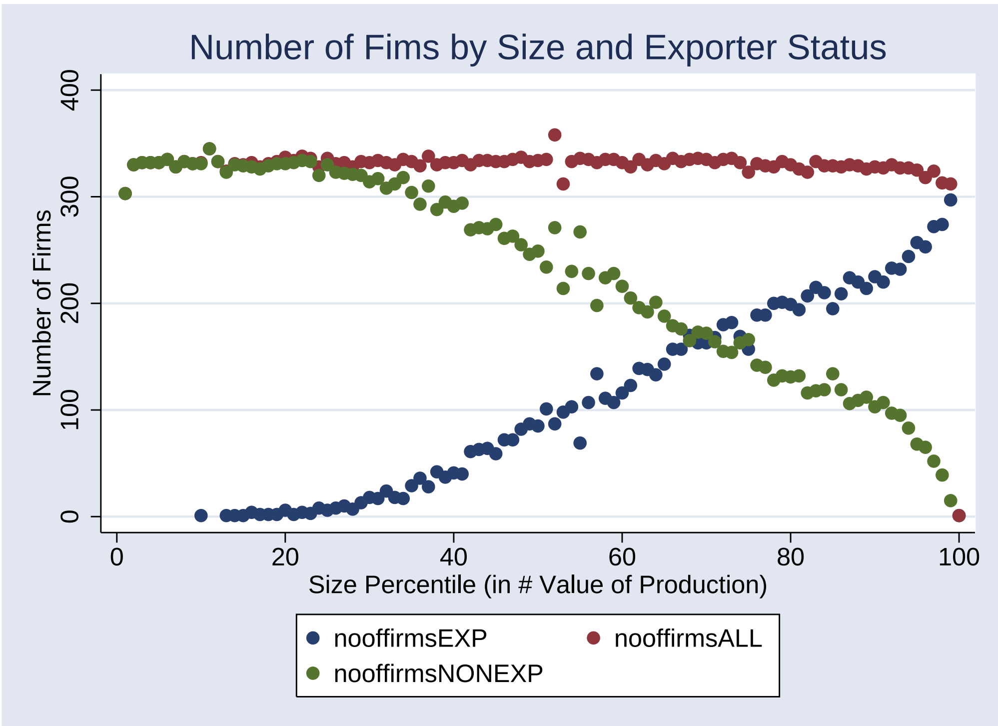


Figure 2: Number of Firms By Size and Exporter Status

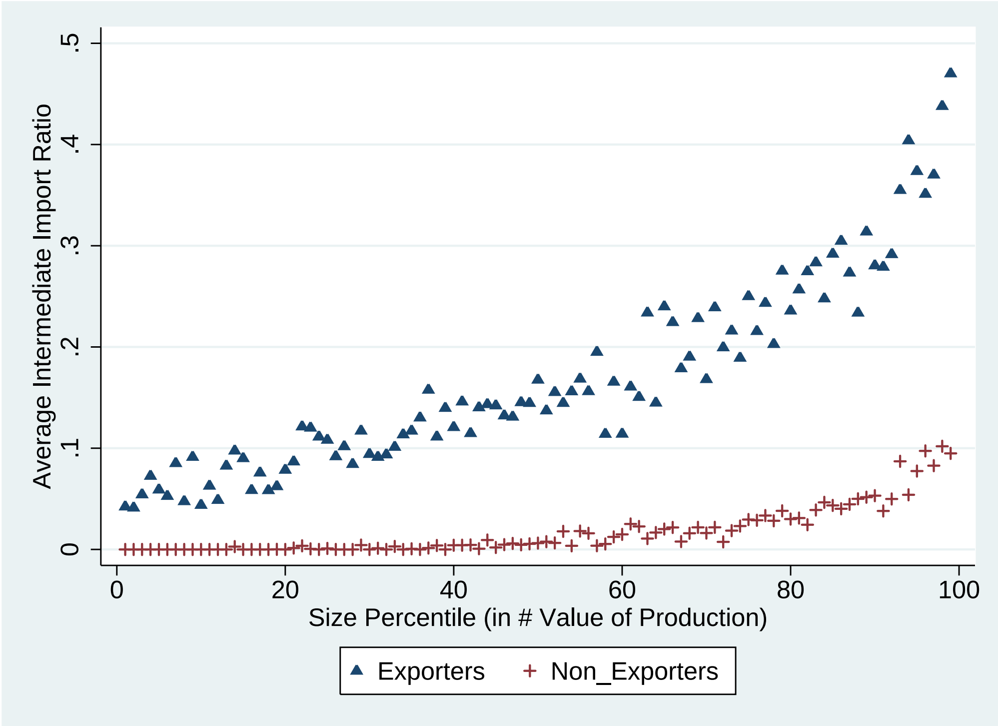


Figure 3: Intermediate Import Ratio by Size (Within)

and calculate the statistics within these separate groups of firms.[6] Then, it becomes more clear that exporters use more intermediate input than the non-exporters in their production, and the share of imported intermediate varieties grows faster with size for exporters than for non-exporters. This figure also makes it clear that the difference between exporters and non-exporters is not only in levels but also in variances. The variance of average intermediate import ratios are higher for exporters.

The findings in Figure 4 complement Figures 1 and 3 by reporting the normalized expenditures on imported intermediate inputs by the fraction of firms buying at least that much. This graph can also be interpreted as a cdf for importer firms' normalized intermediate input expenditure. For instance, if a firm is importing intermediate inputs, with probability 0.1 it is spending at most one thousandth of the mean expenditure, and with probability 0.86 it is spending at most the mean expenditure on imported inputs. The biggest intermediate input importers import more than one million times the smallest importers import.

As the number of different input varieties imported goes up, the number of importers of this many varieties go down. Figure 5 shows that only small fractions of firms import very

[6]This new representation has the advantage of having equally many firms in each size bin for both exporter and non-exporter firms. However, this time we lose the actual size differences between these two types of firms.

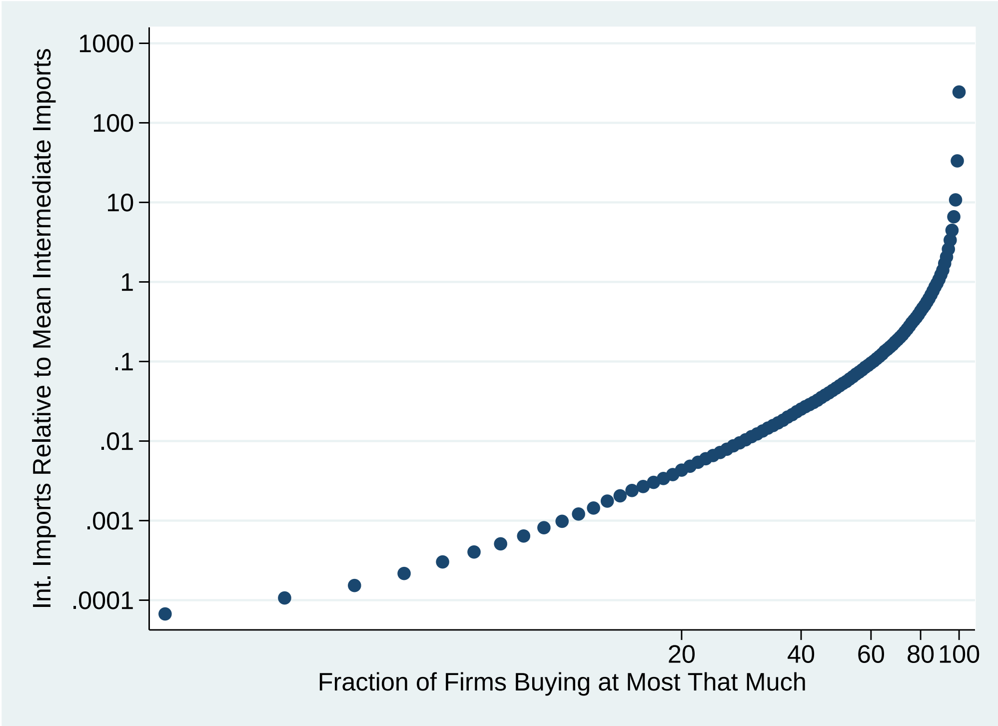


Figure 4: Inter. Good Imports Rel. to Mean Imports vs. Fraction of Firms

diverse sets of intermediate inputs whereas large fractions of firms import only a few different varieties of intermediate inputs. For a given fraction of firms we can observe multiple y values on the figure. It is because of the fact that different numbers of varieties can be imported by the same fractions of firms in the sample. Figure 6 presents a split of the previous figure between exporter and non-exporter firms along size percentiles. The gap between exporter and non-exporter firms in the average number of imported varieties diverges by firm size percentiles.[7]

Figure 7 shows the firm revenues by size for the two sets of firms, exporters and non-exporters. It is obvious that revenues are higher for the exporter ones, and the gap in revenue between the two group of firms grow by size (y axis is in logs). As seen in the Figures 1 and 7, there is not a one-to-one relationship between firm size (or revenue) and firm's exporter status. The biggest non-exporter firms are larger in size than the smallest exporter firms. For capturing this behavior we introduce demand shocks in the exports market.

A concern about the observed behaviors is the impact of foreign ownership of firms on the observations. For checking the impact of FDI participation in firms, we run the same

[7]Treating each HS12 item and country combination or only HS12 item as a good does not change the shapes of the exhibited behavioral patterns. Allowing each HS12 item and country combination to be defined as a good inflates the number of intermediate input varieties imported at firm-level around 10%.

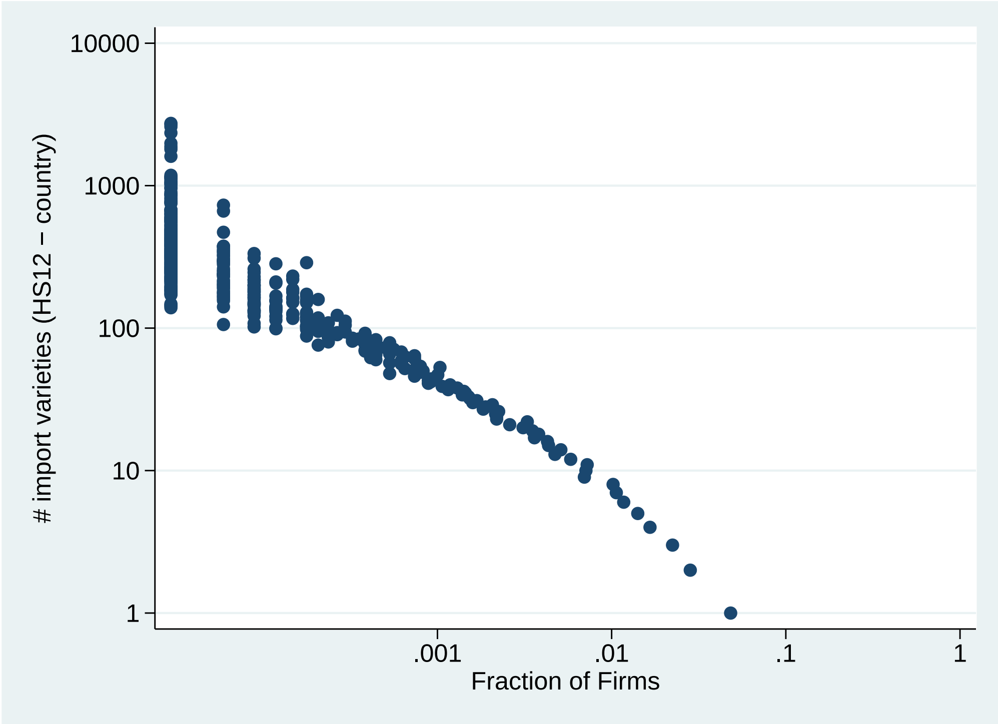


Figure 5: Number of Imported Varieties vs. Fraction of Firms

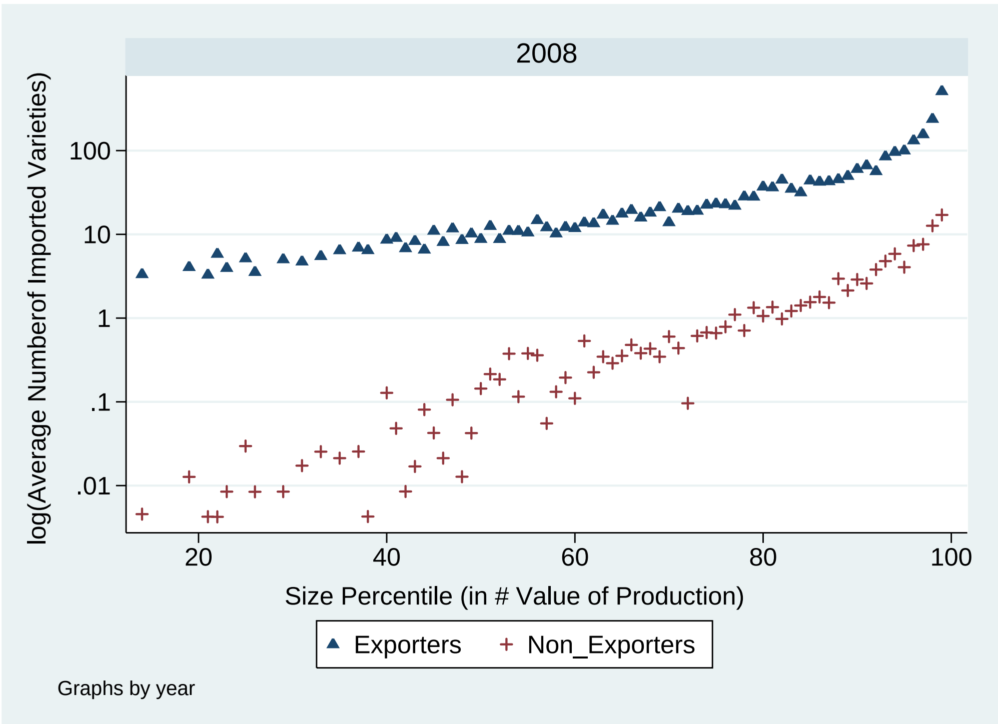


Figure 6: Number of Import Varieties by Size (Within)

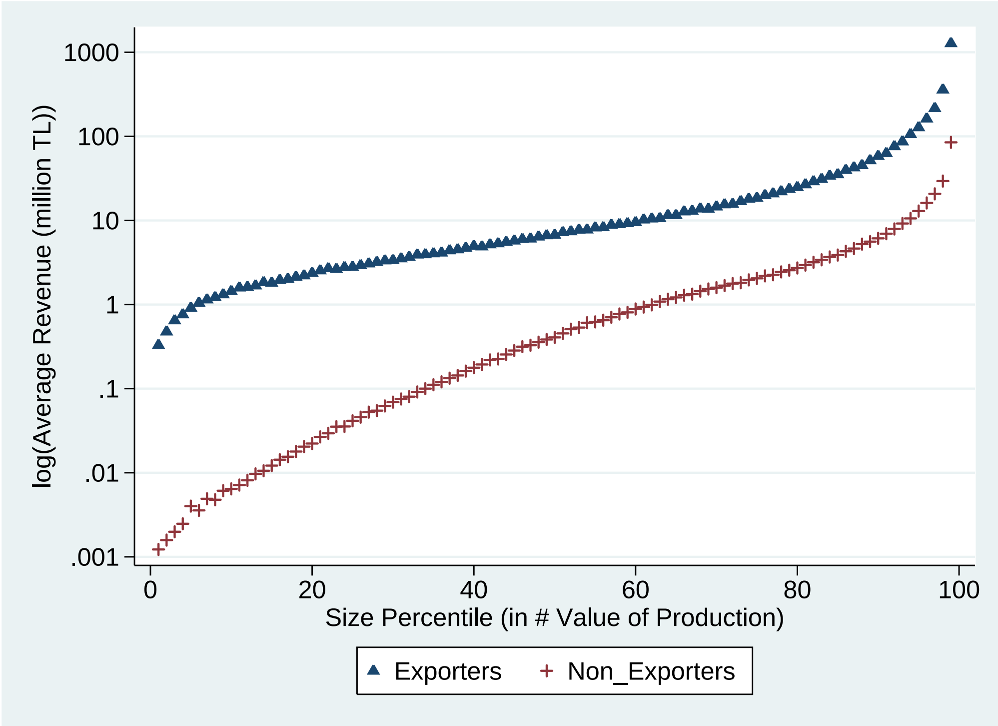


Figure 7: Revenue by Size (Within)

exercises excluding the firms that include FDI in their capital, and we find that the behavioral patterns are very similar only some quantities slightly shift.[8]

3 MODEL

We extend Gopinath and Neiman (2014) by introducing an export market and demand shocks to their model. We will stick with their notation as much as possible. Two countries populate the world economy, home and foreign. Each domestic manufacturing firm i is the monopolist producer of its good, and it combines a bundle of intermediate inputs X_i with some labor $L_{p,i}$ using the production function:

$$Y_i = A_i (L_{p,i})^{1-\mu} X_i^{\mu} \tag{1}$$

where A_i is exogenous firm productivity.

X_i combines bundles of domestic and imported intermediate inputs Z_i and M_i, respectively. Elasticity of substitution between domestic and imported intermediate inputs is $1/1-\rho$, and b is the quality attached to imported intermediate inputs. At this stage, we

[8]Details of this analysis are available upon request.

assume b to be same for all imported varieties. Intermediate goods are produced by monopolistic producers in both the domestic and foreign markets.

$$X_i = [Z_i^\rho + M_i^\rho]^{\frac{1}{\rho}} \tag{2}$$

where

$$\begin{aligned} Z_i &= \left[\int z_{ij}^\theta dj\right]^{\frac{1}{\theta}} \\ M_i &= \left[\int_{\Omega_i} (bm_{ik})^\theta dk\right]^{\frac{1}{\theta}} \end{aligned} \tag{3}$$

Firm i can sell its products in both domestic and foreign markets. g_i is the domestic sales while g_i^* is the exports.

$$Y_i = g_i + g_i^* \tag{4}$$

There are three kinds of fixed costs in the environment. These costs are paid in terms of labor units. The first kind is the fixed entry cost to be paid while entering the foreign market, f_e. The remaining two fixed costs are related to importing intermediate goods. f_I is the fixed part of import costs while f_v multiplies the part that varies with the number of varieties imported.[9,10] $|\Omega_i|$ is the cardinality of the set of varieties imported by firm i. $\lambda > 1$. governs the curvature of the variable cost of importing.[11]

$$F(|\Omega_i|, g_i^*) = [f_I I_{|\Omega_i| \neq 0} + f_v |\Omega_i|^\lambda + f_e I_{|g_i^*| > 0}] \tag{5}$$

Since each firm will import different sets of intermediate goods, the ideal price index of intermediate inputs P_{X_i} may differ for each firm. P_{M_i} is the price index for imported intermediate inputs, will differ across firms depending on the number of varieties that firms import $|\Omega_i|$. P_Z is the equilibrium price index for domestic intermediate goods. For now, we will treat it as exogenous and same for every firm.[12] Price of each imported intermediate input is p_m, and they have the same quality $b > 1$ attached to them.

[9] For starting to import firms need to bear costs of hiring new personnel, learning the legal requirements, and other red tape costs.

[10] Adaptation of new imported intermediate inputs to the production process is costly. New machinery or human resources may be necessary for this adaptation, and f_v captures these costs.

[11] These convex adjustment costs allow us to capture the decreasing number of importer firms in the number of varieties imported, and also the convexly increasing average intermediate import ratios by firm size.

[12] Allowing P_Z to be endogenously determined will definitely add new insights to the model, and in future the model can be extended to that direction.

$$P_{X_i} = \begin{cases} \left(P_Z^{\frac{\rho}{\rho-1}} + P_{M_i}^{\frac{\rho}{\rho-1}}\right)^{\frac{\rho-1}{\rho}} & \text{if firm } i \text{ imports} \\ P_Z & \text{if firm } i \text{ does not import} \end{cases} \tag{6}$$

$$\begin{aligned} P_{M_i} &= \left[\int_{k\in\Omega_i} (\frac{p_m}{b})^{\frac{\theta}{\theta-1}} dk\right]^{\frac{\theta-1}{\theta}} \\ &= \frac{p_m}{b}|\Omega_i|^{\frac{\theta-1}{\theta}} \end{aligned} \tag{7}$$

where $0 < \theta < 1$.

The love-of-variety in the production technology brings about the inverse relationship between between the ideal price index imported intermediate imputs P_{M_i} and the the number of different varieties imported Ω_i.In fact this relationship is a mirror image of the increasing returns to more varieties embedded into the production process as observed in Eq. (3). This inverse relationship is at the core of the model while explaining the observed firm behavior.

3.1 Firm's Problem

Firm has to decide about being an exporter and an importer. If it decides to be an importer, it also has to determine the number of varieties to import.[13]

Unit cost of production for firm i is $C_i = \frac{1}{\mu^\mu(1-\mu)^{1-\mu}} \frac{w^{1-\mu}P_{X_i}^\mu}{A_i}$.

$$m_i = \begin{cases} \left(\frac{p_m}{P_{M_i}}\right)^{\frac{1}{\theta-1}} \left(\frac{P_{M_i}}{P_{X_i}}\right)^{\frac{1}{\rho-1}} X_i & \text{if firm } i \text{ imports} \\ 0 & \text{if firm } i \text{ does not import} \end{cases} \tag{8}$$

Firm i receives demand shock s_i in the foreign market. Aside from the demand shocks, demand and market structures in the foreign market are as they are in the domestic market.[14]

$$g_i^*(s_i, p_i) = \begin{cases} s_i p_i^{\frac{1}{\varepsilon-1}} & \text{if firm } i \text{ exports} \\ 0 & \text{if firm } i \text{ does not export} \end{cases} \tag{9}$$

Sending goods to the foreign market is costly. For delivering one unit of product to the foreign country τ units of good should be shipped from the home country. The price that

[13]In the model we have assumed the imported intermediate varieties to be a continuum, and hence, a firm could decide about its optimal number of varieties to import by continuously differentiating their objective functions. However, for mapping those decisions to the observed physical decisions of firms we have to discretize the varieties, and in the calculations we achieve it by rounding the optimal choices of the firms.

[14]However, market sizes differ. Since we will analyze model in a partial equilibrium environment, we are only interested in the parameters of the distribution from where the demand shocks come.

firm i charges on its products is p_i and p_i^* in domestic and foreign markets, respectively:

$$p_i = \frac{C_i}{\varepsilon},\ p_i^* = \tau \frac{C_i}{\varepsilon} \tag{10}$$

If we allow p_i^* to be the price in the foreign market, then firm i's profit from the domestic and foreign markets are $\pi_i = (p_i - C_i)p_i^{\frac{1}{\varepsilon-1}} = (1-\varepsilon)(p_i)^{\frac{\varepsilon}{\varepsilon-1}}$ and $\pi_i^* = s_i(1-\varepsilon)(p_i^*)^{\frac{\varepsilon}{\varepsilon-1}}$, respectively. $\Pi_i = \pi_i + \pi_i^*$ is the gross profit from both markets.

$$(\Omega_i, g_i, g_i^*) = \arg\max_{\Omega_i, g_i, g_i^*} \{\pi_i = (1-\varepsilon)R_i - wF(|\Omega_i|, g_i^*)\} \tag{11}$$

The firm determines its P_{M_i}, and hence P_{X_i} and consequently the unit cost of production C_i by deciding about the optimal number of varieties to import. The firm's action set about importing and exporting is comprised of four possible actions: neither import nor export, only import, only export, and both import and export. For each action, the optimal number of varieties to import may differ, and the firm maximizes profit by picking one of these actions.

After observing its productivity and demand shocks A and s, a firm decides about whether to be an exporter and how much intermediates to import simultaneously. A firm's exporter status and the number of varieties that the firm imports are positively correlated. A firm earns directly and indirectly from exporting goods. The direct return to the firm from entering into the foreign market is selling its goods in this new market with a markup. The indirect return is through importing more varieties. Since it is selling its goods in a larger market, any effort to reduce unit production costs pays more to the firm. That's why, the firm will be more eager to employ more imported varieties in production, and consequently lower its unit production costs.

As the unit cost of production increases, profits go down, and unit cost of production comoves with factor prices, w and P_X. Even if there is no quality difference between the domestic and imported intermediate goods, more imported varieties decreases the unit costs of production because of the love-of-variety in the production technology. If a quality that is higher than the quality of the domestic intermediates is attached to the imported intermediates -$b > 1$- than the cost reducing impact of imported intermediates becomes stronger.

$$R_i = W[p(\Omega_i)^{\frac{\varepsilon}{\varepsilon-1}} + I(g^* > 0)s_i p^*(\Omega_i)^{\frac{\varepsilon}{\varepsilon-1}}] \tag{12}$$

W is the market size parameter. It multiplies the demands in both home and foreign markets, and acts as a demand shifter.

Firm's FOC regarding Ω is

$$\frac{\partial \pi}{\partial \Omega} = W(1-\varepsilon)(1+I(g^* > 0)s\tau^{\frac{\varepsilon}{\varepsilon-1}})\frac{\partial p(\Omega)^{\frac{\varepsilon}{\varepsilon-1}}}{\partial \Omega} - \lambda w f_\nu \Omega^{\lambda-1} = 0 \tag{13}$$
$$\implies \kappa\frac{\mu\varepsilon}{\varepsilon-1}\frac{\theta-1}{\theta}\left(\frac{p_m}{b}\right)^{\frac{\rho}{\rho-1}} P_X^{\frac{\mu\varepsilon}{\varepsilon-1}+\frac{\rho}{1-\rho}} = \lambda w f_\nu \Omega^{\lambda-\frac{\theta-1}{\theta}\frac{\rho}{\rho-1}}$$

where $\kappa = W(1-\varepsilon)(1+I(g^* > 0)s\tau^{\frac{\varepsilon}{\varepsilon-1}})\varepsilon^{\frac{\varepsilon}{1-\varepsilon}}\left(\frac{w^{1-\mu}}{A\mu^\mu(1-\mu)^{1-\mu}}\right)^{\frac{\varepsilon}{\varepsilon-1}}$. By deciding Ω_i in fact each firm decides about the price of intermediate inputs bundle P_{X_i} that they will face and hence the unit cost of production C_i that they will incur. $\lambda w f_\nu \Omega^{\lambda-\frac{\theta-1}{\theta}\frac{\rho}{\rho-1}}$ represents the marginal cost of increasing the number of imported varieties and adding them to the production process. This marginal cost definitely increases with convexity of the adjustment cost function, and λ governs convexity of this cost function. The exponent term $\lambda - \frac{\theta-1}{\theta}\frac{\rho}{\rho-1}$ exhibits that as the θ goes down which means that elasticity of substitution among imported varieties increases the marginal cost of adapting one more variety. As ρ goes down and hence the elasticity of substitution between the domestic and imported intermediate varieties goes up again marginal cost of adapting imported varieties goes down. The right-hand side of 13 exhibit returns to increasing number of imported varieties embedded to production process. It mainly reduces P_X and this effect is amplifies by the exponent $\frac{\mu\varepsilon}{\varepsilon-1} + \frac{\rho}{1-\rho}$. μ is the cost share of the bundle intermediate inputs in production and marginal returns to importing more varieties is deepened with this cost share as well as the elasticity of demand. More elastic the demand more returns to any decline in unit production costs. Adversely, as ρ goes up the domestic and imported intermediate inputs become more substitutable and hence the unit production cost reducing impact of importing more varieties is lessened.

3.2 Discussions

The expenditure share of import in total intermediate inputs used (IIS) increases with the price of domestically supplied intermediate inputs and decreases with the price of imported inputs. The elasticity of IIS with respect to the optimal number of imported varieties is $\frac{\theta-1}{\theta}\frac{\rho}{\rho-1}$. Since domestic and imported inputs are not perfect substitutes, as θ goes up (hence, the within elasticity of substitution for each type of intermediate inputs) the impact of this change through Ω reduces the IIS. For the same number of imported varieties, the firm will demand more domestic inputs and consequently the expenditure share of imported inputs will increase. For the same number of imported varieties when the elasticity of substitution between imported and domestically produced goods ρ increases, the cost share of imported inputs goes down.

$$\frac{E_m}{E_Z} = \frac{(p_m)^{\frac{\rho}{\rho-1}}(b)^{\frac{1}{\theta-1}-\frac{1}{\rho-1}}}{(P_Z)^{\frac{\rho}{\rho-1}}}\Omega^{\frac{\theta-1}{\theta}\frac{\rho}{\rho-1}} \tag{14}$$

$$\frac{\partial(E_m/E_Z)}{\partial\Omega} > 0, \frac{\partial(E_m/E_Z)}{\partial p_m} < 0, \frac{\partial(E_m/E_Z)}{\partial P_Z} > 0 \tag{15}$$

The elasticity of the cost share of imported inputs with respect to firm size is governed by the elasticity of substitution among goods of the same origin (θ), across goods of different origins (ρ) and the elasticity of the optimal number of imported varieties with respect to firm size.

$$\frac{\partial ln(E_m/E_Z)}{\partial lnY} = \frac{\theta-1}{\theta}\frac{\rho}{\rho-1}\frac{\partial ln\Omega}{\partial lnY} \tag{16}$$

4 Simulation

We analyze this economy in a partial equilibrium setting where domestic intermediate input bundle price index P_Z, price of an imported intermediate variety p_m, and wage w are exogenous.

We numerically simulate the model with 2,000 firms by targeting some moments from the data. The targeted moments are: 1- Intermediate import ratio by size and by exporter status, 2- Number of imported varieties by number of firms, 3- Average number of imported intermediate varieties in each size percentile, and 4- Average revenues by size.

A firm is a tuple of two shocks, A and s. We assume that A and s are distributed jointly log-normal. Specifically, lnA and lns are normally distributed with zero and μ_s, variances 1 and σ_s, respectivley and correlation $corr$. Parameter values are presented in Table 1. Most of the parameters has a one-to-one match with the ones in Gopinath and Neiman (2014).

The levels of revenues in the targeted moment identifies the demand shifter in both markets W whereas the difference in revenue levels between exporters and non-exporters identifies μ_s, and inter-quantile dispersion of average revenues of exporters identifies σ_s. In Eq. (13) we see that the wage w enters both side of the equality multiplicatively, and hence it is not easy to identify it since we already have the demand shifter W. Hence we normalize w to 1.

After fixing some of the parameters to values filtered from the literature and reducing the dimensionality of the search space, we will search through the parameter space for the optimal values by using a simulated annealing algorithm.

The iceberg cost of exports τ is assumed to be 1.2 and Anderson and Wincoop (2004) find it to be 1.21 which includes both transport cost as directly measured freight costs and a

Table 1: Simulation Parameters

Parameter	Value	Description
θ	0.67	elasticity of substitution within intermediate input groups
ρ	0.52	elasticity of substitution between intermediate input groups
b	2	quality attached to imported intermediate varieties
μ	2/3	cost share of intermediate inputs
λ	2.33	curvature of the convex adjustment cost
f_e	0.3	entry cost for the export market
f_v	0.0003	scale parameter for the adjustment cost
f_I	0.0001	entry cost for the import market
τ	1.2	iceberg cost
w	60	wage
p_m	20	unit price of imported intermediate varieties
σ	0.5	std. dev. for the demand shocks
$corr$	0.8	correlation between the demand and productivity shocks
W	1000	demand shifter
P_Z	2	price of the domestically produced intermediate inputs
ϵ	0.75	elasticity of substitution between intermediate input groups

9-percent tax equivalent of the time value of goods in transit. The elasticity of substitution in consumption ϵ is set to 0.75.[15]

5 Preliminary Results

The calibration study has not been fine tuned yet. However, the fit between the model and the data is quite good. Equations 1 and 3 motivate Figure 8, which plots the average cost share of imported intermediate goods in total expenditure on intermediate goods for the firms that are in the same size percentiles. For the exporter firms the model captures the data very well. For the non-exporter ones, although it picks up the slope very well, it slightly overshoots the data.

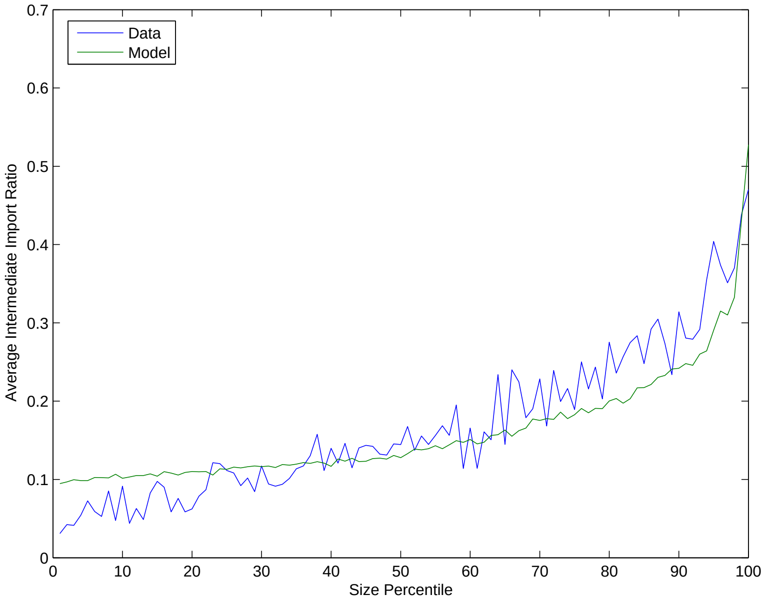
Figure 9 plots the average number of intermediate goods imported by the firms that are in the same size percentiles. The model copies closely the behavior observed in the data, that the average number of varieties imported by the exporter firms increases geometrically. The model matches the behavior of the non-exporter firms successfully, as well.

Figure 10 shows that only few firms import large numbers of different varieties, and big fractions of firms import only few varieties. The model mimics the spread and the

[15] Kasahara and Lapham (2013) estimate this elasticity to be between 0,73 and 0.81 across different industries, and Gopinath and Neiman (2014) takes it to be 0.75

Figure 8: Intermediate Import Ratios

(a) Exporters



(b) Non-Exporters

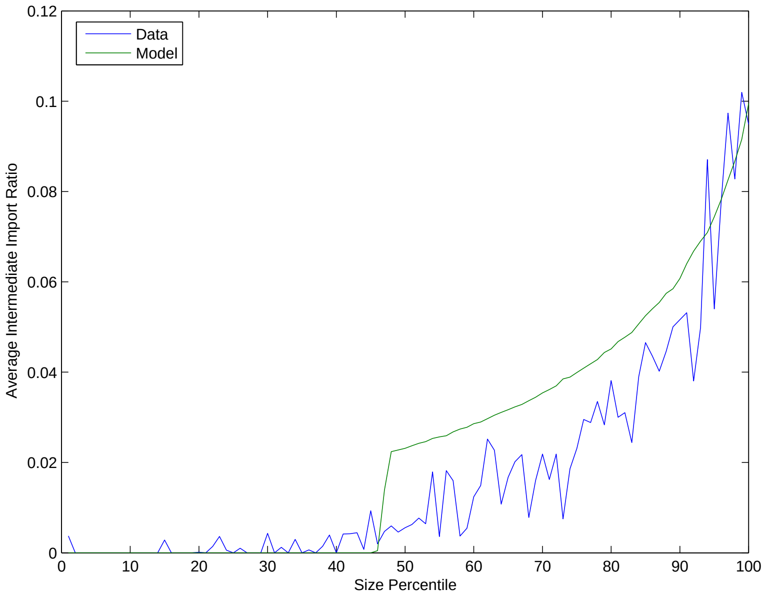
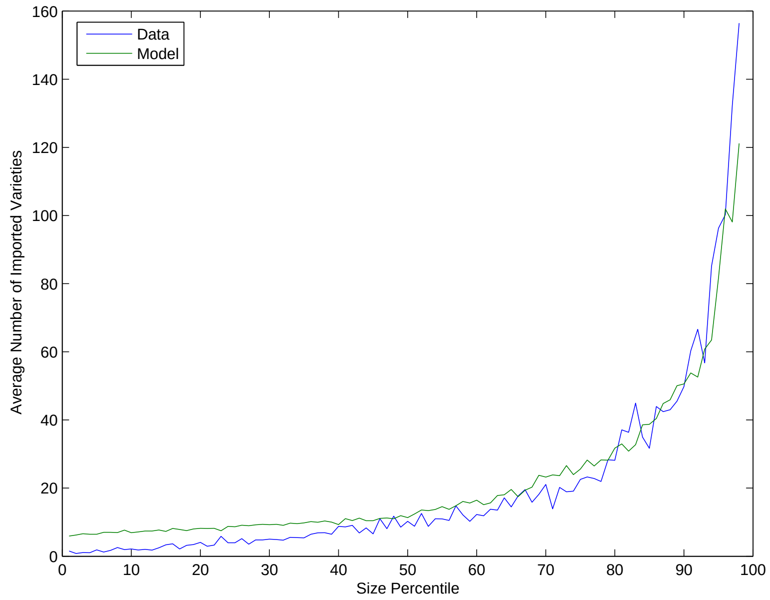
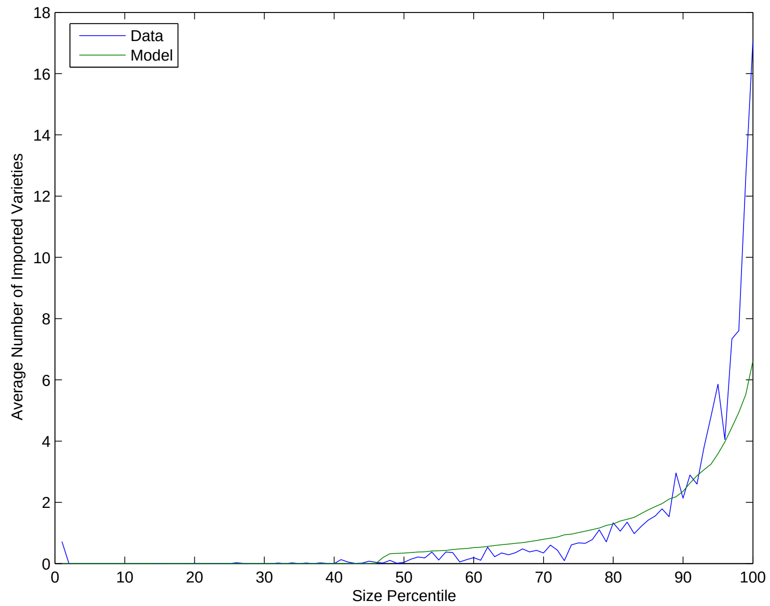


Figure 9: Average Number of Imported Varieties by Firm Size

(a) Exporters



(b) Non-Exporters



slope observed in the data about the relationship between the number of different varieties imported by a firm and the fraction of all firms that import such many varieties. However, there is a level difference between the model and the data that should be worked out.

Import-related costs are an important ingredient of this study for understanding the empirical regularities. Table 2 reports the magnitudes related to these costs.

Table 2: Sunk and Fixed Costs of Trade

tau	f_e	f_I	f_v	lambda	F_e/R	F_I/R	F_v/R	T/R	Revenue
1.2	0.3	0.0001	0.0003	2.33	0.000175	0.0000005	0.1928	0.1452	14731000
1.08	0.3	0.0001	0.0003	2.33	0.007794	0.0000012	0.07472	0.0454	4512000
1.2	0.27	0.0001	0.0003	2.33	0.000164	0.0000005	0.1928	0.1452	14732000
1.2	0.3	0.00009	0.0003	2.33	0.000175	0.0000004	0.1928	0.1452	14731000
1.2	0.3	0.0001	0.00027	2.33	0.000163	0.0000004	0.19902	0.1452	15938000
1.2	0.3	0.0001	0.0003	2.1	0.007825	0.0000012	0.053921	0.14	4552500

Notes: This table shows the magnitudes of trade-related costs where $F_e = \sum_i \mathcal{I}(E_i = 1) w f_e$, $F_I = \sum_i \mathcal{I}(I_i = 1) w f_I$, $F_v = \sum_i \mathcal{I}(I_i = 1) w f_v |\Omega_i|^\lambda$, $T = \sum_i (\tau - 1) p_i g_i^*$, $R = \sum_i p_i Y_i$

Figure 11 displays revenue distribution across firms and how revenue of each firm is split between the domestic and foreign markets. It appears that small firms raise all their revenue from the domestic market. Exporter firms are on average bigger ones and they comprise only a small fraction of all firms in the economy.

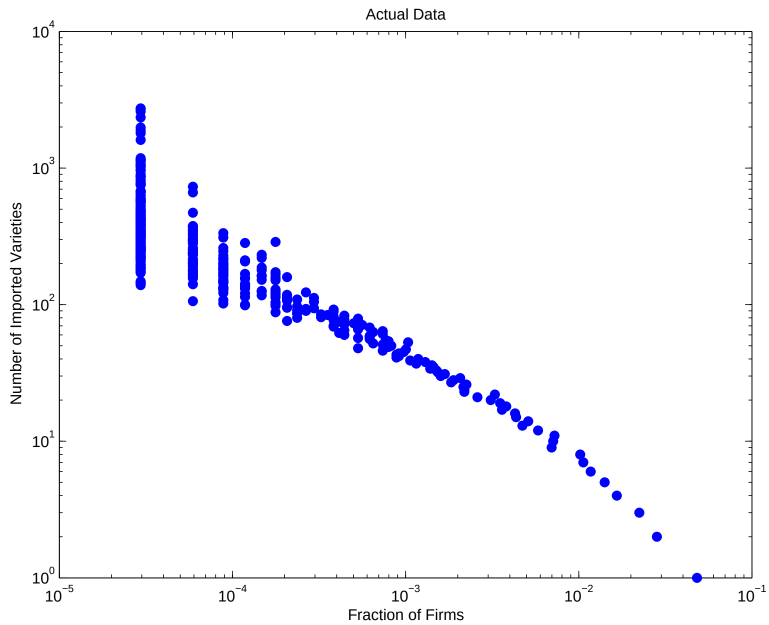
In Figure 12, we observe the how the optimal import and export decisions of firms materialize over the space of shocks. As a firm's productivity or its demand shock increases, the firm becomes more prone to both exporting and exporting.

6 Some Comparative Statics and Growth Accounting

In this section, we want to analyze how shifts in entry and adaptation costs and relative prices change total output, total value added, and domestic value-added content of production and exports as well as the distributions of these economic activities across firms of different size. The explicit structural partial equilibrium setup of this study helps these comparative statics. The impact of tariff reductions, and improvements in transportation and communication technologies can be investigated by changing the iceberg cost τ. Curvature of the adaptation costs is governed by the parameter λ, which may represent some rigidities about the labor market or production technology. Developments in these markets may bring about changes in λ, and we will examine how such shifts influence the behavioral patterns analyzed in this

Figure 10: Number of Imported Varieties by the Fraction of Firms

(a) Actual Data



(b) Model

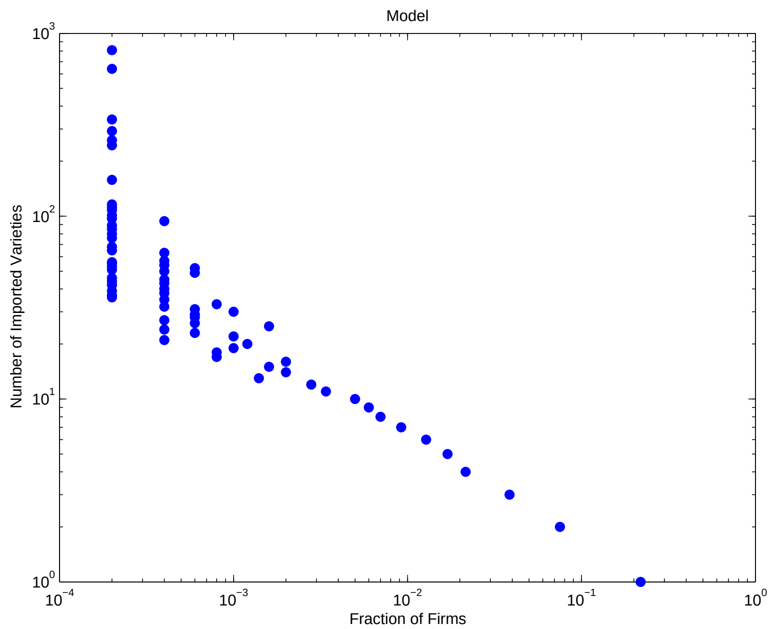
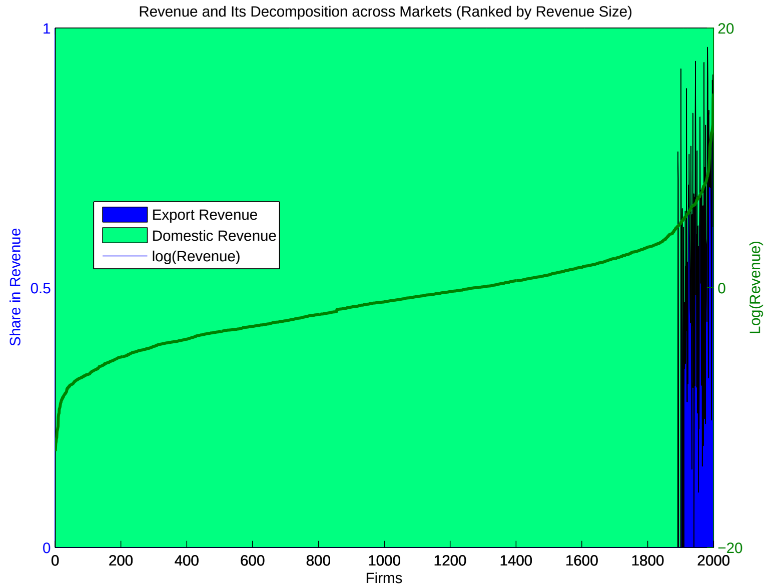


Figure 11: Revenue Decomposition



paper. Lastly, we plan to see the impact of shocks to relative prices of intermediate inputs and labor on the behavior patterns.

Since we have recently been able to produce the preliminary findings, we have not been able to complete these exercises yet. However, we hope to produce results of these exercises soon.

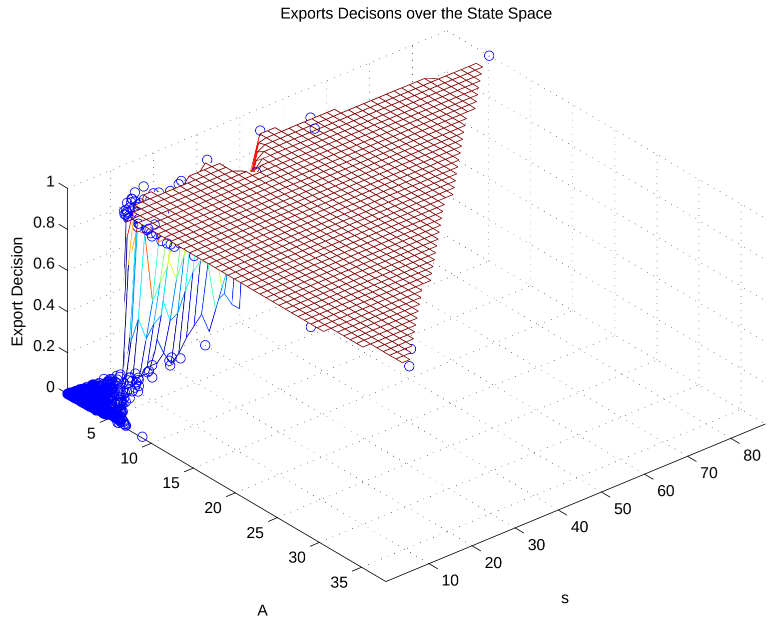
7 What is the Content of the Adjustment Costs?

The convex costs that firms have to endure while embedding more varieties to production plays a crucial role in this model, and the love-of-variety in the production technology allows firms to benefit from effectively lower imported input prices as the number of embedded imported varieties increases. So far, the model has been silent about the content of this adjustment cost. Firms may be adjusting their labor force, organization, machinery or their other facilities to incorporate these imported inputs. From another perspective, the observed increasing returns to scale in the model may also be stemming from the increasing search effort of firms for lower quality-adjusted prices. In the literature, search effort increases by size and the resulting bargaining power increases by size, as well. However, in the model, all of the return comes out of the love-of-variety attribute of the production technology. To check the impact of size on unit import prices we run simple regressions of log(price deviation) on log(quantity deviation).

The regression results given in Table 3 indicates that as firms increase the volume of

Figure 12: Trade Decisions

(a) Export Decisions



(b) Import Decisions

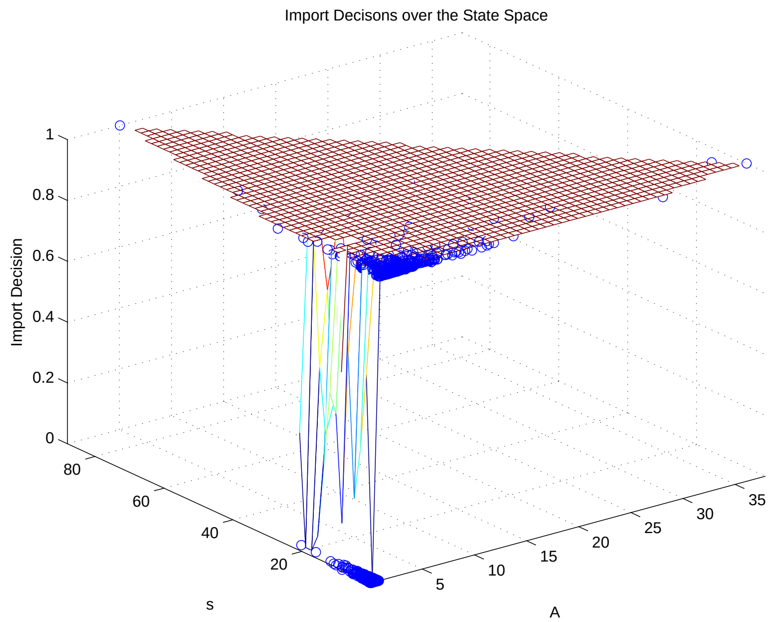
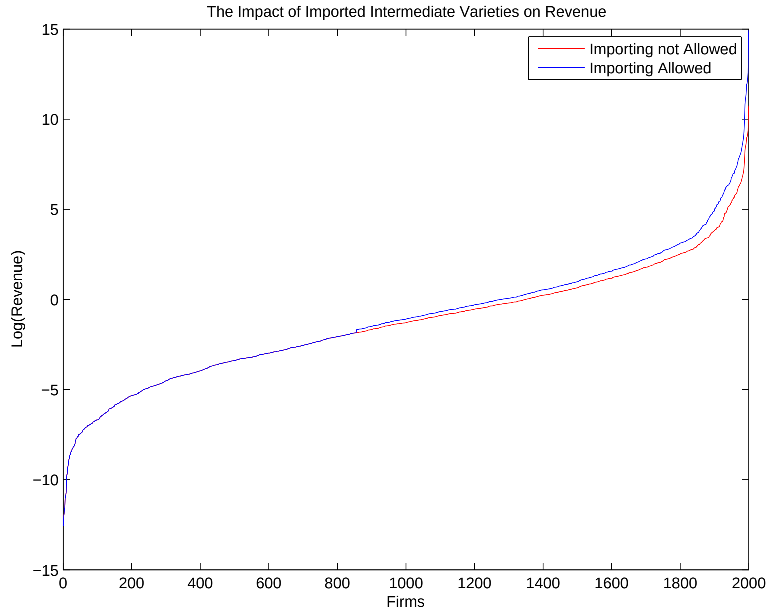


Figure 13: The Impact of Imported Intermediate Varieties on Revenue



their imports they get get lower prices for the same goods. Hence, in following steps of the analyses, we plan to incorporate this phenomenon into the model and recalculate the size of the convex adjustment cost.

8 Possible Extensions

The targeted moments of the data are from a cross-section of the data. A possible extension may be adding an R&D sector to the model, existence of a mechanism for technical change may allow us to talk about how the pace of technical change evolve over time in response to lower trade barriers. Dynamic extension of the model can also shed some light onto the evolution of entry of firms into production, and gross expenditure on R&D as a percentage of GDP. This study highlights the importance of the adaptation costs for imported intermediate inputs. Hence next step of this study can be investigating the nature of these costs using firm level data. These costs may be the adaptation costs of labor to a more diverse set of intermediate inputs.

9 Conclusion

The exhibited findings from Turkish manufacturing firms indicate a strong relationship between imported intermediate goods, firm size and the value-added content of exports. This

Table 3: Bargaining Power

	m1	m2	m3	m4	m5
log(quantity dev.)	-0.078***	-0.078***	-0.078***	-0.078***	-0.078***
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
cons	-0.175***	-0.175***	-0.175***	-0.175***	-0.175***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
N	412396	412396	412396	412396	412396
r2	0.087	0.087	0.087	0.087	0.087

Notes: Dependent variable is the log(price deviation) where price deviation of a firm for a good is the unit price that the firm pays for the good divided by the mean of the unit price paid for the same good across all firms that are importing the good. A good is a HS12-digit good, origin country combination. Unit price of an imported good for an importer firm is the USD amount paid for the good by the firm divided by the amount of the good imported. In columns (3) and (5) regressions are weighted with the relevant dollar values of total imports of the good. The outlier goods which have average price growth rates above 500 percent are excluded from all regressions. Standard errors are clustered at good level. *,**,*** indicate p<.1, p<0.05, p<0.01, respectively.

study sheds some light on how the import and export decision interact with each other by suggesting a cost structure onto import decisions. It explains why the intermediate goods import ratio is higher for exporter firms than for non-exporter firms at all size, and why the share of imported intermediate varieties grows faster with size for exporters than for non-exporters. It also achieves comparative statics on the import content of production in response to changes in adaptation costs for new intermediate inputs, quality differences between domestically supplied and imported intermediate inputs, wage, intermediate input prices and trade barriers. Running the analysis using only subsets of the data can allow inference at the sectoral level as well as intersectoral interactions. The model is calibrated to the data by shutting down some general equilibrium channels. Opening some of those channels may also allow extensions of the study. Counterfactual analyses of trade barrier reductions can allow a growth accounting. The impact of imported intermediates on economic growth can be addressed, and also some policy suggestions about current account deficits can be put forward.

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APPENDIX

Derivation of the first order conditions give n in Eq. (13)

$$\frac{\partial \pi}{\partial \Omega} = W(1-\varepsilon)(1+I(g^*>0)s\tau^{\frac{\varepsilon}{\varepsilon-1}})\frac{\partial p(\Omega)^{\frac{\varepsilon}{\varepsilon-1}}}{\partial \Omega} - \lambda w f_\nu \Omega^{\lambda-1} = 0 \tag{17}$$
$$= W(1-\varepsilon)(1+I(g^*>0)s\tau^{\frac{\varepsilon}{\varepsilon-1}})\varepsilon^{\frac{\varepsilon}{1-\varepsilon}}\frac{\partial C(\Omega)^{\frac{\varepsilon}{\varepsilon-1}}}{\partial \Omega} - \lambda w f_\nu \Omega^{\lambda-1} = 0$$
$$= \underbrace{W(1-\varepsilon)(1+I(g^*>0)s\tau^{\frac{\varepsilon}{\varepsilon-1}})\varepsilon^{\frac{\varepsilon}{1-\varepsilon}}\left(\frac{w^{1-\mu}}{A\mu^\mu(1-\mu)^{1-\mu}}\right)^{\frac{\varepsilon}{\varepsilon-1}}}_{\kappa}\frac{\partial\,(P_X^\mu)^{\frac{\varepsilon}{\varepsilon-1}}}{\partial \Omega} - \lambda w f_\nu \Omega^{\lambda-1} = 0$$
$$= \kappa\frac{\partial\left(\left(P_Z^{\frac{\rho}{\rho-1}} + \mathbf{I}(\Omega>0)P_{M_i}^{\frac{\rho}{\rho-1}}\right)^{\frac{\rho-1}{\rho}}\right)^{\frac{\mu\varepsilon}{\varepsilon-1}}}{\partial \Omega} - \lambda w f_\nu \Omega^{\lambda-1} = 0$$
$$= \kappa\frac{\partial\left(\left(P_Z^{\frac{\rho}{\rho-1}} + \mathbf{I}(\Omega>0)\left(\frac{p_m}{b}|\Omega_i|^{\frac{\theta-1}{\theta}}\right)^{\frac{\rho}{\rho-1}}\right)^{\frac{\rho-1}{\rho}}\right)^{\frac{\mu\varepsilon}{\varepsilon-1}}}{\partial \Omega} - \lambda w f_\nu \Omega^{\lambda-1} = 0$$
$$= \kappa\frac{\mu\varepsilon}{\varepsilon-1}P_X^{\frac{\mu\varepsilon}{\varepsilon-1}-1}\frac{\rho-1}{\rho}P_X^{\frac{1}{1-\rho}}\mathbf{I}(\Omega>0)\left(\frac{p_m}{b}\right)^{\frac{\rho}{\rho-1}}\frac{\theta-1}{\theta}\frac{\rho}{\rho-1}|\Omega_i|^{\frac{\theta-1}{\theta}\frac{\rho}{\rho-1}-1} - \lambda w f_\nu \Omega^{\lambda-1} = 0$$
$$= \kappa\frac{\mu\varepsilon}{\varepsilon-1}\frac{\theta-1}{\theta}\left(\frac{p_m}{b}\right)^{\frac{\rho}{\rho-1}}P_X^{\frac{\mu\varepsilon}{\varepsilon-1}+\frac{\rho}{1-\rho}} = \lambda w f_\nu \Omega^{\lambda-\frac{\theta-1}{\theta}\frac{\rho}{\rho-1}}$$

$$\frac{\partial^2 \pi}{\partial \Omega^2} = \Gamma\left(\frac{\mu\varepsilon}{\varepsilon-1}+\frac{\rho}{1-\rho}\right)P_X^{\frac{\mu\varepsilon}{\varepsilon-1}+\frac{\rho}{1-\rho}-1}\frac{\rho-1}{\rho}P_X^{\frac{1}{1-\rho}}\mathbf{I}(\Omega>0)\frac{\rho}{\rho-1}|\Omega_i|^{\frac{\theta-1}{\theta}\frac{\rho}{\rho-1}-1} \tag{18}$$
$$-\lambda\left(\lambda-\frac{\theta-1}{\theta}\frac{\rho}{\rho-1}\right)w f_\nu \Omega^{\lambda-\frac{\theta-1}{\theta}\frac{\rho}{\rho-1}-1}$$
$$= \Gamma\left(\frac{\mu\varepsilon}{\varepsilon-1}+\frac{\rho}{1-\rho}\right)P_X^{\frac{\mu\varepsilon}{\varepsilon-1}+\frac{2\rho}{1-\rho}}|\Omega_i|^{\frac{\theta-1}{\theta}\frac{\rho}{\rho-1}-1} - \lambda\left(\lambda-\frac{\theta-1}{\theta}\frac{\rho}{\rho-1}\right)w f_\nu \Omega^{\lambda-\frac{\theta-1}{\theta}\frac{\rho}{\rho-1}-1}$$
$$\Longrightarrow \underbrace{\Gamma}_{-}\underbrace{\left(\frac{\mu\varepsilon}{\varepsilon-1}+\frac{\rho}{1-\rho}\right)}_{-,+}\underbrace{P_X^{\frac{\mu\varepsilon}{\varepsilon-1}+\frac{2\rho}{1-\rho}}}_{+} - \lambda\underbrace{\left(\lambda-\frac{\theta-1}{\theta}\frac{\rho}{\rho-1}\right)}_{-,+}\underbrace{w f_\nu \Omega^{\lambda-\frac{\theta-1}{\theta}\frac{2\rho}{\rho-1}}}_{+}$$

where $\Gamma = \kappa\frac{\mu\varepsilon}{\varepsilon-1}\left(\frac{\theta-1}{\theta}\right)^2\left(\frac{p_m}{b}\right)^{\frac{2\rho}{\rho-1}}$. When $\frac{\mu\varepsilon}{\varepsilon-1}+\frac{\rho}{1-\rho}$ and $\lambda-\frac{\theta-1}{\theta}\frac{\rho}{\rho-1}$ positive, the decision problem is concave for sure.

For having $\frac{\mu\varepsilon}{\varepsilon-1}+\frac{\rho}{1-\rho} > 0, -2+\frac{\rho}{1-\rho} > 0, \Longrightarrow 2 < \frac{\rho}{1-\rho} \Longrightarrow \rho > 2/3$

For having $\lambda-\frac{\theta-1}{\theta}\frac{\rho}{\rho-1} > 0, \frac{\lambda\theta}{\theta-1} < \frac{\rho}{\rho-1}0, \frac{\rho}{\rho-1} > \frac{\lambda\theta}{\theta-1}$

$$\text{If } \frac{\lambda\theta}{1-\theta} > \frac{\rho}{1-\rho} > 2$$

$$\begin{aligned}&\text{If } \frac{\lambda\theta}{1-\theta} > \frac{\rho}{1-\rho} > 2\\ &\text{then } \underbrace{\underbrace{\Gamma}_{-}\underbrace{\left(\frac{\mu\varepsilon}{\varepsilon-1}+\frac{\rho}{1-\rho}\right)}_{+}\underbrace{P_X^{\frac{\mu\varepsilon}{\varepsilon-1}+\frac{2\rho}{1-\rho}}}_{+}}_{-} - \underbrace{\lambda\underbrace{\left(\lambda-\frac{\theta-1}{\theta}\frac{\rho}{\rho-1}\right)}_{+}\underbrace{wf_\nu\Omega^{\lambda-\frac{\theta-1}{\theta}\frac{2\rho}{\rho-1}}}_{+}}_{+}\end{aligned}$$