The Spatial Dimension of Import Competition[†]

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Abstract

Exposure to international competition on a country level has been shown to improve the efficiency of domestic producers. We contribute to this literature by studying whether the distance between producers and importers within a country matters for import competition effects at the product level. Using highly detailed geographical information about the location of Swedish manufacturing firms over 2005–2014, we find robust evidence of an increased efficiency in the domestic production when imports rise, but that the effect declines with the distance between the producer and the importer. In addition to the importance of the geographical pattern within a country, we find that the average effect of import competition conceals large variations across firms and products. Highly productive firms respond to import competition by further improving efficiency, which, in turn, translates into both a lower price and a higher markup. Firms are also more likely to drop fringe products while keeping core ones. Products undercut by low import prices within their close proximity respond by lowering prices only, although highly efficient products resist this by a more pronounced improvement in the marginal cost, which, in turn, translates into both a lower price and a higher markup.

JEL classification: F14

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1 Introduction

A general conclusion drawn from the literature on the effects of import competition on firms' performance is that import competition has a potential to press markups and to boost productivity, and according to the latest development in this literature, firms' response patterns vary with differences in the underlying firm and product characteristics (see the overview in De Loecker and Goldberg 2014).[1]

De Loecker and Goldberg (2014), Melitz and Redding (2014), and De Loecker and Biesebroeck (2018) all discuss this development, and they emphasize the importance of understanding the impact of trade on firms by drilling behind generic productivity measures to understand how and why firms respond differently, especially since a small, but growing literature emphasizes two possible offsetting responses to import competition. One, the pro-competitive effect, pushes markups down as competition increases, while the other, the innovation effect, gives firms a chance to escape this pressure by improving their product or production process (see also Aghion et al. 2005; Dhingra 2013; Antoniades 2015). However, the net effect of these responses depends on firm's characteristics, and better performing firms may even increase markups as competition increases due to the innovation effect.

By measuring import competition at a national level, most studies implicitly assume that competition increases simultaneously and symmetrically within an economy as soon as an imported product crosses the border. The possibility of heterogeneity with respect to the spatial dimension of the competitive pressure is, therefore, ignored. Although the spatial dimension within an economy has a minor role in the literature on import competition, it plays a crucial role in identifying (1) the relevant market size in studies focusing on domestic competition (see e.g. Syverson 2004, 2007), (2) the labor market outcomes induced by imports (see e.g. Autor et al. 2013a),[2] and (3) the role of proximity in buyer-seller networks (see e.g. Hillberry and Hummels 2008; Bernard et al. 2019).

Hence, the measurement of import competition at a national level seems to be at odds with the importance of spatial frictions between and within countries.[3] At the same time, the competitive pressure on domestic firms that is induced by imports is likely to

[1]Some recent literature overviews focusing on trade and firms can be found in De Loecker and Goldberg (2014), Goldberg and Pavcnik (2016), and Bernard et al. (2012). Examples of studies investigating the effect of import competition on firm level performance include Hall (1988), Levinsohn (1993), De Loecker and Warzynski (2012), De Loecker et al. (2014), Brandt et al. (2017), and Fan et al. (2018).

[2]See also Autor et al. (2013b), Autor et al. (2015), Caliendo et al. (2015), and Hakobyan and McLaren (2016). In these studies, distance is used to localize import effects by relying on trade frictions and spatial heterogeneity to study the impact on wages and employment within local labor markets (see e.g. Goldberg and Pavcnik 2016).

[3]Anderson and Wincoop 2004 found that "[b]oth international trade costs and local distribution costs are very large and together dominate the marginal cost of production."

be influenced by distance to the importer. A possibility pointed out by De Loecker and Biesebroeck (2018, p. 26): "Perhaps competition is highly localized, and increasing the distance from other firms gradually reduces competitive pressure". That is, short business distances between buyers and sellers imply that when a buyer located in the southern part of Sweden imports products that are also produced domestically, upstream firms located in the neighborhood of the buyer are likely to be more influenced by the increased competition than are sellers located further away. Hence, a nationwide measurement of import competition may be highly imprecise.

Our main contribution is to incorporate distance within a country in the analysis of import competition in order to investigate whether the effect of imports on domestic producers' performance depends on the geographical pattern of importers. In addition, since we focus on firm responses on the product level, we also complement the growing literature focusing on firm-product level responses (see e.g. De Loecker et al. 2016; Dhyne et al. 2017) by investigating potential mechanisms behind a heterogeneous response pattern across firms and products.

To fulfill these contributions, we build on the growing number of studies showing the importance of proximity in buyer-seller networks (see e.g. Hillberry and Hummels 2008; Bernard et al. 2019) by focusing on Swedish producers (i.e., sellers) of intermediate goods used and imported by manufacturing firms (i.e., buyers). We focus on intermediate goods used in manufacturing industries since this allows us, with detailed information about firm location[4], to spatially map producers' import competition patterns through the imports of manufacturing firms, given that manufacturing firms account for almost 85% of the total imports of all intermediate goods produced for the manufacturing sector.[5] In addition, we follow the recent developments in estimating markups, which not only make it possible to decompose the effects of import competition into product-specific effects on markup, marginal costs and price (De Loecker et al. 2016), but also to investigate the possibility of heterogeneous effects across firms.

We find strong evidence of an increased efficiency in domestic production when imports surge, which is revealed by a 1–2% drop in the product-level marginal costs of domestic producers when the exposure to product-level import competition increases by 10%.[6]

Furthermore, we show that the distance between the producers and the importing manufacturing firms matters for the import exposure. This finding implies that using

[4]The location information is based on over 9,000 small areas for market statistics (SAMS). We make use of the 8-digit level of the combined nomenclature (CN) classification to define products.

[5]As for consumer goods, manufacturing firms account for approximately one-sixth of total imports

[6]A finding that import competition increases product-level efficiency is in line with the study by Dhyne et al. (2017), which used Belgian data and product-level technical efficiency. It is also consistent more broadly with firm- and industry-level evidence that product-market competition increases productivity as reviewed by Holmes and Schmitz (2010).

nationwide import exposure fails to consider the spatial pattern of firm location within a nation. In the case of Sweden, changes in the geographical pattern of importers are, on average, more important than changes in import volumes, since the average distance to the first importing firm during the 2005–2014 period fell by about 8 km, while the average import volume of these firms was unchanged.

In addition to the importance of distance, we also find strong evidence of a highly heterogeneous response pattern across firms and products. Productive firms respond to import competition by improving their efficiency (i.e. lowering the marginal cost of production), and these improvements are also transmitted to buyers through a lower price, although some of the improvements are soaked up by a higher markup.

We also find that firms with products undercut by cheaper imports respond by an even greater improvement in efficiency, which is completely transmitted to buyers as a lower price. Highly efficiently manufactured products (i.e. products with a relatively low marginal costs) resist this price competition by not only transmitting a lower marginal cost to buyers as a lower price but also as a higher markup. Approximately 26% of the fall in the marginal cost is transmitted as a lower price while the rest is picked up by a higher markup.

The remainder of this paper is structured as follows. Section 2 discusses our point of departure when it comes to investigating the effects of import competition on firm-product performance. Section 3 presents our data and the empirical approach, while Section 4 focuses on the main results. In Section 5 we decompose our main results into product-specific effects on markup, marginal costs, and price. We examine heterogeneity in the effects of import competition in Section 6. Finally, Section 7 concludes the paper.

2 Prices, import competition, and geography

2.1 Prices and import competition

To investigate the effects of import competition on the price of intermediate goods and the channels behind the response pattern, we build on the following relationship (see De Loecker and Warzynski 2012; De Loecker and Goldberg 2014; De Loecker et al. 2016):

$$p_{ijt} = \mu_{fjt} mc_{ijt},$$

which suggests that firm i's price of product j at time t is set as a markup (μ_{ijt}) over marginal cost (mc_{ijt}). The markup is, in turn, a function of the demand and the market structure, while the marginal cost is influenced by the inputs used, the scale of production, and the efficiency or productivity of the firm. Import competition may, therefore, work its way to the price through both of these channels.

The classical view, and the perspective we focus on in this paper, is a trade shock on the output market, which may lead to a pro-competitive effect as import competition works its way to the price through a fall in the markup. The exact impact of import competition depends, of course, on the demand and the market structure.[7] The complexity of the effects of import competition on prices increases, however, when we also allow for other, more proactive, within-firm responses to escape competition from foreign firms. Firms may, for example, reduce possible X-inefficiencies when opportunity costs change as import competition increases. Leibenstein (1966) suggests that x-inefficiency within a firm is related to imperfections in the knowledge of the production process, labor contracts or the input market. These imperfections create a slack in the organization, which is only addressed by cost reducing changes and innovations when the incentives for this are triggered by an increased competition (see Leibenstein 1966).[8]

The trapped-factor model of Bloom et al. (2013, 2016) reflects such a process by introducing adjustment costs for trapped factors within a firm, which makes them vulnerable to price changes. Increased competition pushes down the prices of the firm's output and, hence, the opportunity cost for those factors trapped within the firm, which improves the firm's return for innovation.[9] Bloom et al. (2016, p. 87) give some support to this possibility since they found that the increased import competition from China "increased technical change within firms" through an increase in the number of patents, total factor productivity and R&D expenditures.[10]

Another perspective on the link between competition and innovation is found in Antoniades (2015), who argues that firms may escape competition through innovation in a model that incorporates both a pro-competitive effect and an innovation effect.[11] The innovation effect consists of an upgrade (through innovation and R&D investments) to avoid competition, and this upward move on the quality ladder prompts firms to increase prices as well as markups. Alongside the innovation effect, firms also face a pro-competitive effect, which has the reverse impact on firms' performance. A firm's

[7] See an extensive discussion of this literature in De Loecker and Goldberg (2014). An alternative perspective on imports and firm performance is to investigate how a trade shock on the *input* market influences firms (see e.g. the impact of lower input tariffs in De Loecker et al. 2016).

[8] An additional within-firm response to an increased import competition is the possibility of multi-product firms becoming leaner and meaner by re-directing resources to their core products (see e.g. Bernard et al. 2010b; Liu 2010).

[9] Entrapments within a firm may stem from inertia related to capital dis-investment or from workers' firm- or product-specific knowledge not being valued outside the firm.

[10] Additional support for increased innovation activity due to trade is found in Bustos (2011), who showed that Argentinean firms upgraded their technology as their export opportunities increased.

[11] Aghion et al. (2005) also discuss how firms could "escape competition" by upgrading due to a change in the returns to innovation as competition increases. Increased innovation activity in response to import competition is also discussed in the multi-product models by Dhingra (2013) and Eckel et al. (2015).

response is, therefore, driven by two opposing effects, and the net effect depends on the underlying characteristics of the firm. More productive firms respond more aggressively by stepping up innovation, quality and markup, while less productive firms are more defensive and lower their markup, or even exit the market. Bellone et al. (2016) expanded the models of Melitz and Ottaviano (2008) and Combes et al. (2012) and Antoniades (2015) by incorporating both the spatial and quality dimensions of differentiation across firms and products. They found that, although competition has a downward pressure on firms' markup, firms counteract this negative impact of competition by increasing quality and, hence, the markup.[12]

2.2 Geography and import competition

In addition to a heterogeneous response across firms, the complexity of the competition effect is amplified by the definition of the geographical demarcation of a relevant market. From a theoretical point, the market size changes endogenously with changes in trade barriers, since it influences the number of buyers and sellers that have access to a particular market (see the discussion of market definition in De Loecker and Biesebroeck 2016).[13] However, empirical studies are often constrained by administrative borders and product classifications, and country borders are often used in the trade literature as a demarcation. Hence import competition is assumed to have a big-bang effect as soon as a product has crossed the border, which implies that all firms are assumed to be equally influenced independent of their location within the importing country (see e.g. Criscuolo et al. 2004; Ben Yahmed and Dougherty 2012; Dhyne et al. 2017). There is, however, a growing literature emphasizing economic frictions within countries.

Both the size of the market and the scope of products is, for example, often much more narrow in the industrial organization literature. One such example is Syverson (2004, 2007), who focused on the ready-mixed concrete industry and used a collection of the U.S. counties based on commuting patterns and newspaper circulations to ensure that the combined counties were linked from an economic perspective. The results in Syverson (2004) support a "competition-driven selection process" in markets with important trade

[12] Several other recent studies find evidence of heterogeneous competition effects. Aw et al. (2011) found, focusing on Taiwan, that firms already in the competitive global export market undertake more R&D investments compared to domestic firms. Bernard et al. (2010a) found that more productive firms are more prone to adding new products while dropping products (or at least net dropping) is associated with small and unproductive firms. Timoshenko (2015) argued that such a product turnover increases as trade costs falls. Bastos et al. (2018) underlined that market experience improves firms' performance when they face global competition on the export market.

[13] This interaction between the market size and trade liberalization is, for example, captured in Melitz and Ottaviano (2008).

or transport costs, which implies that firms in denser markets are more productive.[14]

The local economy has also an increasingly central role in the literature on international trade when it comes to identifying trade-induced changes in the economy. Autor et al. (2013a) use the boundaries of labor markets within the United States to measure the effects of imports on different labor market outcomes such as employment and wages, Ding et al. (2016) study the impact of import penetration on firm performance within Chinese provinces, Bagoulla et al. (2010) focus on regional production adjustments within the French agro-industry, and Bellone et al. (2016) consider the impact of local competition within France on firm markup and productivity.[15] The underlying assumption in these studies is that trade shocks hit regions within a country differently due to the asymmetric distribution of economic activities, and that the shock is contained within a region due to geographical and/or industrial frictions.

In addition, several recent studies support a local bias in firms' economic activity. Bernard et al. (2019) used data on the production network in Japan with supplier-customer links between over 950,000 firms and confirmed the importance of geographic proximity for the matching of suppliers and customers. The median distance to a supplier was no more than 30 kilometers. Wrona (2018) also studied Japan and found significant "border effects in the absence of a border" between Western and Eastern Japan. Trade volume was 23–51% lower between regions compared to within regions. Hillberry and Hummels (2008) used a survey of shipments of U.S. manufacturing plants to study whether the spatial frictions matter. They found that shipments within the same 5-digit zip code were around three times higher relative to those outside the zip code, and the fall in the value of shipments was highly nonlinear and very direct. Their findings suggest that the borders of 5-digit zip codes (with an average radius of around 6 km) represent substantial barriers to trade and the local bias is explained by the co-location of input-producers and output-producers using these inputs in their production process.

The local bias of intermediate producers is supported, in the case of Sweden, by two surveys. Gullstrand (2017) focused on 10,000 manufacturing firms and showed that more than 60% of all small- and medium-sized firms producing intermediate goods sell more than 50% of their output to the local market (defined as the municipality of location plus the adjoining ones). This pattern of a local bias is presented in Figure 1, which shows the percentage of firms for four different regional biases (0–25%, 25–50%, 50–75% and

[14] The role of spatial competition has also been a focus in the literature on retail prices, such as Pinkse et al. (2002), which derived a sellers best reply function for which price is a buyers' demand function. This demand, in turn, was partitioned into different dimensions such as national, regional, and local characteristics, all of which influence the demand for the sellers' products.

[15] Bellone et al. (2016) captured the local competitive pressure on firms by using spatial weights to aggregate the number of rival companies in the same employment area, while import competition was measured at an industry level.

75–100%) split between non-exporting and exporting intermediate goods producers. The local concentration is evident among non-exporters since around 90% of the firms sell 50% or more to the local market. However, the local bias is also important among exporters. Around 50% of the exporting firms sell 50% or more to the local market.

Additional support was found in a survey of Swedish shipments by the Transport Analysis in Sweden.[16] Figure 2 summarizes the results from this survey and shows a significant local bias in shipments. Almost 25% of all shipments of firms in industries focusing on intermediate goods are within a municipality, which, on average, has a radius of 15 km, while 50% of all shipments within Sweden travel no further than 155 km. A gravity like equation of the volume shipped on distance also reveals a significant local bias with a distance parameter of around -0.08. This implies that only around 35% of the volume shipped within Sweden travels beyond the median distance of 155 km.

Hence, frictions within a nation are important and if imports surge in one part of the country, the competitive pressure may be more pronounced among firms in close proximity compared to those further away. We will investigate this possibility in this paper.[17]

3 Data and empirical approach

3.1 Products, trade, and location

To identify the role of distance within Sweden for import competition, we focus on the producers of intermediate goods[18] since they not only tend to sell domestically but also, as shown in the preceding section, locally. Imported intermediate goods are also largely imported directly by manufacturing firms. Approximately 85% of total imports in our sample are accounted for by manufacturing firms, while the pattern is reversed for consumer goods, as around 81% are imported by wholesalers. Hence, we have a better picture of the spatial pattern of potential buyers of intermediate goods.

Our primary data sources are three different datasets provided by Statistics Sweden. The first one includes detailed information on domestic producers and their output. We construct annual 8-digit firm-product observations using the Production of Commodities and Industrial Services (IVP) dataset for the period 2005–2014 for all manufacturing

[16] A detailed description of this survey only exists in Swedish. See Transport analysis (2016). Since this survey lacks information about firms' production, we define firms as intermediate goods producers if they belong to a 5-digit industry that mostly produce intermediate goods according to the BEC classification.

[17] De Loecker et al. (2014) provide some supporting evidence for such a possibility. They investigated the possibility of a spatially heterogeneous response of Belgian firms to foreign competition and found that firms located further away from the German border were less influenced by the changes in German wages.

[18] We define intermediate goods as products with BEC Rev.4 codes 210 or 211.

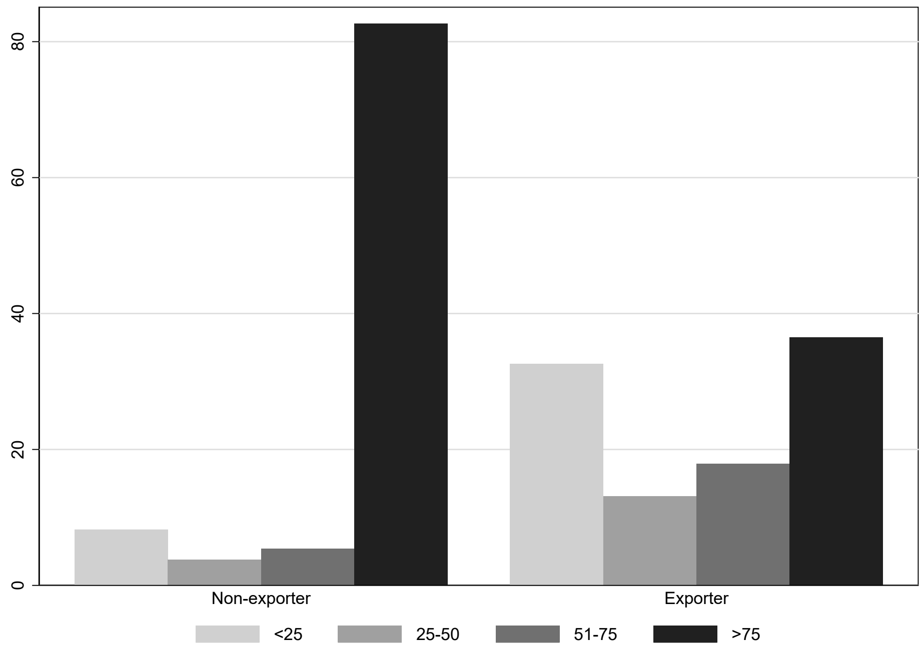

Figure 1: Firms allocation of sales to the local economy, SMEs

Note: Figures are based on a survey described in Gullstrand (2017) and sample weights are used. The local economy is defined as the municipality in which the firm is located plus the surrounding ones.

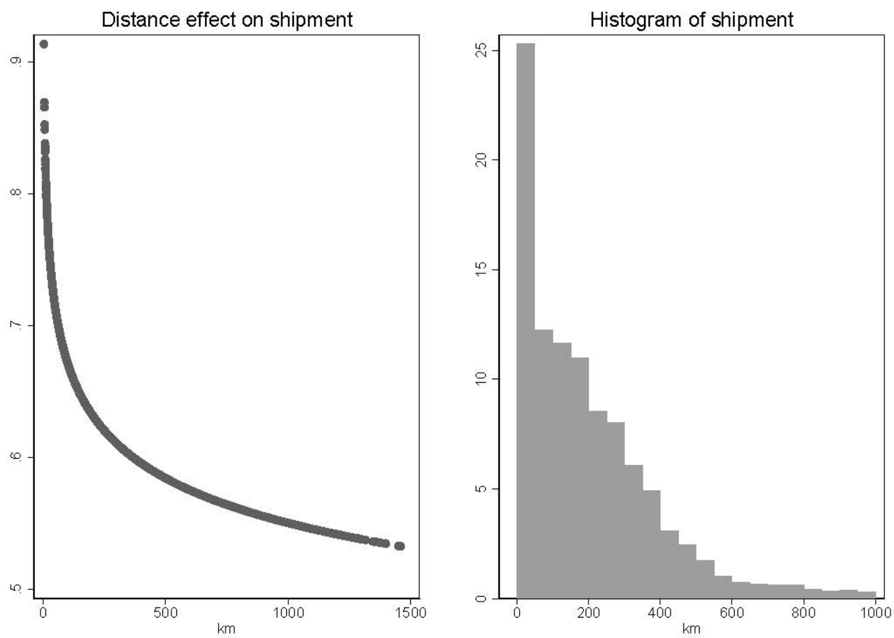

Figure 2: Shipments within Sweden

Note: Figures are based on a survey from the Transport analysis in Sweden, sample weights are used in the regression and in the histogram. The figures are based on shipments within Sweden, and the 2% smallest and largest shipments in kg are excluded. The distance effect is based on the following gravity regression of quantity shipped on distance: $\ln q_{ij} = \beta \ln distance_{ij} + \lambda_m + \delta_j + \epsilon_{ij}$ where i=shipment, j=product, m=shipment municipality, $\beta = -0.086$ (with a robust standard error of 0.00067 and $R^2 = 0.60$).

firms. The IVP survey is designed to cover all Swedish manufacturing firms with at least 20 employees. It provides detailed product-level information such as production quantities and values. To explore the spatial aspect of the data on producers, we restrict the empirical analysis to single-plant firms because geographical location is recorded at a plant level, while production is at a firm level.

Our second dataset, from the International Trade in Goods (ITG), includes detailed country-level trade flows of all Swedish firms, which includes values and quantities of imports and exports at an 8-digit product level.[19] The final dataset is the Swedish Structural Business Statistics (FEK), which includes detailed firm- and plant-level information and covers the universe of Swedish private firms. By merging these datasets, we can spatially locate all our firms (both producers and importers).[20] More specifically, using the information on the location of producers and importers, we can spatially locate production and imports. To allocate imports of multi-plants to specific plants, we distribute import flows according to the plant size (using the number of employees).

Figure 3 shows the weighted average (using import weights of importing firms) of the distance between all our producers and the ten closest importers of the goods they produced in 2014, as well as the closest and 10^{th}-closest neighbor, respectively.[21] The weighted average distance of all ten importing firms is just under 100 km, while the median distance to the closest and the 10^{th}-closest is around 20 km and 100 km, respectively. Given that the average radius of the Swedish municipalities is around 30 km, producers of intermediate goods are surrounded by the manufacturing firms importing their product (i.e. the same product that the domestic producers produce) in the close proximity of their municipality.

3.2 Markups and marginal costs

To date, literature on trade and productivity has, to a large extent, focused on a productivity measure based on deflated revenues, which not only reflects physical efficiency but also markups and demand shocks. Hence, potential imperfections in both product and factor markets may give rise to the so-called output and input price biases, making it difficult to interpret changes in the estimated productivity (De Loecker and Goldberg 2014) and investigate important mechanisms behind firms' responses to import competition.

To tackle these challenges, we rely on the framework developed by De Loecker et al.

[19]Note that detailed intra-EU trade flows are only reported if a firm's total trade flow exceeds SEK 4.5M.

[20]Our location points are based on the centroids of SAMS areas, which divide Sweden into approximately 9,200 small geographical units.

[21]If a producing firm has more than one importing firm within the same distance from its location, we choose the largest firm of the importing firms.

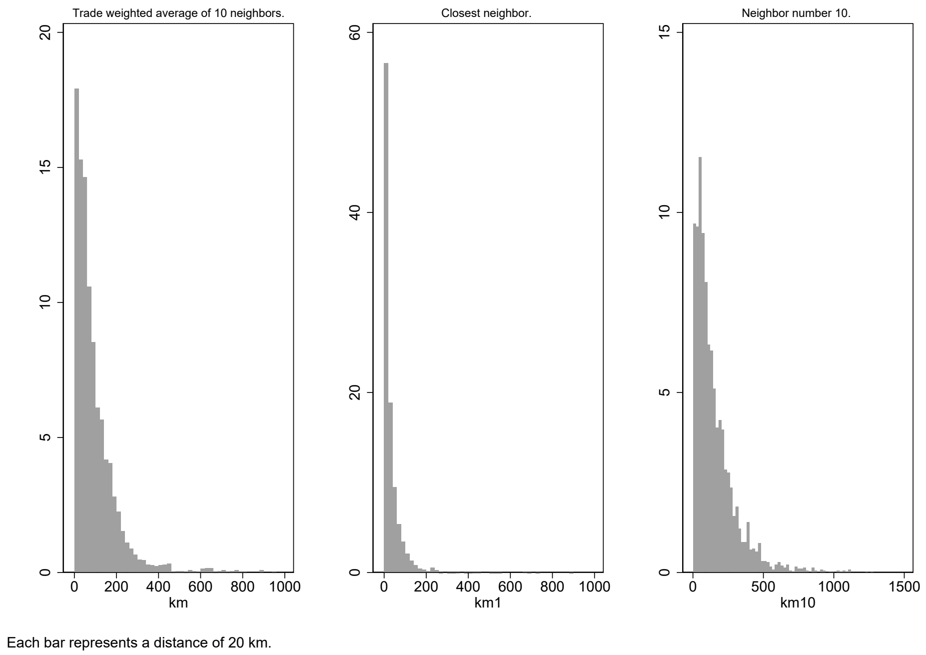

Figure 3: Shipments within Sweden

Note: Each bar represents 20 km (truncated at 1000 km), and the distance in the first histogram is measured as an import weighted average of the 10 closest importing firms.

(2016), which allows decomposing firms' responses into marginal costs, markups and prices. We will start by investigating the impact of imports on firms' marginal costs as marginal costs represent "true" productivity (as discussed in Foster et al. 2008; De Loecker et al. 2016). We will proceed by studying the impact on firms' markups and prices to understand whether changes in firms' marginal costs are passed on prices or whether they are soaked up by markups. Increased competition may also change markups directly without any alterations to firms' marginal costs due to a change in the demand and/or the market structure facing the firm. The framework used to identify these different parts is briefly summarized below, while a more detailed overview is given in Appendix B.[22]

We start by defining markups as the price-cost margin. The marginal costs can, therefore, be derived using the unit price data once markups have been estimated. In this study, just as in De Loecker et al. (2016), we estimate the markup as the ratio between the output elasticity with respect to a variable input (materials) and the input's share in total revenue. Although we have to assume that firms minimize costs, this framework is highly flexible because we do not have to impose any other assumptions on the market conduct or the demand system.

One potential identification issue is the lack of detailed input prices, which implies that we could not observe the variation of input prices, and hence the input-quality variation

[22]For further details see De Loecker et al. (2016).

across firms. Firms with more expensive inputs will have higher expenditure, which does not necessarily indicate higher output in physical terms. Hence, using monetary values as a proxy for physical units of input is likely to introduce bias to the estimated coefficients. To deal with the input price bias, De Loecker et al. (2016) introduced a control function assuming that input price variation across producers arises through input quality differentiation and price variation in local input markets. Thus, input quality is recovered with the help of the output prices. Under the assumption of complementarity in the qualities of outputs and inputs, and, conditionally, on the differences across local input markets, input prices are a function of output quality. Output quality, in turn, is approximated by a polynomial in relevant firm- and product-level characteristics, such as output prices, firms' market share, product dummies, and firms' export status. Although De Loecker et al. (2016) do not have data on regional trade flows, the framework implies that relevant information on trade flows should also be included in the control function. Our dataset allows for this level of detail, and we, therefore, add product-specific imports to the firm's local labor market to account for possible effects of imports on input prices.

As the methodology relies on output measured in physical units, there is no output price bias. However, the data on physical units does impose other challenges to the estimation. More specifically, although our data of outputs is on a product level, the allocation of inputs across products in multi-product firms is unobserved, since these are only observed at firm level. Like De Loecker et al. (2016), we first obtain the allocation of inputs by estimating the output elasticities using a translog product-level production function on single-product firms only. Thereafter, we assume that the physical relationship between inputs and outputs for a given product is the same for single- and multi-product firms, which implies that we back out the input allocation for multi-product firms using the single-product firms. The markup is thereafter obtained as the ratio between the output elasticity with respect to materials and the share of materials in total revenue. The marginal cost is, in turn, calculated as the ratio between the price of a product and the corresponding markup.

Our estimated markups and marginal costs reveal, as expected, a negative correlation (see Figure 4). In addition, we find that firms' share of the total production value as well as their output in quantities increases and decreases with the markup and the marginal cost, respectively (see Figures 5 and 6). These findings are not only very similar to the ones presented in De Loecker et al. (2016), but are also consistent with the expectations laid out in the theoretical literature on heterogeneous firms.[23]

[23]See e.g. Melitz and Ottaviano (2008), Bernard et al. (2011), Bellone et al. (2016), and Mayer et al. (2014).

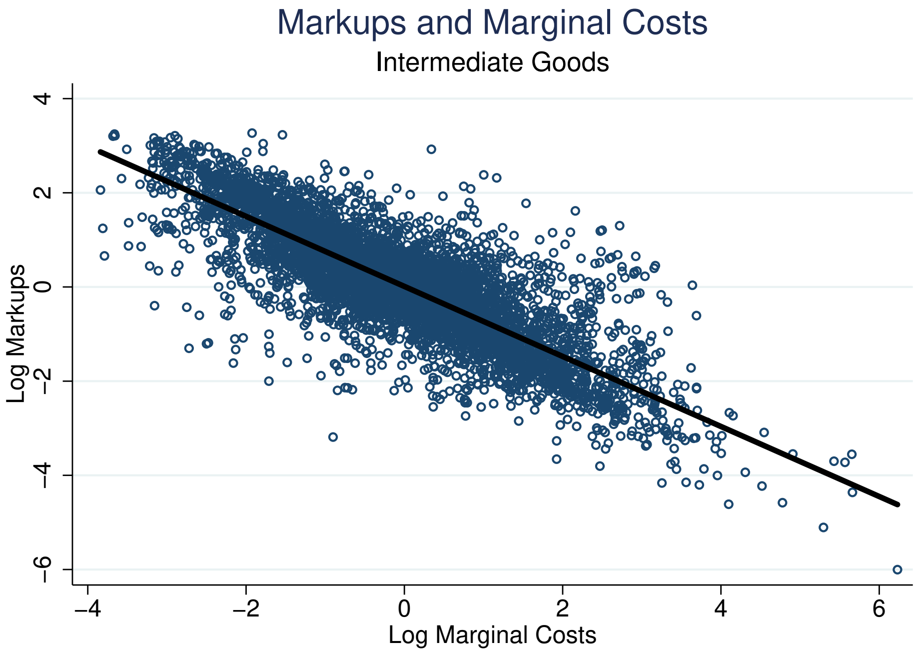

Figure 4: Product-level markups and marginal costs in logs

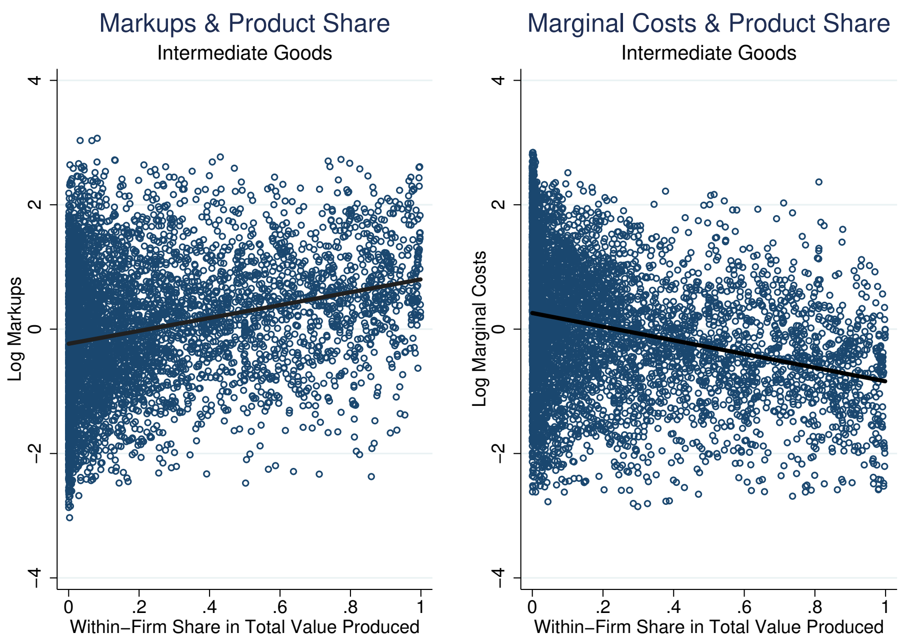

Figure 5: Product-level markups, marginal costs (in logs) and within-firm product shares

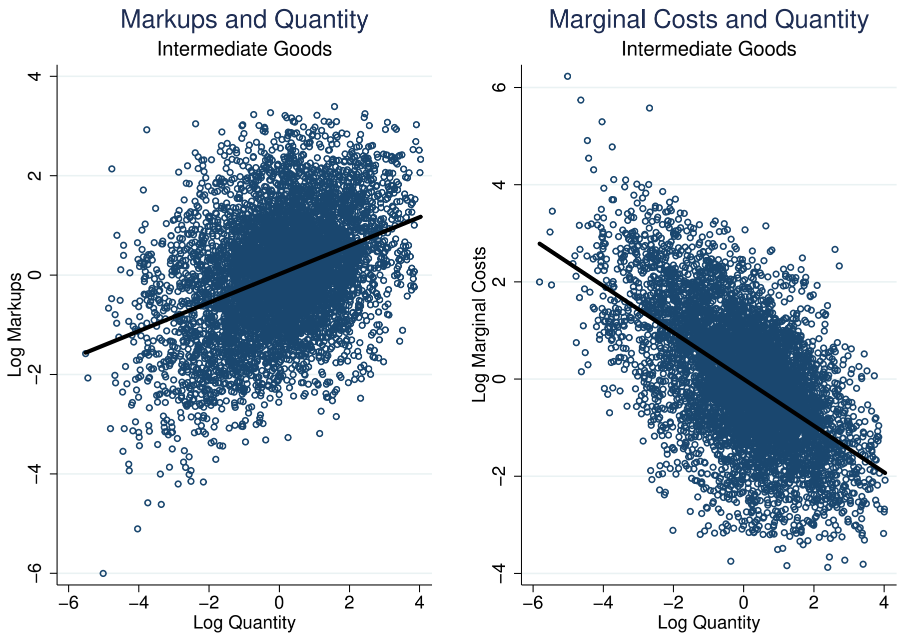

Figure 6: Product-level markups, marginal costs and quantity produced in logs

3.3 Import competition and the empirical specifications

The measurement of import competition in the empirical literature varies widely. It is common to capture import exposure (or penetration) by relating imports of a good to the domestic production or consumption of the same good (see e.g. De Loecker et al. 2014; Olper et al. 2014; Liu and Rosell 2013; Ben Yahmed and Dougherty 2012; Dhyne et al. 2017), while other studies focus on the proportion of imports from a particular country or the exposure per worker in a region (see e.g. Autor et al. 2013a; Liu 2010; Bloom et al. 2016).

In line with the latter studies, we define product-level import exposure by focusing on imports of the product, but we use different geographical demarcations, which are all defined in Table 1. In our first set of measures, geographical demarcations are spatial areas defined using administrative and statistical borders (Table 1, Panel I). We start with the national level as our benchmark since national level is the geographical demarcation dominant in previous studies of import competition. Thus, import exposure at the national level (IC_{jt}^{swe}) is measured as total imports of a product by manufacturing firms in Sweden. Next, to investigate the importance of closeness, we define import exposure at a finer grid around the location of each producing firm. Our second measure is based on imports within the producer's municipality, IC_{jt}^{mun}, and our third uses imports within the producer's SAMS area, IC_{jt}^{sam}.

Our second set of measures of import exposure is based on the x closest manufacturing

Table 1: Import competition measures

Panel I. Spatial areas	
National level: r = Sweden	$IC_{rjt} = IC_{jt}^{swe} = \sum_{f \in \Omega_{r,f \neq i}} m_{fjt}$
Municipality level: r = Municipality	$IC_{rjt} = IC_{jt}^{mun} = \sum_{f \in \Omega_{r,f \neq i}} m_{fjt}$
SAMS level: r = SAMS area	$IC_{rjt} = IC_{jt}^{sam} = \sum_{f \in \Omega_{r,f \neq i}} m_{fjt}$
Panel II. Closest importing firms	
Imports: $r = x$ closest importing firms	$IC_{rjt} = IC_{jt}^{xm} = \sum_{f \in \Omega_{x,f \neq i}} m_{fjt}$
Distance: $r = x$ closest importing firms	$IC_{rjt} = IC_{jt}^{xd} = \sum_{f \in \Omega_{x,f \neq i}} msh_{fjt} d_{if}$
Distance deflated imports:	$IC_{rjt} = IC_{jt}^{xmd} = \frac{IC_{jt}^{xm}}{IC_{jt}^{xd}}$
Panel III. Closest importing firms, expanded	
Imports: $r = n^{th}$ nearest importing firm	$IC_{rjt} = IC_{jt}^{fnm} = m_{fjt}, f \in \Omega_{n,f \neq i}$
Distance: $r = n^{th}$ nearest importing firm	$IC_{rjt} = IC_{jt}^{fnd} = d_{if}, f \in \Omega_{n,f \neq i}$
Distance deflated imports:	$IC_{rjt} = IC_{jt}^{fnmd} = \frac{IC_{jt}^{fnm}}{IC_{jt}^{fnd}}$

Note: m_{fjt} stands for the imports of product j by firm f, which is a part of the set of firms located in region r (Ω_r) or the set of the x closest importing firms (Ω_x). d_{if} is the distance between the producing firm i and the importer f and msh_{fjt} is firm f's share of the total import of firms belonging to the set Ω_x.

firms importing product j manufactured by firm i (Table 1, Panel II). That is, we use data on imports of product j by x manufacturing firms closest to producer i. The first variable in this set of measures is the sum of imports from x importing neighbors (IC_{jt}^{xm}). Since the distance to importing neighbors differs across producers (see Figure 3), we also construct a distance-based measure of import exposure as the weighted distance between the location of the producing firm and the neighbors (IC_{jt}^{xd}).[24] Finally, we make use of both volume and distance dimensions in one variable and construct a measure of import exposure by deflating the total imports of neighbors with the weighted distance to these firms (IC_{jt}^{xmd}).

For our final set of measures (Table 1, Panel III), we want to use the information about the order of the n closest neighbors, i.e. we want to distinguish between the first neighbor, the second one and so on up until the n^{th} neighbor, where n indicates the order of closeness of each neighbor (from 1 to n, where 1 is the closest neighbor). We reshape our sample so that each observation y_{ijt} is expanded to match n neighbors. As in the second set of measures, we use either the total imports of (IC_{jt}^{fnm}), distance to the neighbors (IC_{jt}^{fnd}) or the distance-deflated imports (IC_{jt}^{nmd}). The descriptive statistics for these variables are reported in Table A1 in the Appendix.

To capture the import exposure (or import penetration), we need to relate the different spatial measurements in Table 1 to our subject of interest. As mentioned above, earlier

[24]We use the import shares of the neighboring firms as weights.

studies often related imports to the consumption or production of the same good, but we can be more flexible with the help of a set of control variables in our specification. As is common in this literature, we will examine the effects of import competition on firms' performance with the help of a reduced form. The benchmark specification is as follows:

$$y_{ijt} = \beta_0 IC_{rjt} + \beta_1 q_{ijt-1} + \theta_{ij(n)} + \theta_{st} + \epsilon_{ijt}, \tag{1}$$

where y_{ijt} is the performance (marginal cost, markup or price, in logs) of product j produced by producer i in year t and IC_{jrt} captures import competition (in logs) in the spatial dimension r (see Table 1) for product j.

To capture the import exposure facing each producer, we control for the size of each producer by including the volume produced by the firm (q_{ijt-1}) and we used the lagged production volume since the performance measures are determined simultaneously with the volume produced. In addition to the lagged production volume, we also condition the import exposure on a large set of firm-product(-neighbor) ($\theta_{ij(n)}$) as well as industry-year (θ_{st}) fixed effects.

The firm-product fixed effects implies not only that we focus on the within change of the import exposure but also that we control for the historical production pattern in Sweden.[25] In specifications where we use our third set of import exposure measures (Table 1, Panel III), firm-product-neighbor specific effects are used instead. That is, we use θ_{ijn} in equation 1, and n indicates the order of closeness of each neighbor.

The industry-year fixed effects are defined by 3-digit BEC codes, and they capture broad changes in demand, production or imports by wholesalers for different types of intermediate goods. Wholesalers may be problematic since we have no knowledge about how they spatially allocate their sales of imported intermediate goods to manufacturing firms. We therefore also included wholesales imports of each product and year at SAMS, municipality, and/or national level as additional controls, but these variables were always insignificant. As a robustness check, we also included firm-product-specific trends (i.e., a random trend model) in our model to capture even finer trends in consumption, production and import patterns, but our results are robust to these changes in our specification.

3.4 Instrumenting for import competition

To identify the effects of import competition on firms' performance, we need to address some potential endogeneity issues stemming from underlying demand changes that may influence both the importer and the producer simultaneously, as well as the possibility that

[25] Note that the production pattern is quite stable during the 2005−2014 period, but we check the robustness of our results by controlling for the number of domestic producers as well as the distances to these producers.

manufacturing firms are willing to import if they are located close to low-productivity producers (i.e. firms with a high marginal cost) or that producers and importers intentionally locate in proximity to each other.[26]

To mitigate these concerns, we use two instruments correlated with an increased presence of foreign products on the Swedish market, but not with the performance of domestic producers of these products. In the spirit of Hummels et al. (2014), we make use of world export supply shocks using both a firm-product-time and a product-time dimension. We use product-level data on bilateral trade flows from the COMTRADE database to construct the instruments.[27]

First, for each product j we calculate the world export supply of this product net of the supply to Sweden. We multiply the world export supply of j by the pre-sample share of product j in total imports by the importing firm f to make the instrument firm-product-time specific. We use pre-sample shares to make sure that the input use of the importing firm is not driven by current technology shocks. The resulting firm-product-time specific instrument is constructed as follows: $I_{fjt} = \sum_c s_{fjc} I_{jct}$, where I_{jct} is the world supply of product j by country c at time t and s_{fjc} the pre-sample share of product j imported from c by the domestic importing firm f. Effectively, our instrument has a spatial dimension since it is linked to each importing manufacturing firm through its mix of import sources for each imported product.[28]

The idea behind the instrument is that variation in world-export supply should be positively correlated with the imports of Swedish firms due to supply-side factors (increasing comparative advantage of exporters in production, price changes, deregulation, etc.). Hence, the identifying assumption is that variation in world export supply arises due to supply-side factors.

Although the export supply to the world, net of Swedish exports, may be argued to be unrelated to the performance of domestic producers, one could be concerned that the strength of the instrument stems from the shares used as weights to calculate the firm-product-time dimension of this instrument (this is discussed in two recent working papers by Goldsmith-Pinkham et al. 2018; Jaeger et al. 2018). Hence, we use a second instrument that does not use the information about from where importing firms source their imports and is, instead, product-time specific.[29] In addition, we not only exclude

[26]The latter concern (endogenous location choice) seems to be less of an issue in our sample, since the spatial pattern of producers and importers is quite stable during the period of the observation. If the location choice was endogenous before the start of our sample, our identification strategy should still isolate the relevant variation.

[27]Products are defined at the 6-digit level of the Harmonized System (HS).

[28]Hence, our strategy resembles that in Autor et al. (2013a), which links the instrument − growth of Chinese imports in other countries excluding the United States − to each region by summing up industry imports using regional shares of national industry employment as weights.

[29]In the product-level setting, this type of instrument is also used in Dhyne et al. (2017).

the Swedish supply to the world market but also the supply of neighboring countries to further mitigate the possibility of picking up local or regional demand shocks instead of supply shocks ($I_{jt}^{non} = \sum_c I_{jct}$, excluding Denmark, Norway, Finland and Germany).

The quality of our instruments depends on the following two conditions. First, there should be a strong first stage, meaning that the instruments are required to be correlated with the measure of import competition. Second, for the exclusion restriction not to be violated, the instruments should only affect the performance of domestic producers through import competition. A potential threat to the validity of the instruments is that the world's export supply of j and firm i's performance (measured by the marginal cost, markup and price of j) may be influenced by a worldwide shock (e.g. changes in demand, transport costs or technology) facing all manufacturers of product j. To address this issue we include sector-year fixed effects (i.e. θ_{st}) in all our specifications.[30] In addition, in our most demanding robustness check, we contrast our results with a random trend model that removes firm-product-specific effects.

4 Import competition, distance and marginal costs

We begin by studying the effects of import competition on the marginal cost, which reveals the impact on firms' efficiency in production. The first set of results is based on the import exposure within the different spatial areas as defined in Table 1, Panel I. The results are reported in Table 2, which compares the most commonly used spatial area, i.e. the national level (see column 1), with finer ones, such as municipalities and SAMS areas (see columns 2 and 3, respectively).

Several interesting findings are revealed in Table 2. First, we find a very robust indication of increasing returns to scale since the average impact of a 1% increase of output is that the marginal cost falls by around 0.3% (which is in line with Figures 5 and 6 as well as the findings of De Loecker et al. 2016). This finding is very stable across all our specifications and hence, to save space, we will not show this result again. Second, Table 2 presents the results from an ordinary least squares model with fixed effects (columns 1–3) as well as from two different instrumental variable regressions (columns 4-9). The results without instrumental variables are always insignificant, which is in line with an underestimated negative effect if manufacturing firms shy away from inefficient firms with

[30]Following Hummels et al. (2014) and Autor et al. (2013a), we also tried dropping the products susceptible to high demand in the period of observation and obtained very similar results. We defined high-demand products (on HS4-level) based on the share in total exports in a given year. The examples of products with high demand include wires, gold and chipped wood. We also explored the possibility of a feedback effect, i.e. when shocks originating in Sweden have impact on the comparative advantage of foreign producers. Given that the median exporter-product pair in Sweden accounts for only 0.76% of total sales, Swedish firms are unlikely to have substantial effects on the world supply.

Table 2: Spatial areas and marginal costs

	Marginal Cost								
	OLS			Instrumented with I_{fjt}			Instrumented with I_{jt}^{non}		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
q_{ijt-1}	-0.316***	-0.316***	-0.316***	-0.316***	-0.317***	-0.318***	-0.313***	-0.317***	-0.319***
	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
IC_{jt}^{swe}	-0.000			-0.000			-0.000		
	(0.000)			(0.000)			(0.000)		
IC_{jt}^{mun}		-0.006			-0.109			-0.155**	
		(0.009)			(0.069)			(0.070)	
IC_{jt}^{sam}			-0.005			-0.130*			-0.193**
			(0.012)			(0.073)			(0.075)
Observations	11918	11918	11918	11918	11918	11918	11918	11918	11918
Adjusted R^2	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
F-stat. (1st st.)				14.51	42.82	68.85	46.05	52.62	42.65
Firm-product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The dependent variable is product-level marginal costs. Import competition variables are defined according to Table 1, Panel I. All standard errors are clustered on firm level. ***p<0.01, **p<0.5, *p<0.1

high marginal costs by increasing their imports of intermediate goods.

If we then shift our attention to the import competition effect based on the IV approach, both the magnitude and the statistical significance of the effect increase as the spatial area defining the market becomes more localized. The most local measurement is the one using SAMS areas, and the result from this specification indicates that the marginal cost of producing an intermediate good falls by 1–2% if imports of these goods by potential buyers in close proximity increase by 10% (columns 6 and 9). In other words, import competition in close proximity forces producers of intermediate goods to become more efficient. Since both our instruments are strong and the magnitude is similar, we use the firm-product-time specific instrument (I_{fjt}) as our benchmark and the alternative product-time-specific instrument (I_{jt}^{non}) as a robustness check.

The relationship between imports and firms' marginal costs becomes less precise when we expand the geographical area to the municipality level and it disappears completely when we move up to the national level. This pattern is in line with a survey of Swedish firms' shipments in Figure 2. Imports by potential buyers who are further away should have less impact on a firm's performance because the probability of importing decreases with the distance from the producing firm.

The use of spatial areas, independent of the size, is quite arbitrary since the distance relevant to the producer may differ depending on the ease of transport and the cluster pattern of economic activities, which is reflected by the variation of the distance to the closest importers in Figure 3. There are at least two potential problems with using spatial areas. One is that a spatial area may arbitrarily exclude distant competition outside the specified area. The other is the role of distance within regions. Both these issues may lead to a potential bias in the measurement of the exposure to imports when we move from SAMS areas with an average radius of around 2 km to a municipality with 18 km, to a local labor market with 31 km, and, finally, to a county level with an average radius of approximately 70 km.

To circumvent the issues of using administrative borders, we make use of our detailed information about the location of all plants to measure the distance between a producer of a given product to the manufacturing importers of the same product. Although we experiment with a different number of neighbors, our benchmark result relates to the five closest neighbors and we use both the total imports of and the import-weighted distance to these neighbors (see the definitions in Table 1, Panel II).

Note that the five closest neighbors are, in the majority of our cases, a broader definition compared to our finest administrative definitions. If we compare the total import value of the five closest importing manufacturing firms with the total import within an administrative border, the sum of the five closest importers is larger than the import value at the SAMS level in 77% of all cases and 67% of all cases when we use municipalities.[31]

The results from our IV approach are presented in Table 3.[32] If we first turn to the total imports of the five nearest neighbors (column 1), we find a very similar response to when we used the finer administrative borders. A 10% increase in imports among the five closest importers pushes down marginal costs at product level with around 1.3%. If we use the ten closest neighbors instead, the results, presented in the Appendix (Table C2, column 1), show that the magnitude of the effect becomes smaller. The results, however, are less precise if we move in the other direction by using only the first importing neighbor, which is indicated by the less significant estimated effects of import exposure from the nearest importer in Table C3 in the Appendix. Overall, distance within rather fine spatial areas seems to matter.

To illustrate the importance of omitting distance within Sweden, we regress the error term from column 1 of Table C2 on distance (in a quadratic form) and calculate the marginal effects across ten distance quantiles.[33] If the distance between producers and importers is irrelevant, the error term should not correlate with distance. However, the results in Figure 7 show that a specification without distance underestimates the marginal

[31] If we use labor markets instead of municipalities, the proportion of cases when the sum of imports of the five closest neighbors amount to 40%.

[32] Note that the OLS approach is not presented in this table, but just as in the case of using geographical areas, it underestimates, the effects of import competition, since the results are always statistically insignificant. The instrument in this table is based on the one using pre-sample shares of importing firms. These results are robust to using our alternative instrument on product level and are available upon request.

[33] We do also control for firm, product and year fixed effects.

Table 3: Marginal costs and import competition from five nearest neighbors

	Marginal Cost			
	(1)	(2)	(3)	(4)
IC_{jt}^{5m}	-0.133**	-0.122**		
	(0.054)	(0.051)		
IC_{jt}^{5d}		0.078***		
		(0.029)		
IC_{jt}^{5md}			-0.116**	-0.140***
			(0.047)	(0.049)
Observations	13554	13554	13554	13155
Adjusted R^2	0.93	0.93	0.93	0.39
F-stat. (1st st.)	62.61	59.16	49.93	26.24
Firm-product FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes

Note: The dependent variable is product-level marginal costs. Import competition variables are defined according to Table 1, Panel II, where $x = 5$. All specifications include lagged production volume. All standard errors are clustered on firm level. ***p<0.01, **p<0.5, *p<0.1

cost of production, and the underestimation increases with distance. Already at the fourth quantile, which consists of products facing an average distance to importers of 46 km, the marginal effect is significantly higher compared to those exposed to imports at a closer range.

If we consider the pattern of imports and distance to the nearest importing neighbors of firms producing intermediate goods, the importance of distance becomes evident. The imports among the ten nearest neighbors actually decreased during the period 2005–2014, but the variation is so large that the average difference between 2005 and 2014 is not statistically significant. The average distance also decreased, which, in turn, suggests an increase in competition. The closest and the 10 closest neighbors were, on average, 8.6 km and 18 km closer in 2014 than in 2005, respectively, and both these changes were significant when we compare 2014 with 2005.

Hence, we include the weighted average of distance to the nearest importing neighbors in our specification. The results in column 2 of Table 3 show that distance matters and a 10% increase in distance to importers leads to an 0.8% higher marginal cost. In other words, efficiency gains induced by import competition drop with distance to the importing firms. One concern is that the distance to neighboring importers may be determined simultaneously with the performance of production firms, just like the level of imports.

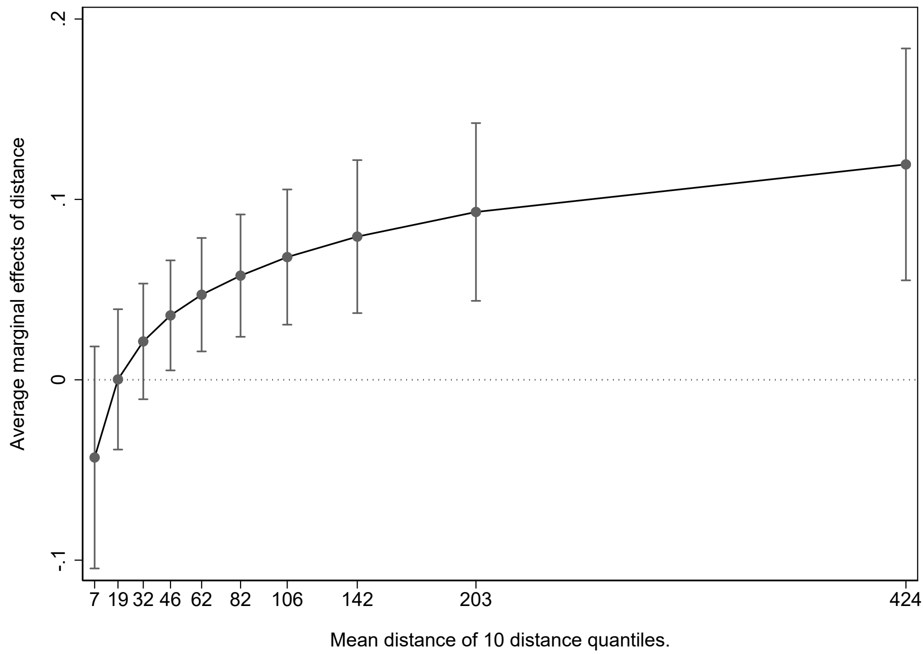

Figure 7: Distance and the error term

If this is the case, the result in column 2 underestimates the impact of distance. We investigate this possibility with two specifications, which use the IV approach.

Our preferred specification makes use of the counteracting effects of distance by deflating imports of the closest importing neighbors with the distance to these firms. The results reported in column 3 of Table 3 support our earlier findings. A 10% increase in import exposure (by an increase in imports, a decrease in distance, or some combination) implies that the marginal cost falls by a bit more than 1%. Our second specification (column 4) investigates the robustness of this result with a random trend model that controls for firm-product-specific trends. The result is robust to this demanding specification.

To investigate the robustness of these results further, we have also controlled the additional competition variables[34] and checked our results on a sample of firms with low levels of imports.[35] Our results are robust across these specifications. The results are also robust using the 10 closest neighbors instead (see Table C2 in the Appendix), although an increase in the size of the relevant market gives us, as before, a lower magnitude of the effect.[36] A final check is to investigate whether past firm performance influences our

[34]We controlled for product-time-specific variables such as the total number of domestic producers, a firm-product-time specific average distance to the five closest domestic producers and the number of importers (Table C4, columns 1–3)

[35]We restricted the sample to firms with the shares of imports of the goods they produce being, at most, 10% (Table C4, columns 4). Limiting samples to firms that do not import the goods they produce considerably reduces the number of observations. The point estimate is still negative.

[36]All results are robust to using the alternative instrument and are available upon request.

Table 4: Marginal costs, prices, markups and import competition

	Marginal Cost (1)	Price (2)	Markup (3)
IC_{jt}^{5md}	-0.116** (0.047)	0.001 (0.020)	0.117*** (0.045)
Observations	13554	13554	13554
Adjusted R^2	0.93	0.97	0.85
F-stat. (1st st.)	49.93	49.93	49.93
Firm-product FE	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes

Note: The dependent variable is in the column name. Import competition variable is defined according to Table 1, Panel II; $x = 5$. All specifications include lagged production volume. All standard errors are clustered on firm level. ***p<0.01, **p<0.5, *p<0.1

estimation. We included lagged (up to three lags) total factor productivity, investment in machines and the number of workers. These performance measures had no impact on our import competition effect (neither as an extra control variable nor as an interaction term).

Overall, our finding that import competition leads to a decline in marginal costs is in line with the findings on product level by Dhyne et al. (2017). Using data on Belgian producers, they show that product-level technical efficiency goes up as import competition increases. While product-level empirical studies of productivity are scarce, a positive effect of competition on productivity has been repeatedly documented on firm and industry levels (see extensive overview of this literature in Holmes and Schmitz 2010). The contribution of our approach is to show that the distance between the producer and the manufacturing importer dampens the effect of import competition on marginal costs.

5 Decomposing import competition effects

Our next step is to decompose the import-competition effect to study whether the reduction in marginal cost is passed over to buyers through a lower price or whether firms capture these improvements by increasing their markup. We use the distance-deflated measure of import competition (i.e. IC_{jt}^{xmd} in Table 3.3), which captures both the value of imports and the distance to importers, and our preferred specification.

The results are presented in Table 4, and column 1 replicates the result in column 3 in Table 3. If we switch to the question of whether the reduction in the cost of production is passed through to buyers or not, we find a very robust pattern in the average response. That is, we do not find a pro-competitive effect among producers of intermediate goods, as their output prices are unchanged as import competition increases (column 2). Instead, firms, on average, increase markup (column 3), which is more in line with the argument of Antoniades (2015) that a firm's total response to increased competition is a mix of both a pro-competitive effect and an active innovation effect to escape it. To investigate the robustness of these results, we used the alternative instrument (i.e. the product-time-specific I_{jt}^{non}), controlled for firm-specific trends (i.e. random-trend model) and controlled for additional competition variables.[37] However, the results were unchanged by these alterations in our specification. We also compared our results with final goods producers, but we found no significant effect of import competition on the marginal cost nor the markup using the same specifications.

6 Heterogeneous responses

The average firm response discussed above may conceal a heterogeneous response, which Antoniades (2015) argues for. Although firms could escape competition by innovating, the magnitude of this offsetting effect depends on the characteristics of the firm (e.g. productivity, as used, theoretically, by Antoniades 2015). Heterogeneous responses are also in line with the literature on multi-product firms, which underlines that firms reallocate resources to their higher-revenue products when competition increases (Bernard et al. 2011; Mayer et al. 2014).

To explore the possibility of a heterogeneous effect, we start to investigate whether firms respond differently depending on firm productivity. The results are presented in Table 5. The non-linearity in firms' responses is captured by interacting their productivity[38] with import exposure and the result is illustrated in Figure 8.[39] This figure shows a clear heterogeneous import competition effect and productive firms respond by increasing their markup as their marginal cost drops. However, the improvements in firms' cost structure are greater than the increased markup, which implies that productive firms pass-through some of the cost reductions to buyers.

To investigate whether these heterogeneous responses originate from an innovation process, as Antoniades (2015) suggests, we study how firms respond to import competition when it comes to investment in immaterial assets and their expenditure on their own

[37] We controlled for product-time-specific variables such as the total number of importers and domestic producers and a firm-product-time specific variable such as the average distance to the five closest domestic producers.

[38] We recover firm-level productivity from the estimation procedure used to obtain marginal costs and markups. The procedure is detailed in Appendix B

[39] The specification excludes the main effect of total factor productivity (TFP), and since it is insignificant, excluding it did not change the fitness of the model. Note that the average elasticity of import exposure mimics those found in Table 4 for all three performance measures.

Table 5: Marginal costs, prices, markups and import competition

	Marginal Cost (1)	Price (2)	Markup (3)
IC^{5md}_{jt}	-0.035	0.037*	0.072
	(0.046)	(0.021)	(0.044)
$IC^{5md}_{jt} \times TFP_{jt}$	-0.033***	-0.015***	0.018***
	(0.004)	(0.003)	(0.004)
Observations	13554	13554	13554
Adjusted R^2	0.93	0.97	0.85
F-stat. (1st st.)	24.81	24.81	24.81
Firm-product FE	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes

Note: The dependent variable is in the column name. Import competition variable is defined according to Table 1, Panel II; $x = 5$. All specifications include lagged production volume. All standard errors are clustered on firm level. ***p<0.01, **p<0.5, *p<0.1

work to improve firms' assets (material or immaterial).[40] The results in Table C5 in the Appendix show that import competition boosts firms' investment in immaterial assets as well as own assets, which is consistent with the notion that firms respond to import competition by innovating and upgrading their products and production units. These results are also in line with the models by Dhingra (2013) and Eckel et al. (2015), which show that increased efficiency of firms in response to import competition may stem from innovation and quality upgrading.

An additional source of heterogeneity may originate from products (produced or imported) instead of firms. Hence, we begin by investigating whether an increased import exposure influences the product portfolio of firms with the help of a product survival analysis. The results are reported in Table 6. Our first result (column 1) indicates that import exposure has no impact on the average probability of dropping a product. However, this effect conceals a heterogeneous effect, since if we condition import exposure on the importance of the product in terms of product's share in a firm's revenue[41], the result

[40] Investment in immaterial assets by definition includes investment in patents, trademarks, brand, etc. It can also include investment in software. Investment in own work is defined as the costs of improvement of both tangible and intangible assets, as long as such costs are likely to result in greater returns for the firm. Although a change in immaterial assets or own work is not necessarily an indication of innovation activity in the narrow sense, i.e. R&D spending or patenting, the significance of these variables is suggestive of firm-level *upgrades* in the broad sense.

[41] To pin down the importance of the product in firm's portfolio, we calculated the product's share in the firm's revenue in the first year the firm is observed in our sample. Based on the share, we define product's rank. Rank takes values from 0 to 3, in which rank 3 indicates the lowest revenue share, i.e. fringe products.

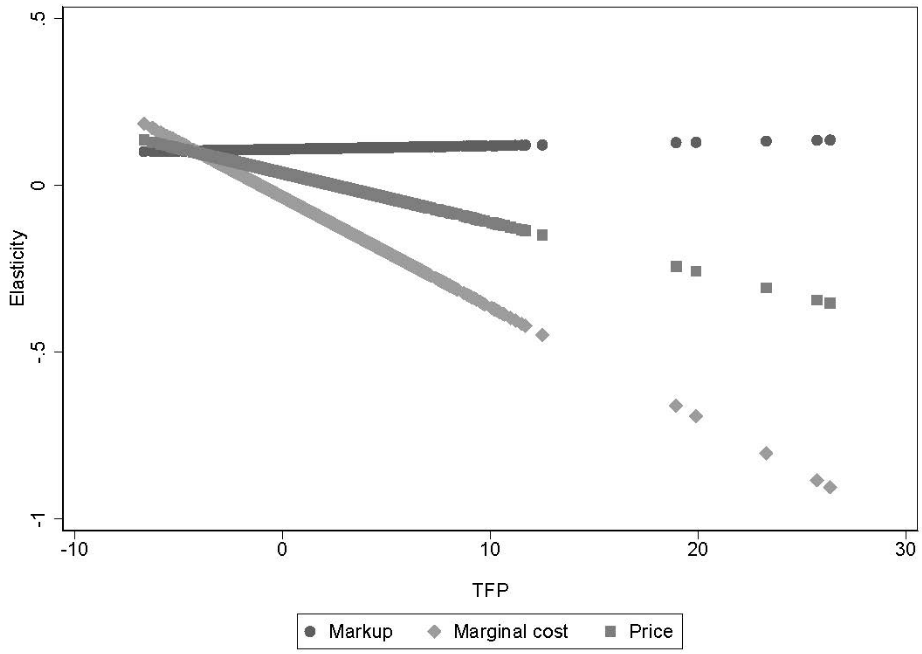

Figure 8: Non-linear responses in productivity (elasticities w.r.t. import competition)

supports a change in the product portfolio. That is, increased import exposure lowers firms' probability of dropping core products, while fringe products face a higher probability of being dropped.

To capture the effect of individual importers, we reshape our dataset so that each importer is used as a single observation. That is, our firm performance measures still have the firm-product-time dimension as before, but our import competition variable has a firm-product-neighbor-time dimension (see our definition of IC_{jt}^{nnmd} in Table 1). This allows us to investigate whether relatively low priced imports have a more pro-competitive effect or not by interacting our import exposure measurement with a dummy taking the value of one, if the initial price of the imported product is lower than the price of its producer. The results in Table 7 show that products facing competition from low-priced imports respond very differently. Producers cut marginal costs even more for these products, and they transmit all of these efficiency gains to buyers through a lower price instead of increasing markups.

However, domestic producers may avoid import competition (as discussed by Antoniades 2015) by climbing the quality ladder for highly efficient products. We investigate this by using an additional dummy that takes value one if the product is produced with a lower[42] marginal cost relative to other producers.[43] This dummy is then interacted with

[42]We used the bottom quartile of marginal costs of the same product as a threshold for defining "relatively low" marginal costs. The results are robust to choosing median or tercile instead.

[43]See Vandenbussche (2014) for an extensive discussion on the use of information on cost for measuring

Table 6: Portfolio adjustment and import competition

	Drop	
	(1)	(2)
IC_{jt}^{5md}	-0.007	-0.061***
	(0.011)	(0.022)
$IC_{jt}^{5md} \times$ Rank		0.029***
		(0.011)
Observations	9556	9556
Adjusted R^2	0.16	0.12
F-stat. (1st st.)	31.82	5.51
Firm-product FE	Yes	Yes
Industry-year FE	Yes	Yes

Note: Only firms that were producing at least two products in the initial year are included in the sample. The dependent variable is an indicator variable that takes value 1 if the product is dropped next period. Import competition variable is defined according to Table 1, Panel II; $x = 5$. *Rank* is a rank of product in terms of the product's share in firm's total sales in the initial year. $Rank = \{0{,}1{,}2{,}3\}$, where rank 3 indicates the lowest revenue share. All specifications include lagged production volume. All standard errors are clustered on firm level. ***p<0.01, **p<0.5, *p<0.1

the one used above. The results show that products manufactured efficiently compared to other domestic producers, could avoid some of the pro-competitive effects of low-priced imports by not only lowering the price to buyers, but also by increasing the markup. This finding is consistent with the idea that product-level quality upgrades shield from import competition.

Overall, our heterogeneity analysis sheds some light on the possible mechanisms behind the effect. First, we find evidence suggestive of firm-level upgrades and innovation in response to import competition. Second, we show that import competition may induce a change in firms' production baskets through dropping fringe products. Third, the detected heterogeneity with respect to the product prices and marginal costs indicates that the mechanisms operate on a product level.[44] We leave the analysis of the exact mechanisms behind the effect (e.g. X-inefficiencies, *product*-level innovation, etc.) for future research.

quality of products

[44] An additional source of heterogeneity may stem from variation across sourcing countries. We explored this by investigating whether a variation in the trade weighted average sourcing income of imported products influenced the competition effect. We found however no effect, which may be explained by the fact that around 87% of the products in our sample are sourced from high-income countries.

Table 7: Marginal costs, prices, markups and import competition

	Marginal Cost (1)	Price (2)	Markup (3)	Marginal Cost (4)	Price (5)	Markup (6)
IC_{jt}^{f10md}	-0.013**	0.002	0.014**	-0.012*	0.002	0.014**
	(0.006)	(0.003)	(0.006)	(0.006)	(0.003)	(0.006)
$IC_{jt}^{f10md} \times lip_0$	-0.011**	-0.007***	0.004	-0.010*	-0.007**	0.003
	(0.005)	(0.003)	(0.005)	(0.005)	(0.003)	(0.005)
$IC_{jt}^{f10md} \times lip_0$ $\times lmc$				-0.093***	-0.025***	0.068***
				(0.005)	(0.002)	(0.004)
Observations	127590	127590	127590	127590	127590	127590
Adjusted R^2	0.95	0.98	0.89	0.95	0.98	0.89
F-stat. (1st st.)	84.57	84.57	84.57	56.37	56.37	56.37
Firm-product FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: The dependent variable is in the column name. Import competition variable is defined according to Table 1, Panel III, where $n = 10$. Dummy lip_0 takes value one if neighbour's import price on a product is lower compared to the producer's price in the first year importer-producer pair is observed. Dummy lmc takes value one if a product is produced with a lower marginal cost relative to other producers (bottom quartile of the distribution of marginal costs of the product). All specifications include lagged production volume. All standard errors are clustered on firm level. ***p<0.01, **p<0.5, *p<0.1

7 Conclusions

In this paper we add the spatial dimension of imports within a country when studying the effects of import competition on domestic producers. We use detailed production data of Swedish intermediate goods producers to evaluate the effects of competition from imports in manufacturing firms by including the distance between producers and manufacturing importers. In addition, we drill behind the generic firm-performance measurement, such as the total factor productivity based on revenues, by focusing on firm-product level performance (decomposed into marginal cost, markup and price).

Our main result suggests that firms increase their efficiency as imports surge but that the distance between the producer and the manufacturing importer dampens this effect. Hence, it is important to incorporate the geographical pattern of buyer-seller networks when the effects of import exposure are investigated. We find that a 10% increase in import exposure (imports deflated with distance) reduces marginal costs by approximately 1%. The importance of the spatial pattern of buyer-seller networks is also emphasized by the fact of an increased concentration of economic activity leading to shorter distance between producers and importers, while the pattern of imports in levels is less conclusive.

The findings discussed in this paper open several avenues for future research on the spatial dimension of import competition. First, incorporating data on buyer-seller trade flows would allow for estimating the effects more precisely and exploring the effect of import competition at both the extensive and intensive margin. Second, examining the role of transportation costs would give us a more nuanced picture of the role of distance in import competition. Third, expanding the present setting to the import competition in services is another promising line for further investigation. By and large, understanding how the spatial dimension of import competition influences domestic producers is important for evaluating the impact of trade on reallocation and growth and, in turn, for the design of the effective industrial policy. Our findings that competition in close proximity has stronger effects on domestic producers imply that omitting the spatial dimension from the analysis may understate the effects of import competition. Further research is needed to help us better understand the drivers behind the resource reallocation in response to import competition.

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Appendices

A Descriptive Statistics

Table A1: Import competition measures

	Mean	s.d.	Min	Max	No. obs.
Spatial areas					
IC^{swe}_{jt}, mln	2379.94	4345.54	0	91521.39	11918
IC^{mun}_{jt}, mln	25.43	237.83	0	20211.72	11918
IC^{sam}_{jt}, th	0.01	0.00	0.01	0.02	11918
5 closest importing firms					
IC^{5m}_{jt} , mln	56.07	565.03	0	27430.77	13554
IC^{5d}_{jt}, km	81.54	108.86	1	1286.68	13554
IC^{5md}_{jt} , mln	3.60	81.58	0	5125.09	13554
10 closest importing firms					
IC^{10m}_{jt}, mln	103.70	867.07	0	33781.44	13554
IC^{10d}_{jt}, km	123.82	135.87	1	1328.29	13554
IC^{10md}_{jt}, mln	3.83	71.95	0	6553.09	13554
10 closest importing firms expanded					
IC^{f10m}_{jt}, mln	10.53	136.57	0	9143.51	127590
IC^{f10d}_{jt}, km	105.88	130.22	1	1414.33	127590
IC^{f10md}_{jt}, mln	1.03	42.98	0	7026.81	127590

Note: Monetary variables are in either millions (mln) or thousands (th) Swedish Krona.

B Estimation of markups and marginal costs

To estimate markups and marginal costs on the product level we closely follow De Loecker et al. (2016).[45] This section describes the methodology in greater detail.

B.1 Production function

Define production function of product j produced by firm f at time t as follows:

$$Q_{fjt} = F_{jt}(V_{fjt}, K_{fjt}) \exp(\omega_{ft} + \epsilon_{fjt}), \tag{1}$$

where Q_{fjt} is physical output, F_{jt} is the production function, V_{fjt} denotes variable inputs (inputs that can be easily adjusted by the firm), K_{fjt} denotes fixed inputs (inputs

[45]While the main empirical analysis in the paper is performed for single-plant firms to enable spatial analysis, we do not need to impose this restriction when estimating markups and marginal costs. The population of firms covered by IVP and FEK datasets is included in the sample.

that require adjustment costs), ω_{ft} is firm's total factor productivity (TFP) and ϵ_{fjt} captures unexpected shocks to the firm's output or measurement error.

Equation (1) imposes several assumptions on the estimation procedure. First, production function F_{jt} is product-specific as is evident from the notation. The implication of the assumption is that the production technology used to manufacture product j is common across all firms, irrespective of whether the firms are single- or multi-product.[46] Second, productivity ω_{ft} is firm-specific.[47] Next, firm-level expenditure is a sum of product-level expenditures. That is, $W^v_{fjt}V^v_{fjt} = \tilde{\rho}_{fjt}\sum_j W^v_{fjt}V^v_{fjt}$, where $\tilde{\rho}_{fjt}$ is the share of firm expenditure on product j, so that $\sum_j \rho_{fjt} = 1$.[48] Note, that this framework imposes no assumptions on market conduct or the demand system.

In the framework, firms are assumed to minimize costs taking output quantity Q_{fjt} and input prices for variable inputs (W^v_{fjt}) and fixed inputs (W^k_{fjt}) as given. The minimization problem of firm f for product j at time t leads to the following Lagrangian function:

$$\mathcal{L}(V_{fjt}, K_{fjt}, \lambda_{fjt}) = \sum_{v=1}^{V} W^v_{fjt}V^v_{fjt} + \sum_{k=1}^{K} W^k_{fjt}V^k_{fjt} + \lambda_{fjt}[Q_{fjt} - Q_{fjt}(V_{fjt}, K_{fjt}, \omega_{ft})]. \quad (2)$$

FOC with respect to the variable input V_{fjt} yields:

$$\frac{\partial \mathcal{L}_{fjt}}{\partial V^v_{fjt}} = W^v_{fjt} - \lambda_{fjt}\frac{\partial Q_{fjt}}{\partial V^v_{fjt}}. \quad (3)$$

After rearranging the terms and multiplying both sides by $\frac{V_{fjt}}{Q_{fjt}}$, the following expression is obtained:

$$\frac{\partial Q_{fjt}(.)}{\partial V^v_{fjt}}\frac{V^v_{fjt}}{Q_{fjt}} = \frac{1}{\lambda}\frac{W^v_{fjt}V^v_{fjt}}{Q_{fjt}}. \quad (4)$$

Defining product-level markup μ_{fjt} as $\mu_{fjt} \equiv \frac{P_{fjt}}{\lambda_{fjt}}$ and rearranging Equation (4) yields the following expression for the markup:

$$\mu_{fjt} = \frac{\partial Q_{fjt}}{\partial V^v_{fjt}}\frac{V^v_{fjt}}{Q_{fjt}}\left(\frac{P_{fjt}Q_{fjt}}{W^v_{fjt}V^v_{fjt}}\right) = \theta^v_{fjt}(\alpha^v_{fjt})^{-1}, \quad (5)$$

where θ^v_{fjt} is the output elasticity of variable input V_{fjt} and α^v_{fjt} is the share of firm's expenditure on input v attributed to product j in the sales of product j. From the definition of markups, marginal costs are obtained by dividing product level prices by

[46] De Loecker et al. (2016) stress that most of the literature on productivity, in which productivity is estimated on a firm level, does not make a distinction between single- and multi-product, thus implicitly making the same assumption.

[47] For an alternative approach to modeling productivity on the product level see Dhyne et al. (2017).

[48] Again, a stricter form of this assumption is not new to the literature (Foster et al. 2008; De Loecker 2011).

markups:

$$mc_{fjt} = \frac{P_{fjt}}{\mu_{fjt}}. \tag{6}$$

Thus, to obtain the markups and, in turn, marginal costs, we need two terms α^v_{fjt} and θ^v_{fjt}. $P_{fjt}Q_{fjt}$ (denominator of α^v_{fjt}) is available in the data. $W^v_{fjt}V^v_{fjt}$ (numerator of α^v_{fjt}) and θ^v_{fjt} need to be estimated. The next section details the estimation procedure.

B.2 Estimation

Taking a logarithm of the production function specified in Equation(1), we obtain:

$$q_{fjt} = f_j(\mathbf{v}_{fjt}, \mathbf{k}_{fjt}; \boldsymbol{\beta}) + \omega_{ft} + \epsilon_{fjt}, \tag{7}$$

where q, v, k denote logs of correspondingly physical output, variable inputs and fixed inputs. As is standard in the literature, we assume that coefficients in the production function are time invariant, which is reflected in the notation.

Equation (7) relates physical output on product-level q_{fjt} to the product level inputs $\boldsymbol{x}_{fjt} = \{\mathbf{v}_{fjt}, \mathbf{k}_{fjt}\}$. Physical output q_{fjt} is observed in the data. However, physical inputs $\boldsymbol{x}_{fjt}$ are unobserved and the best available counterparts to $\boldsymbol{x}_{fjt}$ are expressed in monetary values and are measured at firm level. From the assumption that firm-level expenditure is a sum of product-level expenditure inputs, we know that product-level quantities $\boldsymbol{x}_{fjt}$ are related to monetary values for inputs (denoted as $\tilde{x}_{ft}$) in the following way:

$$x_{fjt} = \rho_{fjt} + \tilde{x}_{ft} - w_{fjt}, \tag{8}$$

where $\rho_{fjt} = ln(\tilde{\rho}_{fjt})$, $\tilde{x}_{ft}$ is firm-level expenditure on inputs (in logs), w_{fjt} is a deviation of the product-specific input price from the industry average (in logs).

Collecting all firm-product-specific input prices in logs in vector $\mathbf{w}_{fjt}$ and inserting Equation (8) into (7) leads to the central equation of the framework:

$$q_{fjt} = f_j(\tilde{\mathbf{x}}_{ft}; \boldsymbol{\beta}) + A(\rho_{fjt}, \tilde{\mathbf{x}}_{ft}, \boldsymbol{\beta}) + B(\mathbf{w}_{fjt}, \rho_{fjt}, \tilde{\mathbf{x}}_{ft}, \boldsymbol{\beta}) + \omega_{ft} + \epsilon_{fjt}. \tag{9}$$

Terms $A(.)$ and $B(.)$ formalize the biases that arise in the estimation of production function. $A(.)$ represents the input allocation bias, which stems from the fact that product-level allocation of inputs is unobserved for multi-product firms. $B(.)$ is the input price bias, which arises from the unobserved input prices.

To deal with input allocation bias $A(.)$, Equation (9) is first estimated for single-product firms as single-product firms are not subject to this kind of bias. Single-product firms allocate inputs to the single product, which means that Equation (9) for single-product firms does not require the inclusion of ρ_{fjt}, nor is product-level index j necessary:

$$q_{ft} = f_j(\tilde{\mathbf{x}}_{ft}; \boldsymbol{\beta}) + B(\mathbf{w}_{ft}, \tilde{\mathbf{x}}_{ft}, \boldsymbol{\beta}) + \omega_{ft} + \epsilon_{ft}. \tag{10}$$

The remaining challenges in estimating Equation (10) are unobserved input prices, simultaneity bias associated with ω_{ft}, and selection bias.

Input price bias arises when there is a variation in input prices among the producers. Firms with more expensive inputs will have higher expenditure, which does not necessarily indicate higher output in physical terms. Hence, using monetary values as a proxy for physical units is likely to introduce bias to the estimated coefficients. It is unlikely that our data is free from the variation in input prices, therefore, it is important to address it. To deal with the input price bias, De Loecker et al. (2016) introduces a control function assuming that input price variation across producers arises through input quality differentiation and price variation in local input markets. Central to this approach is the idea that to produce high-quality products, firms use high-quality inputs and such inputs are expensive.[49] Hence, input quality is recovered with the help of the output prices. Under the assumption of complementarity in the qualities of outputs and inputs and conditional on the differences across local input markets, input prices are a function of output quality. Output quality, in turn, is approximated by a polynomial in relevant firm- and product-level characteristics, such as output prices, a firm's market share, product dummies, and a firm's export status. Although De Loecker et al. (2016) does not have data on regional trade flows, the framework, in general, implies that relevant information on trade flows should also be included in the control function. Our dataset allows for this level of detail, and we, therefore, add product-specific imports in the firm's local labor market to account for possible effects of imports on input prices.

Productivity ω_{ft} is potentially observed and predicted by firms, but unobserved by econometrician, which is likely to give rise to simultaneity bias. Simultaneity bias arises because firms observe ω_{ft} before choosing inputs. To address the bias we use the standard approach in the literature introduced by Olley and Pakes (1996) and advanced by Levinsohn and Petrin (2003) and Ackerberg et al. (2015). The approach is based on the idea that development of productivity ω_{ft} over time (so-called *law of motion)* can be described as a function of the lagged productivity and innovation in the productivity shock. Building on the insight that demand for inputs is monotonically increasing in ω_{ft} and that ω_{ft} can be expressed as a function of inputs, law of motion can be substituted in the production function thus eliminating unobserved productivity from the equation.

[49] This idea has found broad support in both theoretical and empirical literature (Manova and Zhang 2012; Manova and Yu 2017; Kugler and Verhoogen 2012; Kremer 1993). De Loecker et al. (2016) further show that this assumption fits a large set of theoretical models.

Production function is then estimated using a two-step generalized method of moments (GMM) as suggested by Ackerberg et al. (2015). Moments for GMM are formed based on the orthogonality of the innovation shock to the firm-level inputs of the same period t. Central to the framework by De Loecker et al. (2016) is that the law of motion is endogenized, that is ω_{ft} depends not only on its lagged values and an innovation shock, but also on other firm-level choices and factors external to the firm (such as import competition). In particular, following De Loecker et al. (2016), we include trade-related variables (firm-level imports and exports), as well as a selection correction term; the selection into single-product firms is described next.

Given that many firms in our dataset switch from being single-product to multi-product, it is important to address the selection into adding/dropping a product. To deal with the selection bias, we follow the standard selection correction procedure introduced by Olley and Pakes (1996). We estimate the selection correction term as the probability that a firm keeps producing a single product next period. This probability is estimated nonparametrically as a function of firm-level observable characteristics. This selection correction term is then included in the law of motion.

Having addressed these challenges, we proceed to the estimation of Equation (10). Estimation of Equation (10) requires specifying a functional for $f(.)$. We specify $f(.)$ as a translog.[50] The major benefit of translog is that the estimated elasticities are allowed to vary across firms and products. Inputs to the production function (i.e. input expenditure $\tilde{\mathbf{x}}_{ft}$) include labor, intermediate inputs and capital.[51]

We recover productivity for single-product firms in the following way:

$$\hat{\omega}_{ft} = \hat{q}_{ft} - f(\tilde{\mathbf{x}}_{ft}; \hat{\boldsymbol{\beta}}) + B(\hat{\mathbf{w}}_{ft}, \tilde{\mathbf{x}}_{ft}, \hat{\boldsymbol{\beta}}), \tag{11}$$

where $\hat{q}_{ft}$ stands for the predicted physical output obtained from the projection of $\hat{q}_{ft}$ on the covariates in of the production function.

At this stage, we have estimates of output elasticities. To obtain product-level markups and marginal costs for the whole sample, we need to know how multi-product firms allocate their inputs to products. De Loecker et al. (2016) show that input allocation can be recovered by exploiting the assumption that firm-level expenditure is a sum of product-level expenditure $W^v_{fjt} V^v_{fjt} = \tilde{\rho}_{fjt} \sum_j W^v_{fjt} V^v_{fjt}$. Now, as we have estimates of output elasticities, Equation (9) can be rewritten as a sum of two terms, where one term contains only the arguments that do not depend on input allocation term ρ_{fjt} and the other term has only

[50] $f(l,k,m) = \beta_l l + \beta_k k + \beta_m m + \beta_{ll} l^2 + \beta_{kk} k^2 + \beta_{mm} m^2 + \beta_{lk} lk + \beta_{lm} lm + \beta_{km} km + \beta_{lkm} lkm + \omega_f$

[51] We measure labor as the total wage cost. Intermediate inputs are a sum of costs on raw materials and costs on commodities. Capital is measured as the sum of assets on machinery, equipment and buildings. These variables are deflated with the two-digit producer price index.

Table C2: Marginal costs and import competition from the ten nearest neighbors

	Marginal Cost			
	(1)	(2)	(3)	(4)
IC^{10m}_{jt}	-0.117**	-0.109**		
	(0.052)	(0.048)		
IC^{10d}_{jt}		0.045		
		(0.031)		
IC^{10md}_{jt}			-0.099**	-0.105**
			(0.044)	(0.046)
Observations	13554	13554	13554	13155
Adjusted R^2	0.93	0.93	0.93	0.44
F-stat. (1st st.)	90.44	112.36	142.64	32.64
Firm-product FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes

Note: The dependent variable is in the column name. Import competition variable is defined according to Table 1, Panel II; $x = 10$. All specifications include lagged production volume. All standard errors are clustered on firm level. ***p<0.01, **p<0.5, *p<0.1

the arguments that depend on ρ_{fjt}. Together with $\sum_j \rho_{fjt} = 1$ (which follows from the assumption on expenditure allocation), this yields a system of equations that can be solved with respect to ρ_{fjt}. Once ρ_{fjt} is obtained, input allocations are known, allowing us to back out firm-level productivity (which we use in the discussion of the mechanisms) and finally obtain the estimates of markups and marginal costs using Equations (5) and (6). The variable input that we use in the calculations is the materials. That is, we obtain markups as a ratio between the output elasticity of materials and the shares of materials in the total sales.

C Robustness and additional results

Table C3: Marginal costs and import competition from the one nearest neighbor

	Marginal Cost			
	(1)	(2)	(3)	(4)
IC_{jt}^{1m}	-0.057*	-0.062*		
	(0.030)	(0.032)		
IC_{jt}^{1d}		0.034**		
		(0.015)		
IC_{jt}^{1md}			-0.066*	-0.140***
			(0.036)	(0.049)
Observations	13554	13554	13554	13155
Adjusted R^2	0.93	0.93	0.93	0.39
F-stat. (1st st.)	70.24	64.59	50.69	26.24
Firm-product FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes

Note: The dependent variable is in the column name. Import competition variable is defined according to Table 1, Panel II; $x = 1$. All specifications include lagged production volume. All standard errors are clustered on firm level. ***p<0.01, **p<0.5, *p<0.1

Table C4: Robustness: Additional controls for competition

	Marginal Cost			
	Whole sample			Imp. Share < 0.1
	(1)	(2)	(3)	(4)
IC_{jt}^{5md}	-0.116**	-0.118**	-0.115**	-0.118***
	(0.047)	(0.047)	(0.047)	(0.046)
No. producers	0.001			
	(0.000)			
Distance to producers		0.000		
		(0.000)		
No.importers			-0.000	
			(0.000)	
Observations	13554	13554	13554	13406
Adjusted R^2	0.93	0.93	0.93	0.93
F-stat. (1st st.)	49.89	50.09	49.57	48.55
Firm-product FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes

Note: The dependent variable is product-level marginal costs. Import competition variable is defined according to Table 1, Panel II; $x = 5$. Columns 1-3 include various proxies for competition. *No. producers* is number of domestic producers producing the same good at a given year. *Distance to producers* is the average distance to ten nearest producers. *No. importers* is the number of importers of the good at a given year. In Column 4 sample consists only of firms whose share of imports of the good they produce is at most 10 percent. All specifications include lagged production volume. All standard errors are clustered on firm level. ***p<0.01, **p<0.5, *p<0.1

Table C5: Immaterial assets, own work, and import competition

	Immaterial Assets (1)	Own Work (2)
IC_{it}	0.685** (0.292)	0.374** (0.189)
Observations	5146	5146
Adjusted R^2	0.64	0.57
F-stat. (1st st.)	55.95	55.95
Firm FE	Yes	Yes
Year FE	Yes	Yes

Note: The dependent variable is firm-level marginal costs, calculated as a weighted average of product-level marginal costs, where product's share in total sales is used as weights. IC_{it} is a measure of import competition faced by firm i. It is calculated as a weighted sum of product-level imports by five closest buyers, with products' shares in total sales of firm i used as weights. All specifications include lagged firm-level output. All standard errors are clustered on firm level. ***p<0.01, **p<0.5, *p<0.1