

# Supplier Search and Market Concentration \*

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## Abstract

I examine how lower search costs in input markets reshape the firm sizes distribution. Using Swedish firm-level import data, I document four facts: (i) more productive firms pay lower input prices, (ii) the dispersion in imported varieties across firms is widening, (iii) the sales distribution among importers has become more unequal, and (iv) firms, especially productive ones, located in municipalities with better technology that facilitate search experience faster supplier network growth. To interpret these patterns, I develop a quantitative model of monopolistic competition with frictional input markets, in which firms incur fixed costs to search and bargain with suppliers. The model shows that falling search costs reallocate resources toward more productive importers, raising aggregate output by but also hugely increase gap between big and small firms and therefore increasing market concentration by . A counterfactual exercise indicates that a 10 percent tariff on inputs would largely offset these gains and also reduce market concentration.

*Keywords: Search costs; Input markets; Firm-to-firm trade; Market concentration; Misallocation; Tariffs*

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# 1 Introduction

It is now much easier for firms to expand their supplier networks internationally. For example, online meetings, now ubiquitous but rare two decades ago, allow firms to connect with suppliers located thousands of kilometers away from their physical location. This development holds true for both small and large firms. Smaller firms can now enter international supply chains that were previously too costly to access, while larger firms that were already importing can expand their supplier networks more easily. These reductions in search costs benefit firms of all sizes, but are the benefits equally distributed? If not, how do they reshape the distribution of firm sizes and market concentration?

There is broad consensus that trade liberalization affects the firm size distribution. Notably, intensified import competition is a major explanation for rising market concentration (Amiti and Heise, 2025), where foreign varieties displace less productive domestic producers. However, most of this literature focuses on imports or exports of final goods rather than on the impact of trade on production processes. Yet in major economies, a large share of imports consists of intermediate inputs. For instance, OECD (2009) documents that 56% of global goods trade consists of intermediate goods. In 2023, 60.5% of EU imports were intermediate goods, compared with 17.3% for consumer goods (Eurostat). Importing final goods directly competes with domestic firms, generating effects similar to a demand shock. By contrast, importing inputs alters the measured productivity of domestic firms, which is more akin to a productivity shock. This perspective shifts the question: rather than studying how trade reallocates demand across firms (Eaton et al., 2011), I ask how differences in access to international suppliers affect production, efficiency, and market concentration. In this way, the paper complements existing work by highlighting a margin of trade that has received less attention but is economically important.

To investigate this mechanism, I use Swedish administrative data to document four key empirical facts about importing manufacturing firms. First, I find that more productive firms pay lower input prices. Second, there is wide dispersion in the number of imported varieties across firms. While the lower end of the distribution remains stable, the upper tail now imports many more varieties than it did twenty years ago. Third, I show that the sales distribution among Swedish importing firms has also become increasingly dispersed over the last two decades. Fourth, I use the rollout of high-speed internet as a proxy for declining search costs and find that firms located in municipalities that are more fiber ready grow their supplier network about 7% quicker and more productive firms grow a further 19% faster.

To interpret these facts, I develop a quantitative model that embeds a frictional intermediate-input market within a canonical monopolistic competition framework. In the input market, heterogeneous domestic firms must pay a fixed search cost to acquire inputs from foreign suppliers. I compare equilibria under different levels of search costs. The model generates predictions on how search costs affect the distribution of suppliers, sales, and productivity across firms. I then map simulated model moments to the empirical patterns observed in the administrative data. Through the lens of this model, I identify search costs in input markets as a channel that helps explain rising market concentration and derive relevant policy implications.

The model highlights how reducing search costs benefits firms asymmetrically. Firms that were already importing expand their networks further, while firms at the margin gain access to international supply chains that were previously out of reach. However, for firms that never engage in supplier searches, lower search costs have little effect. In general equilibrium, these non-importing firms become relatively less productive compared to their importing counterparts, leading to declining sales and profits. I find that reducing search cost can increase both market concentration by 12% and aggregate domestic consumption by 54%.

I also conduct a counterfactual exercise in which the government imposes a uniform tariff on all imported intermediate inputs. The results show that a 10% tariff is sufficient to reverse both the output gains and the market concentration effects associated with the decline in search costs over the past 20 years.

This paper contributes to the literature in three ways.

First, I uncover the role of search costs in input markets as a determinant of market concentration. In doing so, I complement existing studies that emphasize other drivers of concentration, such as rising entry barriers (Covarrubias et al., 2020), intensified import competition (Amiti and Heise, 2025), and falling market spanning costs due to advances in information technology (Aghion et al., 2023).

Second, this paper relates to the growing literature on firm-to-firm trade. Using Swedish import data, I document rising dispersion in the number of imported varieties and substantial input price heterogeneity, consistent with Atalay (2014). Prior studies attribute such patterns to mechanisms such as buyer market power (Morlacco, 2020; Rubens, 2023), input quality differences (Kugler and Verhoogen, 2012), and match-specific frictions (Burstein et al., 2024). I extend this literature by documenting new correlations between price gaps and firm characteristics and by highlighting additional empirical regularities. I build a model of buyer-supplier relationships that features

bargaining Alviarez et al. (2023), search Eaton et al. (2022a) and matching Eaton et al. (2022b). This unified framework allows for endogenous relationship formation with bargaining over both quantities and prices. The model is complex but it has the clean features resembling random-job search model McCall (1970). It also contributes to the labor search-and-matching literature by providing a framework that incorporates explicit search costs, two-sided heterogeneity, and multidimensional bargaining, features that are also realistic in labor market settings.

Third, I show that importing intermediate goods can increase markup distortions, contrasting with the findings of Edmond et al. (2015), who show the opposite effect for imports of consumer goods. This places my work within the misallocation literature pioneered by Restuccia and Rogerson (2008) and Hsieh and Klenow (2009), and further developed by Dhingra and Morrow (2019). I study how search costs in supply chains affect allocative efficiency for downstream firms. My theoretical framework, which models search and bargaining between buyers and suppliers, generates endogenous price gaps and allows me to assess their impact on aggregate output. This introduces a novel mechanism, whereby the wedge depends directly on firms' productivity. This mechanism provides an alternative explanation why some countries gain more from trade liberalization, because places with institutions can outsource more inputs, as explained in (Boehm and Oberfield, 2020).

The remainder of the paper is organized as follows. Section 2 describes the data and Section 3 documents the four facts. Section 4 develops the model. Section 5 maps model predictions to the data and quantifies the impact of falling search costs on productivity and concentration. Section 6 presents the tariff counterfactual. Section 6 concludes.

## 2 Data

My theoretical framework can be used to study general supplier-buyer relationships, domestic and international ones alike, but I limit the empirical analysis to international imports of Swedish manufacturing firms. The first reason is data availability.

### 2.1 Trade Data

The main data block is the import part of the *Utrikeshandel med varor*, Foreign Trade in Goods dataset. Swedish trade data cover import records at the firm, year, country

of shipment, and HS8 product level for the period 1998–2021. A short coming is, if a company import german cars in 2018 from two different suppliers, I can only see one aggregated record. Each record includes the import value and weight. For a subset of products, the data also include an additional variable “Other Quantities” (e.g., pieces for pencils or  $m^2$  for curtains).<sup>1</sup> I use these records to compute unit values, which I interpret as price.

The dataset covers all imports during 1998–2021 from outside the EU (including Switzerland and EEA countries) and intra-EU imports for firms whose total annual imports exceed SEK 9 million (See SCB (2018) for more).<sup>2</sup>

Imported inputs are very important to the Swedish economy. Using the Trade in Value Added (TiVA) 2023 edition, year 2020 dataset provided by OECD, I calculate 2 statistics - percentage of Foreign Value Added in Swedish manufactured goods, and the percentage of intermediates in import. The domestic value added in Swedish manufactured product: 69%, which means 31% is foreign value added. Also, around 36% of all imports are intermediate goods. Both figures show that imported inputs are non-trivial for Sweden.

Each entry includes value and quantity of the imported product. I define the product-country pair  $pc$  as a variety. And I define price as the log residualized price

$$P = \log\left(\frac{P_{fvy}}{\bar{P}_{vy}}\right)$$

where the numerator is the deflated value over quantity of one data entry and the denominator is the within-variety-year weighted-average price

$$\bar{P}_{pcy} = \frac{\sum_{pcy} \text{Deflated Value}}{\sum_{pcy} \text{Quantity}}$$

I deflate the value using aggregate CPI data to adjust for inflation.

For some analysis, I construct a firm-level price index, which is the weighted average across all variety the firm buy within a year:

$$\frac{\sum_f \text{Price} * \text{Deflated Value}}{\sum_f \text{Deflated Value}}$$

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<sup>1</sup>See the subset of products in the Övrigt om varukoder section on <https://www.scb.se/lamna-uppgifter/undersokningar/intrastat-in--och-utforsel-av-varor/varukoder-kn-for-uppgiftslamnande-till-intrastat/>

<sup>2</sup>There is a cutoff for intra-EU trade. In 2021, Britain left EU and below-cutoff imports from Britain that would not be in the sample before will now show up. It create a mechanical effect where suddenly in 2021, there are more small imports than previous years. To address this, I exclude observations that is after 2020 and from Britain for the trends plots.

For example, if a company buy 10000SEK worth of german cars at 20% higher unit price than average german cars buyer and 3000SEK worth of Chinese headphones at 30% lower price than average. Then, their firm level price index is:

$$\frac{1.2 * 10000 + .7 * 3000}{10000 + 3000}$$

I did basic data cleaning by excluding observations where the total value is below 100 SEK (around 9USD). I also exclude observations where its unit price is more or less than 15 times of the average variety price. I suspect those records are either not arm-length trade, a typo or just a placeholder value.

I also compute a firm-level input price and quantitiy index, where the firm-level price and quantity is defined as:

$$\begin{aligned} \text{Input Price}_{f,t} &= \frac{\sum_{\text{All Imports}_{f,t}} \text{Value}_{f,t} \log(\frac{P_{f,v,t}}{P_{v,t}})}{\text{Total Value of Imports}_{f,t}} \\ \text{Input Quantity}_{f,t} &= \frac{\sum_{\text{All Imports}_{f,t}} \text{Value}_{f,t} \log(\frac{\text{Quantity}_{f,v,t}}{\text{Quantity}_{v,t}})}{\text{Total Value of Imports}_{f,t}} \end{aligned}$$

## 2.2 Balance Sheet Data and other supporting dataset

To characterize importing firms, I link customs data to firms' balance sheets. I restrict the sample to manufacturing firms based on their SNI codes in the balance sheet data. This linkage allows me to compare importers' characteristics with the broader firm population. I focus primarily on sales and employment, and also construct a measure of firm productivity (TFPQ). First, I estimate revenue-based productivity TFPR under Cobb-Douglas assumption:

$$\text{TFPR}_{f,t} = \frac{(p_{f,t} y_{f,t})}{(w_{f,t} l_{f,t})^{\alpha_l} K_{f,t}^{\alpha_k} (\sum T_{f,t,u})^{1-\alpha_l-\alpha_k}}$$

where  $py$  is sales,  $wl$  is the wage bill,  $K$  is capital and  $T$  is intermediate cost, which are all observables on the balance sheet. I assume the capital rental rate  $r = 0.15$ , which is standard estimates from the literature. The remaining unknown parameters  $\alpha$ s can be easily back-out using the Cobb-Douglas property where  $\alpha$  equal to the expenditure share of that input under cost minimization. I assume  $\alpha$  is constant within industry

and is equal to the industry average expenditure share. As long as the firm use positive wage, intermediate cost and capital

I then estimate the adjusted TFPQ by:

$$\text{TFPQ}_f = p_f \text{TFPR}_f$$

, where  $p$  is the price of the firm's production.  $p$  can be obtained from the producer price index (PPI) or export database. One caveat is that the PPI database covers only the largest firms, and larger companies are typically those that tend to export. Consequently, the sample analyzed in this section is biased toward larger firms. In the Appendix, I have used an model-based estimation to calculate the output price, so that product quality is taken into account and most of the sample can be included. The conclusion is consistent.

## 2.3 Internet Data

As a proxy for search cost, I look into internet infrastructure that make communications with suppliers easy. To measure digital infrastructure, I use municipality-level internet connection data from the Swedish Post and Telecom Authority (PTS)<sup>3</sup>. The dataset provides historical information on internet coverage by technology across municipalities, including the number of firms in total and the number of firms with access to internet through a given technology. From these data, I use the share of firms in the municipality with access to fiber broadband as a proxy for (inverse) search costs. This variable is available annually for the period 2010–2023. There is also municipality code in the administrative data on the establishment level. I

## 3 Stylized Facts

In this section, I describe the empirical results. I will use the empirical moments and regularities to motivate how can reduction of search cost influence firms behaviour in input markets. Particularly, how firms of different sizes and productivities differ in their reaction to a environment with lower search cost. Then, I will provide secular trends about firm size ditributions in the input markets.

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<sup>3</sup>[\url{https://statistik.pts.se/telekom-och-bredband/mobiltackning-och-bredband/dokument/}](https://statistik.pts.se/telekom-och-bredband/mobiltackning-och-bredband/dokument/)

### 3.1 Static Moments

In this section, I describe how can change in search cost in the input market affect firm size distribution. In the first part of the this section, I use internet connection as a measure for search cost to see how it affect firms behaviour for acquiring inputs. In the second part, I look at how prices are different for different buyers and explains why.

#### 3.1.1 Determinants of Input Prices

In this section, I primarily examine what determines input prices, as we know that it is another important channel that input markets can affect productivity and allocative efficiency. First off, I examine how a firm's output productivity influences the prices it face in the input market. I run the following regression:

$$\text{Input Price}_{f,t} \sim \text{TFPQ}_{f,t} + \text{Input Quantity}_{f,t} + \text{FE}_{\text{industry}} + \text{FE}_t$$

The firm level price index is negatively correlated to TFPQ. That means more productive firms pay lower unit price compared to their less productive competitors for the same input bundle.

Table 1: Regression Results on Price of Input Bundle

	(1)	(2)	(3)
Intercept	0.9069 <sup>***</sup> (0.0099)	0.3496 <sup>***</sup> (0.0031)	0.5208 <sup>***</sup> (0.0079)
log TFPQ	-0.2333 <sup>***</sup> (0.0084)	—	-0.1235 <sup>***</sup> ( 0.0066 )
Weighted Input Quantity	—	-0.2395 <sup>***</sup> (0.0039)	-0.2314 <sup>***</sup> (0.0038)
Observations	72801	72801	72801
$R^2$	0.0244	0.1867	0.1934
Industry FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes

Notes: Standard errors in parentheses. Dashes indicate the variable is not included in that specification.

\*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

It is interesting because this correlation means that on top of their productivity advantage, more productive gain further step ahead to their less productive counterpart in the input market. This correlation widened the gap between productive and unproductive



firms. This potentially make the variance of firm size distribution larger and can have implication of increasing concentration.

Note that this relationship doesn't hold when we replace TFPQ by sales or TFPR. The reason is simple. Sales or TFPR is positively correlated with the output price  $p$  and output price  $p$  is positively correlated to marginal cost and input cost, which is the independent variable. Therefore, the negative correlation we see in the figure above maybe cancelled out/dampened or even dominated by this positive correlation. However, this result is robust when TFPQ is quality-adjusted (See Appendix).

It is also important to note that the slope is similar every year.

### 3.1.2 Internet

From the internet data, I use the percentage of firm that have access to internet through fiber as a proxy for (inverse) search cost. I choose the this technology as the proxy instead of xDSL/cable because fiber is the fastest and most realiable internet technology, which is optimal for video calls. Therefore, having fiber connection can significantly reduce communication costs with suppliers. The fiber rollout in Sweden can be seen in the graphs below:

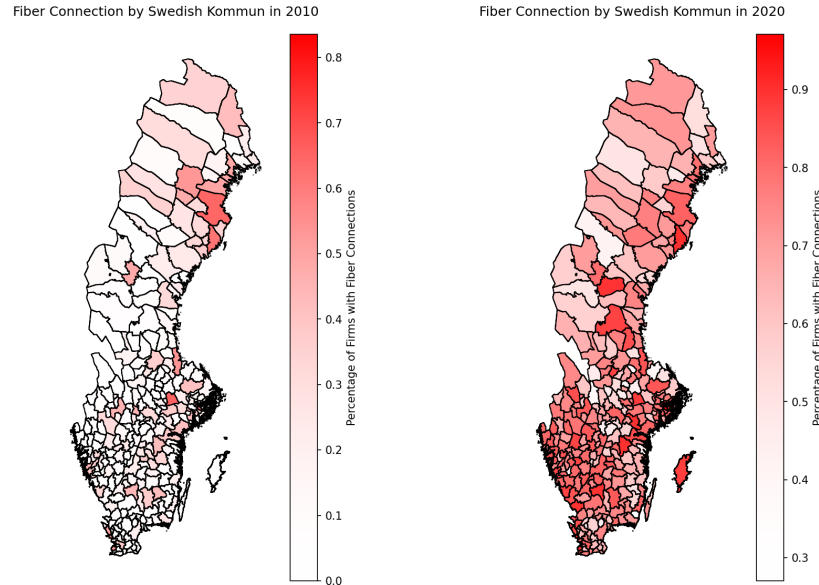


Figure 1: Fiber Map in Sweden

I run the following regression:

$$\begin{aligned} \log\left(\frac{\text{No. of Varieties Imported}_{f,t+1}}{\text{No. of Varieties Imported}_{f,t}}\right) &\sim \% \text{Fiber}_{m,t} \\ &+ \mathbf{1}\{\text{TFPQ}_{f,t} > \text{TFPQ}_{i,t}\} \times \% \text{Fiber}_{f,t} \\ &+ \text{FE}_t + \text{FE}_i + \text{FE}_m \end{aligned}$$

Table 2: Regression Results - Fast Internet Connection on Growth of Varieties Imported

	(1)	(2)
Fiber	0.149*** (0.016)	0.0733** (0.0199)
Fiber x 1(Productive)	—	0.187*** (0.0246)
Observations	112022	112022
$R^2$	0.0013	0.0024
Industry FE	Yes	Yes
Time FE	Yes	Yes
Municipality FE	Yes	Yes

Notes: Standard errors in parentheses.

\*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

I examines how access to fiber internet influences the number of imported varieties. The table show that firms located in municipalities with fiber coverage tend to import a broader range of products. When distinguishing between firms by productivity, the pattern becomes even clearer. All firms expand their set of imported varieties once fast internet is available, but the effect is particularly pronounced for the more productive firms. This suggests that fiber access reduces barriers to searching for and coordinating with foreign suppliers, and that firms with higher capabilities are best positioned to take advantage of these opportunities. The regressions control for differences across industries, years, and municipalities, so the effects are not driven by compositional changes in the data. Even though the share of variation explained is small, the results consistently point to a strong role of digital infrastructure in facilitating firms' access to imported inputs.

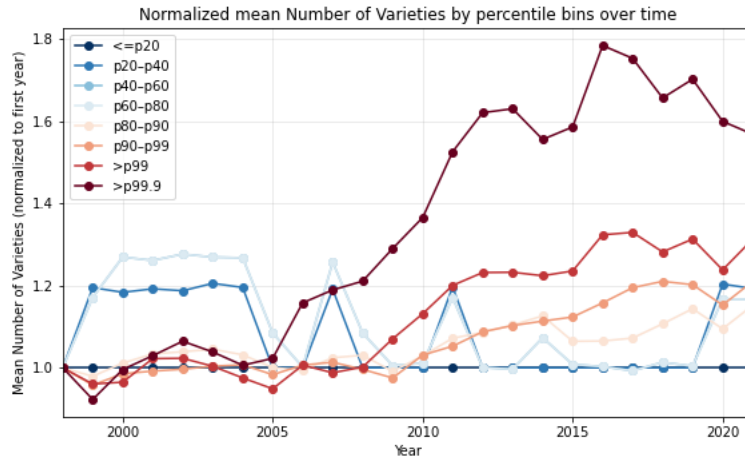
### 3.2 Trends in Input Market

It is true that search costs have been decreasing with transport and communications technology advances swiftly in the last 30 years. It can also be reflected in the fiber

connection in Sweden. In 2010, there are only 27% of commercial establishments that are connect to internet by optical fiber, the number is 79% in 2021. Therefore, given the mechanisms in section above, it can be expected that there are big distributional changes within the input market. In this section, I will show changes of different variables within the input markets and discuss how can it be translated to final market concentration.

### 3.2.1 Dispersions within the Import Market

I define a "variety" as a unique country-product pair. In the graph presented, I compare the number of varieties imported ou To facilitate comparison across variety percentiles, I normalize the annual number of varieties by their respective values from 1998. I observe that, except for the top percentiles, most variety percentiles have not experienced significant changes in the number of imported varieties. In contrast, the firms that import the most (specifically, the 90th and 99th percentiles) have increased the variety of imports by up to 20%. Given that the number of varieties imported directly relates to search activities, this observation suggests differential effects of search costs across distribution.



Large part of this pattern is driven by the entry of smaller firms. When I focus on only a balanced panel that imports every year in the data, all firms have import more varieties compared to in 1998.

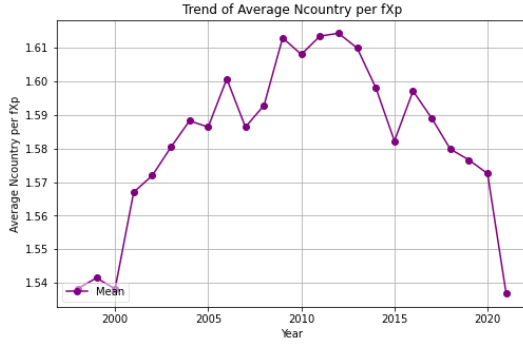


Figure 2: Average No. of Source Country by FirmXProduct Pair

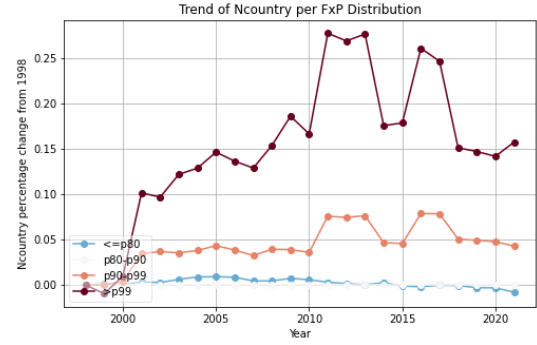


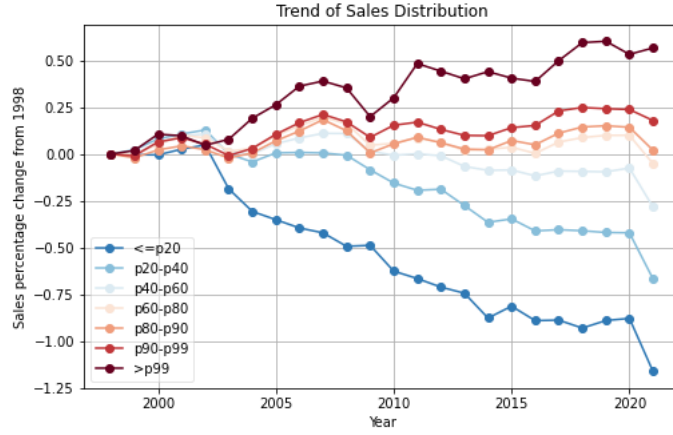
Figure 3: Distribution of No. of Source Country by FirmXProduct Pair

### 3.2.2 Importing Firm Size Dispersion

In this section, I examine changes in firm size, measured by annual sales, at various percentiles over the period from 1998 to 2021. Specifically, I analyze how firm sizes at different percentiles evolve relative to their 1998 levels by normalized by their respective values from 1998.

The graph clearly shows a significant reduction in firm size at the median and lower percentiles. For instance, the 5th percentile firm in 2021 is approximately 80% smaller than the 5th percentile firm in 1998. This substantial decrease likely results from reduced search costs, which acted as a barrier to entry into the import market. Lower search costs may have allowed less productive firms, which previously faced prohibitively high barriers, to enter the market. It is an indicator that entry cost to the international supply chain has reduced drastically.

In contrast, firm sizes at higher percentiles have substantially increased, by up to 40% at the 99th percentile, demonstrating the rapid growth potential of the largest firms. This growth can likely be attributed to reduced search costs facilitating expansion through the addition of new suppliers for incumbent, larger firms, which is explained in the previous section. As a result, we can observe that incumbent importers, who already import from 1998, at all parts of the distribution experience substantial sales growth. (Graph in Appendix)



Overall, these findings indicate increasing dispersion in firm sizes within the market. A potential contributing factor can be falling search costs, which simultaneously influence entry barriers and expansion costs, thereby affecting both the intensive and extensive margins of the firm-size distribution.

### 3.3 Summary

On top of the 4 main empirical facts, I document also:

- Firms that receive a lower weighted-average input price tends to have higher profit share.
- More productive firms import more varieties

These data moments are used in model validation and are further explained in appendix.

In conclusion, I have look into the data to uncover some important characteristic that intermediate input market exhibit. First of all, there is an inverse relationship between productivity and weighted average unit price, but no relationship between productivity and just unit price. Also, for realized transactions, price and quantity are inversely correlated. There are also big within firm price difference and large quality differences. Among all these, search costs seem to play an important role.

On top of my own findings, I also adopt 2 additional features in my model from recent trade literature. The first one concerns the time dependency of the supplier network. Martin et al. (2023) suggests that a median buyer-supplier relationship last around an year. Therefore, as my model period is an year, having a repeated static model

is not unreasonable and simplifies the numerical exercises by a lot. The second is related to inventory. Alessandria et al. (2010) point out that average company import internationally every 150 days, which indicate that inventory also should not matter for most firms in a yearly model.

## 4 Theory

Based on my empirical findings, I build a intermediate good market that features search and bargaining on top of a standard monopolistic competitive model.

The model timing is as followings: All productivities (and quality for seller) realize and are observed by the buyer  $d$  and seller  $u$  themselves according to some commonly known distribution. Buyers start from intermediate good  $XQ = 0$ , where  $Q$  is the corresponding quality. Given the intermediate good contracted  $XQ$  and self-productivity, buyers pay search cost  $\kappa(n)$  or drop out from searching. The searching buyers will randomly meet a seller. Sellers produce with linear technology:

$$x_u = z_u l$$

with labor as its only input. The cost of production is  $\frac{w_f}{z_u}$ , where  $w_f$  is the foreign wage. Without loss of generality, I henceforth assume  $w_f$  to be 1, so all the efficiency measure of the supplier is captured by  $z_u$ .<sup>4</sup> Productivity  $z_u$  and quality  $q$  are observable to the buyer. The matched firms will (Nash) bargain over a contract which specify intermediate good quantity  $xq$  (can be nothing) and total price  $T$ . After a contract is signed, buyer can stop or pay another search cost  $\kappa$ .

After all firms stop searching, the buyer will be endowed with intermediate good  $X_d = (\int x_u^\rho du)^{\frac{1}{\rho}}$ , where  $Q_d$  is the quality. Buyers produce consumption good with Cobb-Douglas technology:

$$y_d = z_d (X_d)^\alpha l^{1-\alpha}$$

by choosing labor and household consumes final good  $Y = (\int (y_d)^{\frac{\epsilon}{\epsilon-1}} dd)^{\frac{\epsilon-1}{\epsilon}}$ . When next period starts,  $X$  is reset. Search cost  $\kappa_t$  is decreasing every period.

The model can be summarized into 4 value functions, which represent search decision:

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<sup>4</sup>It will be same if I just named another efficiency variable  $e_u = \frac{w_f}{z_u}$ , but as I don't distinguish between different foreign countries that doesn't matter.

$$V(z, XQ, n) = \max\{V^s(z, XQ, n), V^{NS}(z, XQ)\}$$

The buyer with productivity  $z$  with contracted inputs  $XQ$  have to decide if she want to have her  $n$ th search by comparing value function  $V^s$  and  $V^{NS}$  for searching and not searching respectively. She will choose the decision that brings her bigger expected value.

The search value is:

$$V^s(z, XQ, n) = \int V^m(z, z_u, XQ) dF(z_u) - w\kappa_t(n)$$

where  $\lambda > 0$ .

The not-searching value is simply the profit that can be obtained based on the exiting input  $XQ$ . Given  $XQ$  and the demand system, the firm solve the deterministic profit maximizing function:

$$\begin{aligned} \max_{p,y} & py - w\left(\frac{y}{zX^\alpha Q^\alpha}\right)^{\frac{1}{1-\alpha}} \\ \text{s.t.} & yQ^{\alpha(1-\epsilon)} = C\left(\frac{p}{P}\right)^{-\epsilon} \end{aligned}$$

The output price, output quantity, labor usage and thus the profit function all have closed form solutions in terms of  $(z, X)$ , where  $V^{NS}$  is just the profit:

$$\begin{aligned} V^{NS}(z, XQ) &= p^*(z, X)y^*(z, X) - w\left(\frac{y^*}{z(XQ)^\alpha}\right)^{\frac{1}{1-\alpha}} \\ &= \left[\frac{1 + \alpha(\epsilon - 1)}{\epsilon}\right] \left(\frac{w\epsilon}{(\epsilon - 1)(1 - \alpha)}\right)^{\frac{(1-\alpha)(1-\epsilon)}{1+\alpha(\epsilon-1)}} \left(\frac{C}{P^{-\epsilon}}\right)^{\frac{1}{1+\alpha(\epsilon-1)}} (zX^\alpha Q^\alpha)^{\frac{\epsilon-1}{1+\alpha(\epsilon-1)}} \end{aligned}$$

Note that the intermediate cost and search costs are sunk once the search-and-bargaining round is done, so they do not show up in the profit function.

The matching value is:

$$\begin{aligned}
V^m(z, z_u, XQ) &= -T(z, z_u, XQ) + V(z, X^N Q^N) \\
X^N &= (X^\rho + x^\rho)^{\frac{1}{\rho}} \\
Q^N &= \frac{1}{X^N} \left( \sum_{u \in U_i} x_u^\rho q_u^\rho \right)^{\frac{1}{\rho}}
\end{aligned}$$

The bargaining problem:

$$\max_{T, xq} (-T + V(z, X^N Q^N) - V(z, XQ))^\theta \left( T - w \frac{xq}{z_u} \right)^{1-\theta}$$

In this Nash bargaining framework, the buyer and supplier negotiate over the payment  $T$  (from the buyer to the supplier) and the quality-adjusted input quantity  $xq$ . The buyer possesses a bargaining power of  $\theta$ , and its surplus is defined as the value gained from a successful negotiation minus the payment. The seller's surplus, on the other hand, is the payment received minus the production costs required to fulfill the contract. Due to the linear nature of the production technology, the bargaining process does not affect the seller's outside option, which can therefore be set to zero.

In the general equilibrium model, good and labor markets should be clear and budget constraint for the household should be satisfied.

The problem for the 2 types of household :

$$\begin{aligned}
\max_{c_i} C &= \int (y_i Q_i^\alpha)^{\frac{\epsilon-1}{\epsilon}} di)^{\frac{\epsilon}{\epsilon-1}} \\
s.t. PC &\leq wL_t + \pi
\end{aligned}$$

Factor Market Clearing:

$$\int \mathbb{E}[l + \kappa|z] dz = \bar{L}_t$$



Good Market Clearing:

$$\int \mathbb{E}[y|z]dz = C$$

## 4.1 Restrictive Model

I start with looking at an restrictive model where firms can only have one supplier (variety), no quality differentiation and both upstream and downstream productivity follows a simple  $U(0, 1)$  distribution. It become a quite familiar model of McCall (1970) random job search model. With this class of model, we can solve the optimal stopping problem by getting the reservation productivity  $z_u^R(z)$  and  $z^R$ . I can get an idea how search cost  $\kappa$  affect firm size distribution from a fixed point solution.

The reservation supplier productivity is solved by 2 equations. The first equation is the definition of the outside option  $D$ :

$$D = \int_{z_u^R}^{\bar{z}_u} [\pi(z_u) - T(z_u)] dF(z_u) + \int_{z_u}^{z_u^R} D dF(z_u) - w\kappa$$

which consists of 3 terms: The first one is expected profit given the probability of meeting a satisfactory supplier ( $z_u \geq z_u^R$ ), the second one is falling back to outside option if the supplier is worse than the reservation productivity and the last term is minus the search cost.

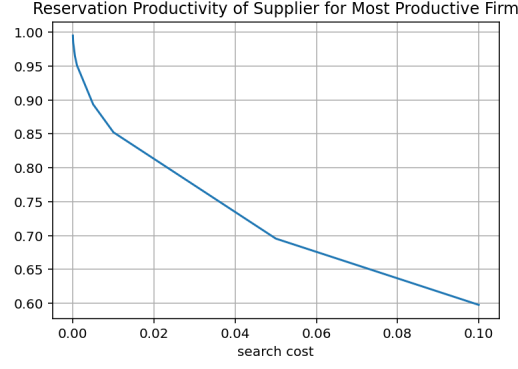
The second equation is defined by the indifference condition, where for any buyer, she should be indifferent between the profit for meeting the reserved supplier and going into outside option:

$$\pi(z, z_u^R) - T(z, z_u^R) = D$$

Combining the equations we get a expression for solving  $z_u^R$  for each  $z$ :

$$\frac{\kappa}{K z^{\epsilon-1}} = [1 + \alpha(\epsilon - 1) z_u^{R[\alpha(\epsilon-1)+1]} - (\alpha(\epsilon - 1) + 1) z_u^{R\alpha(\epsilon-1)}]$$

This expression provides a relationship between  $z_u^R$  and  $\kappa$  for any firm with productivity  $z$ . And solving this fixed point formula gives:

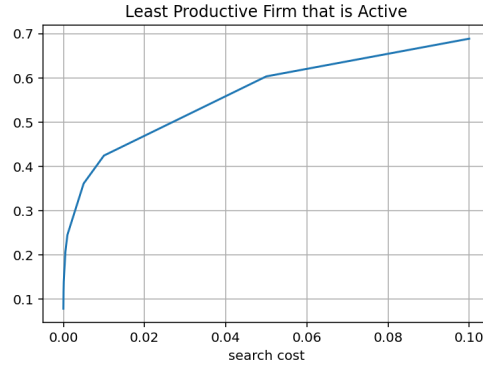


This shows that when search cost decrease, the reservation productivity, given  $z$ , is increasing. In other words, when search cost decrease, the expected productivity of the supplier increase. It is obvious that matching with a more productivity supplier means producing more. Therefore, downstream firm produce more when search cost decrease. It showcase, in this restrictive model, search cost also functions as expansion cost.

On top of that, I can show that the lowest productivity  $z^R$  where this downstream firm still remain active can be calculated by solving:

$$\frac{\kappa}{1 - F[z_u^R(z^R)]} = \int_{z_u^R(z^R)}^{\bar{z}_u} [\pi(z_u, z^R) - T(z_u, z^R)] dF(z_u)$$

And keeping everything but search cost  $\kappa$  constant,  $z^R$  increase with  $\kappa$ :



It shows that when search cost decrease, less productive firm can also enter the intermediate good market and produce. This showcase search cost can act as entry barrier.

## 5 Quantitative Model and Results

### 5.1 Full Equilibrium Model

In the full model, I add further features. First of all, there is outside options for production for firms. It is unrealistic to assume firms cannot produce without imports. The outside option is to assume there is a domestic supplier  $D$  that use only labor to produce. I normalize  $z_D = 1$  and assume that market is perfectly competitive such that domestic inputs  $M$  is provided at price  $p_M = w$ .

Therefore, after firms search (or not search), the production function becomes:

$$y = z \max\{X, M\}^\alpha l^{1-\alpha}$$

Also, I add a entry cost  $e$  for firms that want to start importing.

### 5.2 Numerical Solution, Calibration and Simulation

The full model have no closed form solutions, so I resolve to numerical method. I first calculate the policies of firms given states  $z$  and  $X$ .  $X = (\sum_u^{N_i} x_{i,u}^\rho)^\frac{1}{\rho}$  is sufficient as a state variable to represent the history of contracted inputs  $\{x_{i,1}, x_{i,2}, \dots, x_{i,u}\}$ . Observe that if I add a new  $x_N$  to list, so that the new aggregate input is:

$$\begin{aligned} X_N &= \left( \sum_u^{N_i} x_{i,u}^\rho + x_N^\rho \right)^\frac{1}{\rho} \\ &= (X^\rho + x_N^\rho)^\frac{1}{\rho} \end{aligned}$$

I solve the model by a standard VFI procedure. In the PE model, I first make an initial guess on the search value function  $V^S$  and calculate not-search  $V^{NS}$  based on the closed form solution above. Based on  $V^S$  and  $V^{NS}$ , I solve the firm search policy and get a guess  $V$ . Assuming this guess of  $V$  is true, I solve the policy functions for payment  $T$  and quality-adjusted quantity  $xq$  by grid searching. Then, I calculate the matching value  $V^m$  by plugging in the optimal  $T$  and new state  $X^N Q^N$  and update the expected search value  $V^S$  and  $V$ . The process stops when the value functions converge.

To speed up the VFI, I prove that the bargaining problem is strictly concave in  $T$  (See Appendix). So I can use a first order condition of  $T$  given fixed  $x$ :

$$\begin{aligned}(1 - \theta)\text{Buyer Surplus} &= \theta\text{Supplier Surplus} \\ \theta\left(\frac{T - K(x)}{V(x) - T}\right)^{1-\theta} &= (1 - \theta)\frac{V(x) - T}{T - K(x)} \\ T &= (1 - \theta)V(x) + \theta K(x)\end{aligned}$$

where  $K(x) = w\frac{qx}{z_u}$  and  $V(x) = V(z, X_N) - V(z, X)$ . And plug this into the original bargaining problem, I get:

$$\max_x \theta^\theta (1 - \theta)^{1-\theta} (V(z, X_N) - V(z, X) - w\frac{xq}{z_u})$$

In this way, I reduce the 2D optimization to 1D and I can ignore the constants  $\theta^\theta(1 - \theta)^{1-\theta} > 0$ .  $V$  is not concave in  $x$  because of the discrete search cost. Therefore, I have to find the optimization with grid-search.

I simulate the full model with various different parameters to understand 1) how does search cost change allocative efficiency and concentration 2) how does economy in different condition subject to this friction.

I first initiate a set of downstream firms with productivity  $z_d$  according to the distribution  $F(z)$ . Given a set of parameters and the policies, I simulate forward. The downstream firms choose to search according to the search policy and its state. The downstream firms will get a random draw of supplier  $z_u$  and gain intermediate good and pay according to the policy functions that I solved previously. I then obtained a panel of simulated inputs  $xq$ , payments to suppliers  $T$  and search cost  $\kappa$ .

I put limit on extrapolation. Therefore, firms with very high productivity will be dropped out from the simulation. It is on one hand, problematic, as I want to study concentration where super large firms are important. However, if it is unclear if the extrapolation will be very correct, if it is very far from the policy grids.

I use the following parameters:

I first talk about the calibration of productivity  $z$ . I assume it is log normally distributed. Therefore, I have 2 parameters that I need to calibrate against (at least) 2 empirical moments. Productivity is hard to be accurately measured in data, so I look at sales distribution. The 2 moments I choose are 1) market share of the top 1% firm and 2)

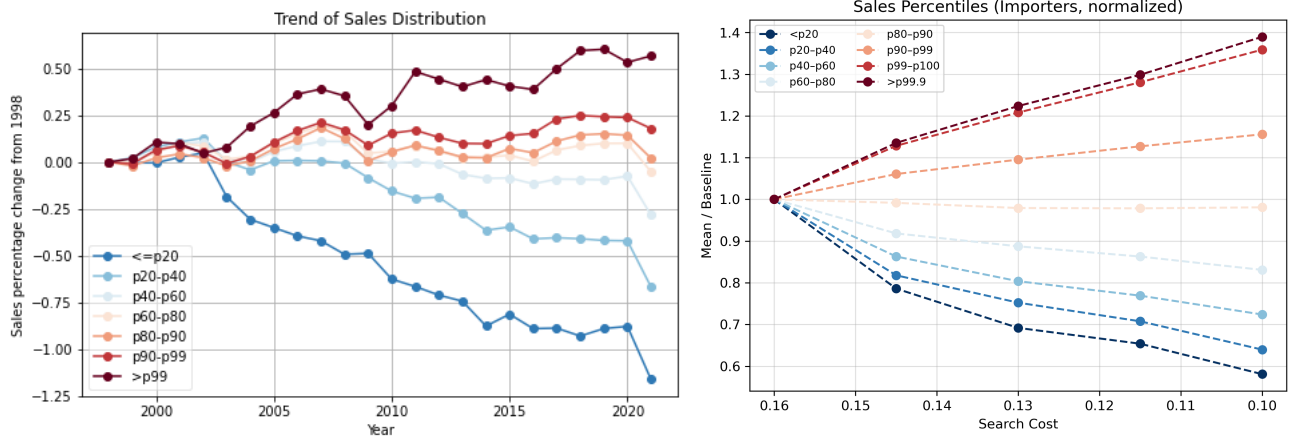
Variable	Values	Source
Final Market Elasticity $\epsilon$	4	Standard
Intermediate Elasticity $\rho$	4	Standard
Cobb-Douglas Intermediate $\alpha$	.7	Intermediate Share
Distribution of $z$	$\log N(0,2)$	Sales Distribution
Distribution of $z_u$	$\log N(0,2)$	Assume to be same as Domestic Firms
search cost $\kappa_0$	[.07, .15]	Nsupplier Distribution time Series
import entry cost $e$	.15	Percentage of firms that imports
Buyer's Bargaining Power $\theta$	.83	Alviarez et al. (2023)

Table 3

sales ratio between top 1% firm and the median firm within industry. I calculate these with only industries that have more than 5 firms to avoid industries with natural or regulatory monopoly. I then take the median industry as my calibrated moments. For the top market share, within my data period, the top 1% sales share increase from 43.9% to 48.8%. For the top 1% vs median ratio, the ratio, have increase from 414 to 948.<sup>5</sup>

I also have an entry cost for import market. To calibrate this, I look at the empirical share of manufacturing firms which imports. The share is fairly steady over my data periods, with its starting point as 17.0% at 1998, the lowest point as 14.8% at 2006 and highest point as 17.9% at 2021.

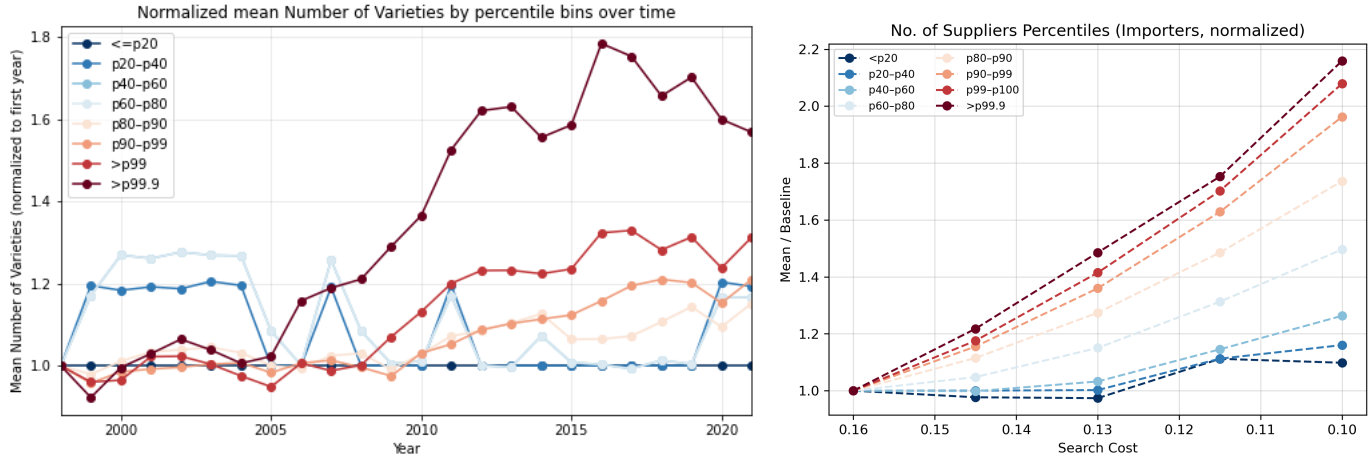
### 5.3 Market Concentration



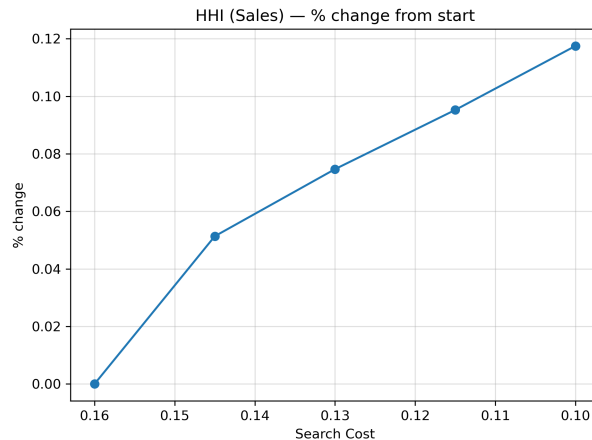
In the data, firm size distribution is increasing, that assembles the first part of the graph. On one hand, smaller firms get to enter the market, but the firms that expand

<sup>5</sup>I have truncated the distributions on the .01 and 99 percentile in the simulations.

the fastest are the most productive firms. However, under this parameterization, very quickly the all potential downstream entrants are active, this allows me to focus on the expansion channel. In the model, when the search cost further decrease, the growth rate of median firms catch up with the most productive firms. And then eventually, the growth rate of even smaller firms catch up. The reason is the discrete increase of suppliers and the concavity of profit function. When search cost is high, let's assume the most productive firm have 20 suppliers while the median firm has 1. While adding one extra supplier is not a lot for a firm with 20 suppliers, a increase from 1 to 2 is a big jump. That's why at the start big firms expand the quickest. However, when the search cost decrease enough that less productive firms also start to expand, they expand quicker because the big firms have less incentive to further grow because of the concavity of the profit function.



As a result, the market concentration, measured by HHI, is increasing with search cost, as shown in the following graph.

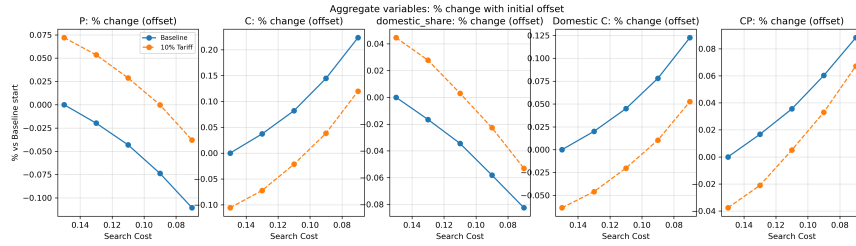


## 5.4 Policy Counterfactual - Tariff

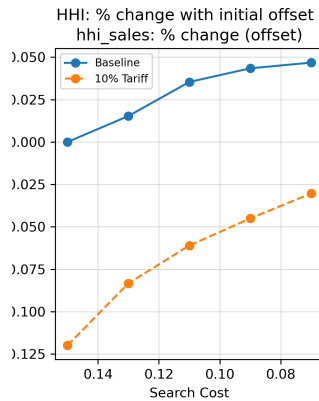
In this subsection, I conduct a policy experiment introducing a 10% tariff and compare the outcomes to a baseline environment without trade protection. The implementation of tariff rate  $\tau$  is as follows:

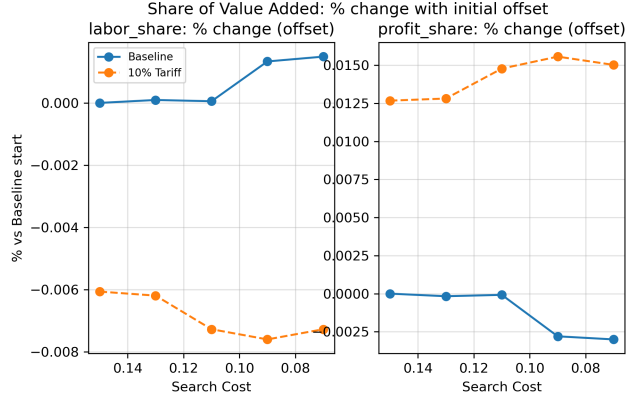
$$\max_{T,xq} (-(1+\tau)T + V(z, X^N Q^N, n+1) - V(z, XQ, n+1))^\theta (T - w_f \frac{qx}{z_u})^{1-\theta}$$

In the baseline, declining search costs systematically widen the sales gap, reduce markups, and increase sales-based concentration. By contrast, the tariff scenario flattens these slopes: the sales gap expands more slowly, markups remain persistently higher, and sales concentration stabilizes at a lower level. Thus, while the direction of change with lower search costs is similar across regimes, tariffs consistently moderate the magnitude of adjustment rather than eliminating it.



The tariff also alters distributional and aggregate outcomes. Labor's share of value added remains largely unchanged in the baseline but declines under the tariff, while profit shares diverge upward, reflecting a shift in income distribution. At the aggregate level, lower search costs in the baseline reduce prices and stimulate both overall and domestic consumption. These upward responses remain present with tariffs but are uniformly dampened, with prices even shifting upward relative to the baseline. Taken together, the results indicate that tariffs do not offset the effects of falling search costs entirely but instead introduce systematic level shifts that blunt their impact.





## 6 Conclusion

This paper has examined how reductions in search costs in input markets reshape the distribution of firm sizes. Using detailed Swedish administrative data, I documented four empirical facts: more productive firms pay lower input prices, there is widening dispersion in imported varieties, the sales distribution among importers has become increasingly dispersed, and municipalities with greater fiber-optic coverage experience faster supplier network expansion, especially for more productive firms.

To interpret these findings, I developed a quantitative model that embeds a frictional input market into a canonical monopolistic competition framework. The model shows that lower search costs benefit importing firms more strongly, allowing them to expand supplier networks and raise productivity, while non-importers become relatively less competitive. As a result, aggregate productivity rises but market concentration increases. A counterfactual exercise further showed that even a modest tariff on intermediate goods could offset these gains.

These results highlight the importance of input market frictions in shaping firm dynamics, productivity, and concentration. They suggest that policies affecting search costs, whether through infrastructure investments, digital technologies, or trade regulation, can have substantial effects on firm performance and aggregate outcomes.

## References

Philippe Aghion, Antonin Bergeaud, Timo Boppart, Peter J Klenow, and Huiyu Li. A Theory of Falling Growth and Rising Rents. *The Review of Economic Studies*, 90



- (6):2675–2702, November 2023. ISSN 0034-6527. doi: 10.1093/restud/rdad016. URL <https://doi.org/10.1093/restud/rdad016>.
- George Alessandria, Joseph P. Kaboski, and Virgiliu Midrigan. Inventories, Lumpy Trade, and Large Devaluations. *American Economic Review*, 100(5):2304–2339, December 2010. ISSN 0002-8282. doi: 10.1257/aer.100.5.2304. URL <https://www.aeaweb.org/articles?id=10.1257/aer.100.5.2304>.
- Vanessa I. Alviarez, Michele Fioretti, Ken Kikkawa, and Monica Morlacco. Two-Sided Market Power in Firm-to-Firm Trade, May 2023. URL <https://www.nber.org/papers/w31253>.
- Mary Amiti and Sebastian Heise. U.S. Market Concentration and Import Competition. *The Review of Economic Studies*, 92(2):737–771, March 2025. ISSN 0034-6527. doi: 10.1093/restud/rdae045. URL <https://doi.org/10.1093/restud/rdae045>.
- Enghin Atalay. Materials Prices and Productivity. *Journal of the European Economic Association*, 12(3):575–611, 2014. ISSN 1542-4766. URL <https://www.jstor.org/stable/90023276>. Publisher: Oxford University Press.
- Johannes Boehm and Ezra Oberfield. Misallocation in the Market for Inputs: Enforcement and the Organization of Production\*. *The Quarterly Journal of Economics*, 135(4):2007–2058, November 2020. ISSN 0033-5533. doi: 10.1093/qje/qjaa020. URL <https://doi.org/10.1093/qje/qjaa020>.
- Ariel Burstein, Javier Cravino, and Marco Rojas. Input Price Dispersion Across Buyers and Misallocation, November 2024. URL <https://www.nber.org/papers/w33128>.
- Matias Covarrubias, Germán Gutiérrez, and Thomas Philippon. From Good to Bad Concentration? US Industries over the Past 30 Years. *NBER Macroeconomics Annual*, 34:1–46, January 2020. ISSN 0889-3365. doi: 10.1086/707169. URL <https://www.journals.uchicago.edu/doi/full/10.1086/707169>. Publisher: The University of Chicago Press.
- Angus Deaton. Quality, Quantity, and Spatial Variation of Price. *The American Economic Review*, 78(3):418–430, 1988. ISSN 0002-8282. URL <https://www.jstor.org/stable/1809142>. Publisher: American Economic Association.
- Swati Dhingra and John Morrow. Monopolistic Competition and Optimum Product Diversity under Firm Heterogeneity. *Journal of Political Economy*, 127(1):196–232, February 2019. ISSN 0022-3808. doi: 10.1086/700732. URL <https://www.journals.uchicago.edu/doi/full/10.1086/700732>. Publisher: The University of Chicago Press.

- Jonathan Eaton, Samuel Kortum, and Francis Kramarz. An Anatomy of International Trade: Evidence From French Firms. *Econometrica*, 79(5):1453–1498, 2011. ISSN 1468-0262. doi: 10.3982/ECTA8318. URL <https://onlinelibrary.wiley.com/doi/abs/10.3982/ECTA8318>. \_eprint: <https://onlinelibrary.wiley.com/doi/pdf/10.3982/ECTA8318>.
- Jonathan Eaton, David Jenkins, James R. Tybout, and Daniel Xu. Two-Sided Search in International Markets, January 2022a. URL <https://www.nber.org/papers/w29684>.
- Jonathan Eaton, Samuel S Kortum, and Francis Kramarz. Firm-to-Firm Trade: Imports, Exports, and the Labor Market. 2022b.
- Chris Edmond, Virgiliu Midrigan, and Daniel Yi Xu. Competition, Markups, and the Gains from International Trade. *American Economic Review*, 105(10):3183–3221, October 2015. ISSN 0002-8282. doi: 10.1257/aer.20120549. URL <https://www.aeaweb.org/articles?id=10.1257/aer.20120549>.
- Eurostat. International trade in goods by type of good. URL [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=International\\_trade\\_in\\_goods\\_by\\_type\\_of\\_good](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=International_trade_in_goods_by_type_of_good).
- Chang-Tai Hsieh and Peter J. Klenow. Misallocation and Manufacturing TFP in China and India\*. *The Quarterly Journal of Economics*, 124(4):1403–1448, November 2009. ISSN 0033-5533. doi: 10.1162/qjec.2009.124.4.1403. URL <https://doi.org/10.1162/qjec.2009.124.4.1403>.
- Maurice Kugler and Eric Verhoogen. Prices, Plant Size, and Product Quality. *The Review of Economic Studies*, 79(1):307–339, January 2012. ISSN 0034-6527. doi: 10.1093/restud/rdr021. URL <https://doi.org/10.1093/restud/rdr021>.
- Julien Martin, Isabelle Mejean, and Mathieu Parenti. Relationship stickiness and economic uncertainty. 2023. URL [http://www.isabellemejean.com/MMP\\_2023.pdf](http://www.isabellemejean.com/MMP_2023.pdf).
- J. J. McCall. Economics of Information and Job Search. *The Quarterly Journal of Economics*, 84(1):113–126, 1970. ISSN 0033-5533. doi: 10.2307/1879403. URL <https://www.jstor.org/stable/1879403>. Publisher: Oxford University Press.
- Monica Morlacco. Market Power in Input Markets: Theory and Evidence from French Manufacturing, 2020. URL [https://www.dropbox.com/s/4ic4ylvngngzn947/BP\\_draft\\_01102020.pdf?dl=0](https://www.dropbox.com/s/4ic4ylvngngzn947/BP_draft_01102020.pdf?dl=0).

- OECD. Trade in Intermediate Goods and Services, November 2009. URL [https://www.oecd.org/en/publications/trade-in-intermediate-goods-and-services\\_5kmlcxtldlk8r-en.html](https://www.oecd.org/en/publications/trade-in-intermediate-goods-and-services_5kmlcxtldlk8r-en.html).
- James E. Rauch. Networks versus markets in international trade. *Journal of International Economics*, 48(1):7–35, June 1999. ISSN 0022-1996. doi: 10.1016/S0022-1996(98)00009-9. URL <https://www.sciencedirect.com/science/article/pii/S0022199698000099>.
- Diego Restuccia and Richard Rogerson. Policy distortions and aggregate productivity with heterogeneous establishments. *Review of Economic Dynamics*, 11(4):707–720, October 2008. ISSN 1094-2025. doi: 10.1016/j.red.2008.05.002. URL <https://www.sciencedirect.com/science/article/pii/S1094202508000203>.
- Michael Rubens. Market Structure, Oligopsony Power, and Productivity. *American Economic Review*, 113(9):2382–2410, September 2023. ISSN 0002-8282. doi: 10.1257/aer.20210383. URL <https://www.aeaweb.org/articles?id=10.1257/aer.20210383>.
- SCB. STATISTIKENS FRAMSTAELLNING, Utrikeshandel med varor, 2018. February 2018.

# Data Appendix

## Summary Statistic

I calculated for an average year in my dataset, the summary statistics:

Table 4: Summary Statistics - Imports

Variable	Mean	Std. Dev.	P10	Median	P95
No. Varieties per Firm	20.8	78.8	1.0	4.0	84.9
No. Product per Firm	13.2	31.6	1.0	3.3	54.7
No. Country per Firm	4.6	6.4	1.0	2.0	17.0
No. Country per Product	7.7	8.7	1.0	5.0	25.0
No. Firms per Variety	3.1	7.3	1.0	1.0	10.0
No. Country per FirmXProduct	1.6	1.8	1.0	1.0	4.0
No. of Firms			8432		
No. of Product			7406		
No. of Varieties			56778		
No. of Countries			179		
Percentage of Domestic Firms			0.29		
Imported Intermediate share			0.00063		

And a comparison between Importing and all firms:

Table 5: Summary Statistics - Importing Firm vs All Firm

Variable	Importers	All Firms	Ratio
No. of Firms per Year	8432	52811	0.16
Total No. of Firms	36864	150046	0.25
Sales	1.63e+11	2.83e+10	5.75
Employment	58.83	11.15	5.28
Labor Productivity	19.95	19.72	1.01
Intermediate share of Production	0.44	0.36	1.23

## Within EU Data Selection and Non-EU subsample

Imports originating from other EU countries will not go through the customs because Sweden has been part of EU from 1995 on. Therefore, data on EU imports are collected from mandatory self-reports by firms. However, if the firm import below a certain value threshold, then they have no obligation to report. This cutoff is 1.5 million SEK worth of goods in 1998-2004, 2.2 mil SEK in 2005-2008, 4.5 million SEK in 2009-2014 and 9.0

million SEK onwards (See SCB (2018) for more). Due to these rules, when Britain exit the EU in 2020, it also cause some irregularities in the data of year 2021. However, if we limit the sample to only non-EU imports or exclude Britain for all years, the conclusion of the this paper hasn't change that much. In opposite, focusing on the Non-EU sample let us understand the bottom part of the distribution of importing firms better. Non-EU import consist around 50% of the full sample.

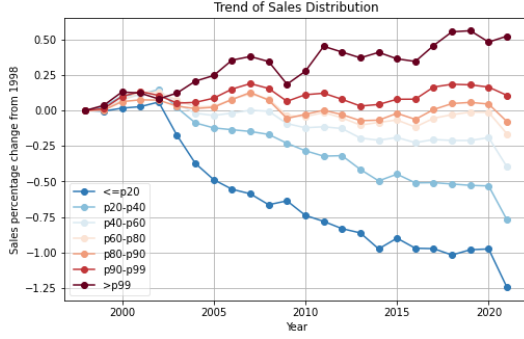


Figure 4: Sales Percentiles

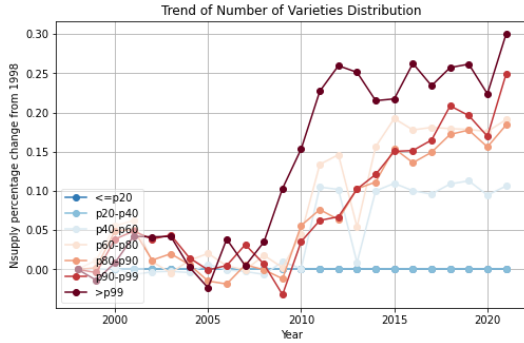


Figure 5: No. of Variety Percentiles

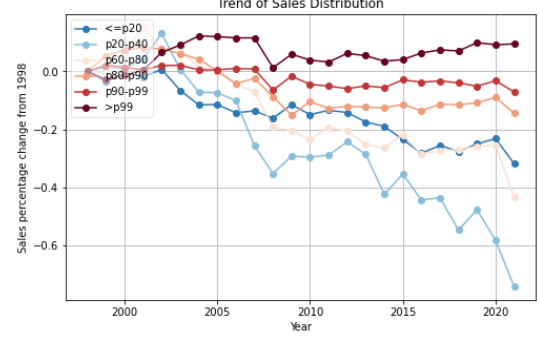


Figure 6: Sales Percentiles, with industry FE

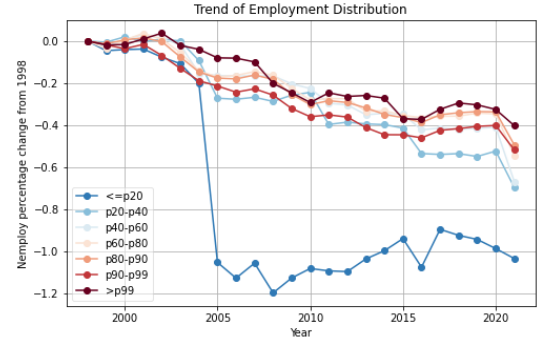


Figure 7: Employment Percentiles

Explain the bottom part.

## Robustness Tests on Sales Percentiles Evolution

There can be alternative theories why firm size distribution is dispersing. One clear alternative is the composition of firms that are importing change due to other reasons, for example structural changes or sector-specific technological shocks. To address this, I test the following 4 robustness test. I do the same exercise to follow the evolution of firm size distribution in the following sub-sample. In the first graph I plot the distribution of the balanced panel, where the subsample is firms that exist in all periods in the dataset. We can see that in this subsample, the top firms (99th percentile) is actually leading in growth rate, while other firms have no particular order and similar growth rate, which

points to the same style of dispersion in the number of variety graphs, where the top of the distribution is getting away from the rests.

However, when we look at the sample subsample, but we follow the same basket of firms every year, it tells another story.

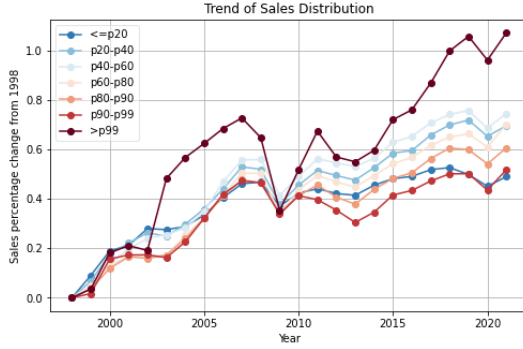


Figure 8: Balanced Panel

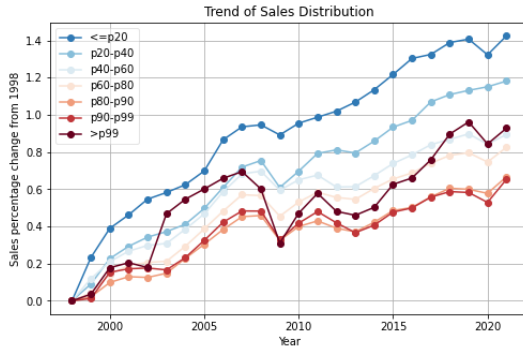


Figure 9: Balanced Panel, Fixed Basket

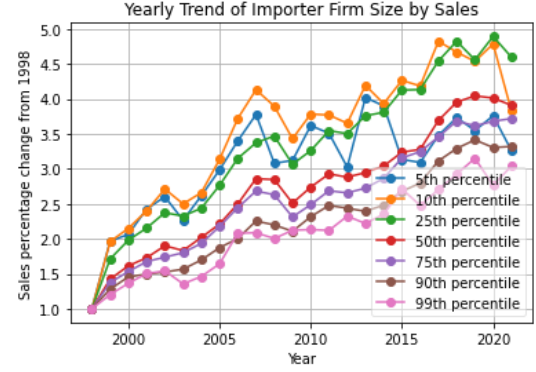


Figure 10: Incumbent that imports already at 1998

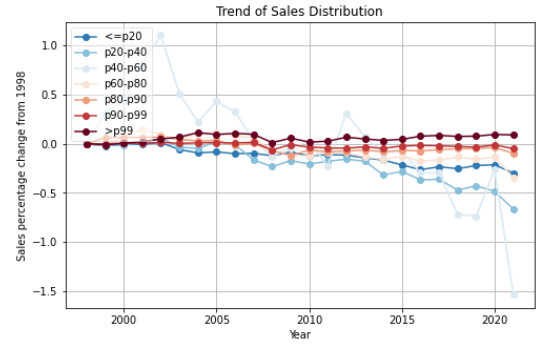
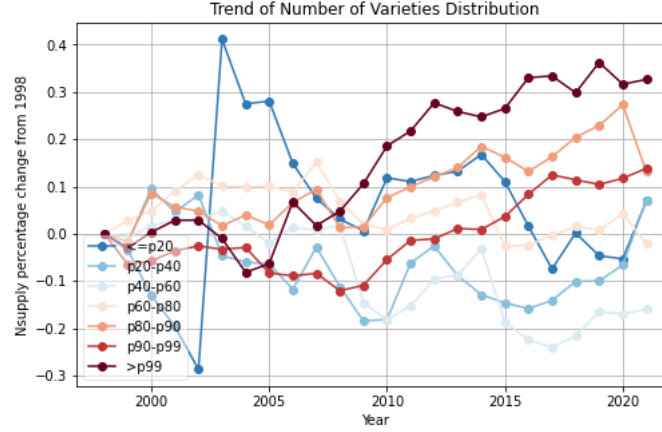


Figure 11: Industry Fixed Effects

## Robustness Tests on Number of Variety Percentiles Evolution

In the main parts of this paper, I have been looking at the Number of Variety Distribution. It is also interesting to look at how big firms and small firms behave differently in this aspect. I still define a "variety" as a unique country-product pair and measure "firm size" based on annual firm sales. In the graph presented, The graph below illustrates the number of varieties (product  $\times$  country) imported by each Swedish manufacturing firm. To facilitate comparison across firm-size percentiles, I normalize the annual number of varieties by their respective values from 1998. While the median and lower-percentile firms have experienced no change or even slight decrease in the number of imported varieties from 1998 to 2021, the largest firms have increased their imported varieties by approximately 10% to 30%. Given that the number of varieties imported directly

relates to search activities, this observation suggests differential effects of search costs across firm sizes.



## Quality-adjusted TFPQ (need to redraw graph with consistent TFPR)

In the main part of the paper, I used a direct measure output price from PPI and export price. There are 2 potential drawbacks of that approach. First, it select a small subsample where output price are observed. These are usually bigger firms and therefore the results can be biased. Second, in my model estimation, there is heterogeneous quality across firms, but quality is omitted by using direct output price measure.

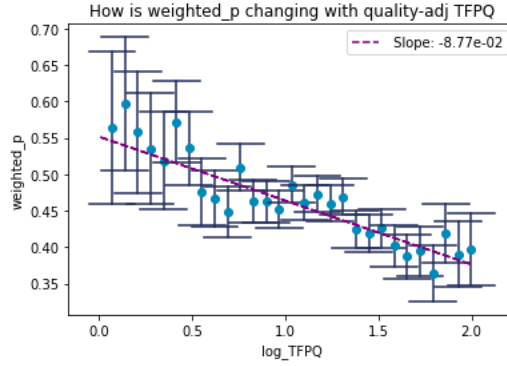
I define the revenue productivity the same way as above, but then I estimate the quality-adjusted TFPQ by:

$$TFPQ_f = \frac{p_f}{Q_f} TFPR_f$$

, where  $p$  is the price and  $Q$  is the quality of the firm's production. Unfortunately, quality  $Q$  is generally not observable. To obtain an estimate of  $Q$ , I have to rely on the theory. Assuming the monopolistic competition in final good demand, the household optimization gives:

$$\frac{p_i y_i}{p_j y_j} = \left( \frac{p_i / Q_i}{p_j / Q_j} \right)^{1-\epsilon}$$

where Sales  $py$  are observables in the data. I can then back out  $\frac{p}{Q}$  by applying the standard elasticity  $\epsilon = 5$ . Now that I get an estimate for quality-adjusted TFPQ, without substantially reducing sample size and includes quality. I do the same analysis as above:



As predicted, the coefficient is also negative with a smaller magnitude than the non-quality adjusted version. As explained in Kugler and Verhoogen (2012), firms with higher productivity usually use higher quality inputs, which dampens the quality-adjusted coefficient.

Also different aggregation level (industry digit) or including capital/not, doesn't change the result much.

## Realized Price and Quantity Relationship

Another distinct feature of the intermediate good market is the negative correlation between price and quantity. It can be a result by many causes, such as non-linear pricing, market power or simply downward sloping demand curve as it is yearly data. However, it is a complement evidence to my claim in last subsection. More productive firms will in expectation buy more, therefore find more efficient suppliers and pay lower unit price.



A major concern is measurement error of quantity can mechanically create correlation between price and quantity (Deaton (1988)), as I use value and quantity to back out unit price. In the dataset I use, around 25% of observations have both variable. I assume



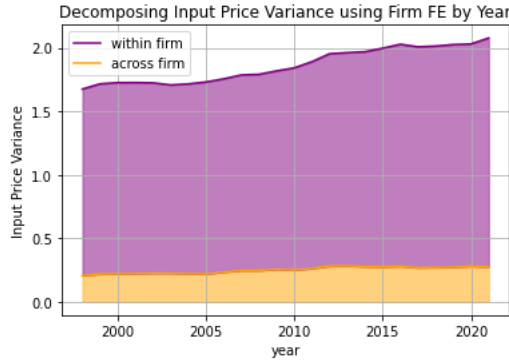
that it is unlikely that both quantity measures have measurement error at the same time. Under this assumption, I compute unit price with one measure and regress it on the other quantity as a robustness check against such potential error. In this exercise, the shape and coefficient slightly changes, but the most important negative correlation is robust against measurement error.

## Within-Across Firm Decomposition

Also, note that it is not true that productive firm get a lower price consistently across all products they purchase. To illustrate that, I run a regression on price against only the firm fixed effect:

$$p_{fpcy} = 1 + FE_f$$

And then I decompose the variance. That part of the variance that the Fixed Effects explain is the across-firm effect and the rest is the within-firm effect. The result is rather surprising.

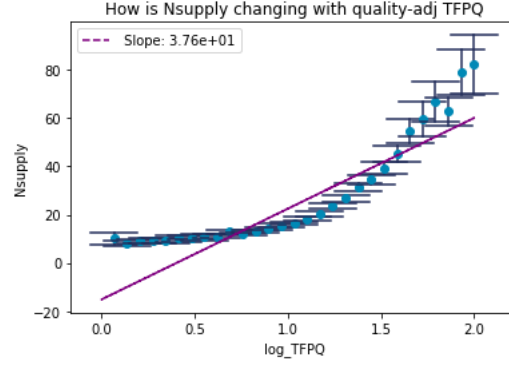


At odds with many model, that features firm level heterogeneity of markup or markdown, the across-firm effect is only around 15% of the total variance. It means that a same firm can purchase one input very cheaply, but another expensively.

## TFPQ and Variety

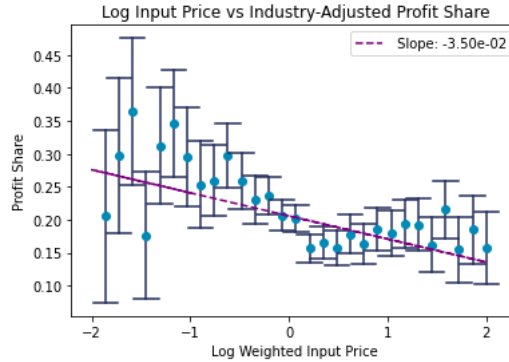
Another productivity-related empirical fact is that more productive firms purchase more variety. It is another piece of evidence that it is likely that productive firms also benefit

from the decreasing search cost because they search more. When the productive firms expect to produce more, they also have more incentive to search for the most efficient suppliers and also have multiple of them. Where else, the less productive suppliers even they finally gain access to the market,



## Input Price and Economic Outcome

Input price also directly affect the firm's profitability directly. I find a negative correlation between firm-level input price and profit share, even controlling for industry Fixed Effects. It means that the standard CES model with constant markup probably misses important features of the intermediate good market.



## Quality Differences

As researchers such as Kugler and Verhoogen (2012) show that it is a important channel of input price differences, I estimate the dispersion of input price that is generated from quality differences.

I use a reduce form approach that utilize the Rauch (1999) classification, where he separate goods into 3 classes: traded in organized exchange, traded with referenced

With resale	Std Dev
Organized Exchange	.9
Referenced Price	1.18
Differentiated Goods	1.44

price and differentiated goods. Organized exchange goods also included products that have a organize exchange but can also be traded decentralized. Some examples are banana, wool or other basic agriculture products. Those products, however, have very little quality differences and therefore are suitable reference goods to estimate quality differentiation.

To link the Rauch’s classifications that is based on or SITC Rev. 2 the main dataset which use CN code, I refer to the HS-SITC conversion tables provided by UNSD<sup>6</sup>. The CN code shares the first 6 digit with the HS code system and I assume all products that shares the first 6 digits should get the same Rauch classifications. I look at the price standard deviation of the 3 groups of products:

We can see that while differentiated goods have higher standard deviation, some part of the dispersion persist also in the “organized exchange” category. This exercise shows that quality difference cannot explain all the differences in input prices.

The important thing is there is no trend of quality differences year by year? As non-differentiated goods have minimal quality variation, I can define the quality gap as the price variance gap between differentiated and non-differentiated goods. Within my observed years, there are no big changes of quality gap. By weighted average, there are no change at all. Also, the composition of differentiated goods as a fraction of all imported goods is stable at 74% ~ 76%. One way or the other, it is not sufficient to explain the price variance increase.

## Decreasing Search Cost for Suppliers and Input Price Dispersion

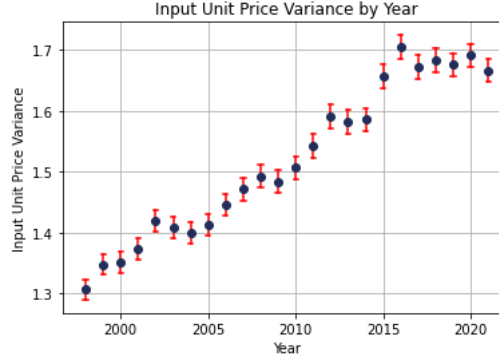
Related to the decreasing search cost and the influx of smaller firms into the import market is the input price dispersion. As the distribution of importer size become more disperse, variance of input price is also increasing. I define input price dispersion as:

$$\text{Var}(P) = \text{Var}(\log(\frac{P_{fvy}}{P_{vy}}))$$

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<sup>6</sup><https://unstats.un.org/unsd/classifications/Econ>

It is also robust when I limit the analysis to within-EU import or imports from most of Sweden's major trading partner.



One potential link between the two dispersing distribution is that input unit price is inversely correlated to firm size. When there are a lot of small firms goes into the import market, they buy very little and they are not familiar with the market, therefore they will pay a relatively high price. On the other hand, big firms become bigger, gain market power and face a even lower price. In this case, the price gap will grow. I will present more evidence below.

It is also important to note that quality differences is likely not the reason. I measure the price variance driven by quality difference by comparing price variance within differentiated products and non-differentiated ones, as defined by Rauch (1999). It is a very conservative measure that likely exaggerate the important because this gap likely include other channel such as bargaining and information frictions. But what is important is that the quality gap hasn't been increasing during the period, neither does the composition of differentiated products in all products. See more in Appendix.

## Background Volatility

To check the how much of the price differences are unrelated to buyer characteristic, I look at currency volatility as one representative background noise. I construct a currency-year volatility index (against Swedish Krona) using data from the Swedish Riksbank. I then linked the currency volatility to the volatility.

I then run a regression against the variance of price:

$$\text{Var}(\log(\frac{P_{pc}}{P_p})) \sim \text{volatility}_{cy}$$

I find very little relationship between the 2 variables. (Need check)

## **Robustness Check - Arm length**

To test if my results holds for non-arm-length trade (i.e. Trade that happens not within the same multi-national corporation group), I have carry out robustness test on the sub-sample of firm that neither 1.) do not belong to a foreign-based corporate group nor 2) belong to a corporate group that owns subsidiary abroad. In this case, any international trade of this firm have to be arm-length. The reason for using such conservative measure is that I still lack the indicator of the dataset (will be delivered). This subsample contains around 25% of the observations in the original dataset.

For arm length trade, 1) the negative relationship between TFPQ-Input Price is unchanged 2) the evolution of number of variety imported is slightly different, the 99th percentile firm still increase significantly, 90-99th percentile drop slightly while all other ones are flat. I believe the same conclusion can be drawn. 3) Nsupply increase much less in TFPQ when we throw out all this companies, but it is not surprising and a bit unclear if this result are affected by excluding non-arm-length trade or excluding the biggest/most productive multi-national firms. 4) Price Dispersion result also holds, the absolute value of variance in all years increase. Interestingly, there is a big drop in 2020 (COVID-19), this is not seen in the original graph.

## **Theory Appendix**

### **Structural Estimation - Quality**

Before I get to the counterfactual, note that even though quality-adjusted inputs  $XQ$  have been treated as one variables through out the model solving stage. However, they have different implications when I need to calculate welfare, misallocation etc. The reason is quality  $Q$  goes into the consumer's welfare with a power  $\alpha$ . Decomposing  $X$  and  $Q$  also help me to understand the real price dispersion.

However, input quality is in general unobservable in the data, but I have backed out output quality in the empirical section regarding productivity. Assuming the model is

correct and quality distribution is constant across suppliers of all efficiency  $z_u$ , there is a mapping between input and output quality. This has been documented in extensive literature such as XXX and XXX. From the data, I get calculate the moments  $(\mu_Q, \sigma_Q)$  of the downstream quality distribution. One caveat is that I mostly observe output quality of bigger firms. I make the log normal assumptions and calculate by XXX.

I then try to solve for the moments  $(\mu_q, \sigma_q)$  of the upstream quality distribution, which I assume to be log normal. I guess and moments, then simulate a panel of quality  $q_u$ . As I have already simulated the corresponding  $XQ$  and  $xq$  in the previous section, I can solve for the simulated downstream  $Q$  by the following equations:

$$\begin{aligned} q &= \frac{xq}{x} \\ XQ &= \left( \sum_{u \in U_i} x_u^\rho q_u^\rho \right)^{\frac{1}{\rho}} \\ X &= \left( \sum_{u \in U_i} x_u^\rho \right)^{\frac{1}{\rho}} \\ Q_i &= \frac{1}{X} \left( \sum_{u \in U_i} x_u^\rho q_u^\rho \right)^{\frac{1}{\rho}} \end{aligned}$$

I then estimate the simulated moments of  $Q$ , compare it to the empirical moments and update the upstream moments  $(\mu_q, \sigma_q)$  until the simulated and empirical moments are close enough.

## Closed Form Solution for Important Variables

Output Price and output:

$$\begin{aligned}
& \max_{p,y} py - w\left(\frac{y}{zX^\alpha}\right)^{\frac{1}{1-\alpha}} \\
& \text{s.t. } yQ^{\alpha(1-\epsilon)} = C\left(\frac{p}{P}\right)^{-\epsilon} \\
\Rightarrow & \max_p p^{1-\epsilon} \frac{C}{Q^{\alpha(1-\epsilon)}P^{-\epsilon}} - wp^{\frac{\epsilon}{\alpha-1}} \left(\frac{\frac{C}{P^{-\epsilon}}}{Q^{\alpha(1-\epsilon)}zX^\alpha}\right)^{\frac{1}{1-\alpha}} \\
& D_p : (1-\epsilon) \frac{C}{Q^{\alpha(1-\epsilon)}P^{-\epsilon}} p^{-\epsilon} = \frac{w\epsilon}{\alpha-1} p^{\frac{\epsilon-\alpha+1}{\alpha-1}} \left(\frac{\frac{C}{P^{-\epsilon}}}{Q^{\alpha(1-\epsilon)}zX^\alpha}\right)^{\frac{1}{1-\alpha}} \\
& p^{\frac{1+\alpha(\epsilon-1)}{1-\alpha}} = \frac{w\epsilon}{(\epsilon-1)(1-\alpha)} \left(\frac{C}{P^{-\epsilon}}\right)^{\frac{1}{1-\alpha}} \left(\frac{1}{Q^{\alpha^2(1-\epsilon)}zX^\alpha}\right)^{\frac{1}{1-\alpha}} \\
& p = \left(\frac{w\epsilon}{(\epsilon-1)(1-\alpha)}\right)^{\frac{1-\alpha}{1+\alpha(\epsilon-1)}} \left(\frac{C}{P^{-\epsilon}}\right)^{\frac{\alpha}{1+\alpha(\epsilon-1)}} \left(\frac{Q^{\alpha^2(\epsilon-1)}}{zX^\alpha}\right)^{\frac{1}{1+\alpha(\epsilon-1)}} \\
& y = \frac{C}{Q^{\alpha(1-\epsilon)}} \left(\frac{p}{P}\right)^{-\epsilon} \\
& = \frac{C}{Q^{\alpha(1-\epsilon)}P^{-\epsilon}} \left(\frac{w\epsilon}{(\epsilon-1)(1-\alpha)}\right)^{\frac{-\epsilon(1-\alpha)}{1+\alpha(\epsilon-1)}} \left(\frac{C}{P^{-\epsilon}}\right)^{\frac{-\epsilon\alpha}{1+\alpha(\epsilon-1)}} \left(\frac{1}{Q^{\alpha^2(1-\epsilon)}zX^\alpha}\right)^{\frac{-\epsilon}{1+\alpha(\epsilon-1)}} \\
& = \left(\frac{w\epsilon}{(\epsilon-1)(1-\alpha)}\right)^{\frac{-\epsilon(1-\alpha)}{1+\alpha(\epsilon-1)}} \left(\frac{C}{Q^{\alpha(1-\epsilon)}P^{-\epsilon}}\right)^{\frac{1-\alpha}{1+\alpha(\epsilon-1)}} (zX^\alpha)^{\frac{\epsilon}{1+\alpha(\epsilon-1)}}
\end{aligned}$$

Profit Function:

$$\begin{aligned}
\pi(z, QX) &= py - w\left(\frac{y}{zX^\alpha}\right)^{\frac{1}{1-\alpha}} \\
&= \frac{C}{Q^{\alpha(1-\epsilon)}P^{-\epsilon}} p^{1-\epsilon} - w\left(\frac{w\epsilon}{(\epsilon-1)(1-\alpha)}\right)^{\frac{-\epsilon}{1+\alpha(\epsilon-1)}} \left(\frac{C}{Q^{\alpha(1-\epsilon)}P^{-\epsilon}}\right)^{\frac{1}{1+\alpha(\epsilon-1)}} (zX^\alpha)^{\frac{\epsilon-1-\alpha(\epsilon-1)}{1+\alpha(\epsilon-1)} \frac{1}{1-\alpha}} \\
&= \left\{ \left(\frac{w\epsilon}{(\epsilon-1)(1-\alpha)}\right)^{\frac{(1-\alpha)(1-\epsilon)}{1+\alpha(\epsilon-1)}} - w\left(\frac{w\epsilon}{(\epsilon-1)(1-\alpha)}\right)^{\frac{-\epsilon}{1+\alpha(\epsilon-1)}} \right\} \left(\frac{C}{Q^{\alpha(1-\epsilon)}P^{-\epsilon}}\right)^{\frac{1}{1+\alpha(\epsilon-1)}} (zX^\alpha)^{\frac{\epsilon-1}{1+\alpha(\epsilon-1)}} \\
&= \left[\frac{1+\alpha(\epsilon-1)}{\epsilon}\right] \left(\frac{w\epsilon}{(\epsilon-1)(1-\alpha)}\right)^{\frac{(1-\alpha)(1-\epsilon)}{1+\alpha(\epsilon-1)}} \left(\frac{C}{Q^{\alpha(1-\epsilon)}P^{-\epsilon}}\right)^{\frac{1}{1+\alpha(\epsilon-1)}} (zX^\alpha)^{\frac{\epsilon-1}{1+\alpha(\epsilon-1)}} \\
&= \left[\frac{1+\alpha(\epsilon-1)}{\epsilon}\right] \left(\frac{w\epsilon}{(\epsilon-1)(1-\alpha)}\right)^{\frac{(1-\alpha)(1-\epsilon)}{1+\alpha(\epsilon-1)}} \left(\frac{C}{P^{-\epsilon}}\right)^{\frac{1}{1+\alpha(\epsilon-1)}} (zX^\alpha Q^\alpha)^{\frac{\epsilon-1}{1+\alpha(\epsilon-1)}}
\end{aligned}$$

The labor cost is:

$$\begin{aligned}
w\left(\frac{y}{zX^\alpha}\right)^{\frac{1}{1-\alpha}} &= \left(\frac{C}{Q^{\alpha(1-\epsilon)}P^{-\epsilon}}\right)^{\frac{1}{1+\alpha(\epsilon-1)}} w\left(\frac{w\epsilon}{(\epsilon-1)(1-\alpha)}\right)^{\frac{-\epsilon}{1+\alpha(\epsilon-1)}} (zX^\alpha)^{\frac{\epsilon-1}{1+\alpha(\epsilon-1)}} \\
&= \frac{(\epsilon-1)(1-\alpha)}{\epsilon} py \text{ or } \left[\frac{(\epsilon-1)(1-\alpha)}{1+\alpha(\epsilon-1)}\right] \pi
\end{aligned}$$

## Concavity of Bargaining Problem

Given all possible  $x$ , I can use FOC to find  $T$  because the following function is strictly concave (as long as it is defined). To simplify notation, I define  $V(x) := V(z, X_N) - V(z, X)$  and  $K(x) := \frac{w}{z_u}x$

$$\begin{aligned}
B(\delta T_1 + (1 - \delta)T_2) &= (V(x) - \delta T_1 - (1 - \delta)T_2)^\theta (\delta T_1 + (1 - \delta)T_2 - K(x))^{1-\theta} \\
\exp &\sim \theta \log[(\delta + (1 - \delta)V(x) - \delta T_1 - (1 - \delta)T_2)] \\
&\quad + (1 - \theta) \log[\delta T_1 + (1 - \delta)T_2 - (\delta + 1 - \delta)K(x)] \\
\exp &> \theta \{\log[\delta(V(x) - T_1)] + \log[(1 - \delta)(V(x) - T_2)]\} \\
&\quad + (1 - \theta) \{\log[\delta(T_1 - K(x))] + \log[(1 - \delta)(T_2 - K(x))]\} \\
\exp &= [\log(\delta^\theta (V(x) - T_1)^\theta \delta^{(1-\theta)} (T_1 - K(x))^{(1-\theta)})] \\
&\quad + [\log((1 - \delta)^\theta (V(x) - T_2)^\theta (1 - \delta)^{(1-\theta)} (T_2 - K(x))^{(1-\theta)})] \\
&= e^{\log(\delta B(T_1))} e^{\log((1-\delta)B(T_2))} \\
&= \delta B(T_1) + (1 - \delta)B(T_2)
\end{aligned}$$

Because log is a strictly concave function.. As long as  $V(x) \geq K(x)$ , the solution exist and is unique. I can get a function  $Bargain(x)$ , which is the best value given  $x$  and then I just find the arg max. Proof: Call  $T(x^o) = \arg \max_T B(x^o, T)$ , which is proved to be unique. Now assume  $(x^*, T^*)$  is the maximizer of function  $B$  and  $B(x^*, T^*) \geq B(x', T')$  for all  $(x', T')$  pairs. Let's say  $T^* \neq T(x^*)$ , then  $B(x^*, T^*) \geq B(x^*, T(x^*)) \implies T(x^*)$  is not the unique  $\arg \max_T B(x^*, T)$ , which cannot be true. Thus contradiction.

I can then obtain  $Bargain(x)$  (i.e. Bargaining Problem that is 1-dim, instead of 2d) by plugging the FOC into the bargaining problem:

$$\begin{aligned}
Bargain(x) &= (-T + V(z, X_N) - V(z, X))^\theta (T - w \frac{x}{z_u})^{1-\theta} \\
&= (-(1 - \theta)V(x) - \theta K(x) + V(x))^\theta ((1 - \theta)V(x) + \theta K(x) - K(x))^{1-\theta} \\
&= (\theta V(x) - \theta K(x))^\theta ((1 - \theta)V(x) - (1 - \theta)K(x))^{1-\theta} \\
&= \theta^\theta (1 - \theta)^{1-\theta} (V(x) - K(x)) \\
&= \theta^\theta (1 - \theta)^{1-\theta} (V(z, X^N Q^N, n + 1) - V(z, X Q, n + 1) - w \frac{x}{z_u})
\end{aligned}$$



# Static Moments Graphs

Here is the relevant data moments. In the main text of the paper, some of these moments are shown as regressions tables.

