

Gullstrand, Joakim; Knutsson, Polina

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Working Paper 2019:13

Department of Economics
School of Economics and Management

The Spatial Dimension of Import Competition

Joakim Gullstrand
Polina Knutsson

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The spatial dimension of import competition[†]

Joakim Gullstrand[‡]

Lund University

Polina Knutsson[§]

Lund University

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 assessing whether the distance between producers and importers, within a country, matters for import competition effects at product level. Using detailed geographical information about the location of all manufacturing firms in Sweden during the period 2005–2014, we find strong evidence of an increased efficiency in the domestic production when imports surge, but that the effect diminishes 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, is transmitted to 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 in their proximity respond by lowering prices only, although highly efficient products resist this by a more pronounced improvement in the marginal cost, which, in turn, is transmitted to both a lower price and a higher markup.

JEL classification: F14

Keywords: *Import competition, distance, firm-product performance*

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[‡]Department of Economics, Lund University, Sweden; Email: joakim.gullstrand@nek.lu.se; Homepage: <https://sites.google.com/site/jagullstrand>

[§]Corresponding author. Department of Economics, Lund University, Sweden; Email: polina.knutsson@nek.lu.se; Homepage: <https://www.polinaknutsson.com/>

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 pattern varies with differences in underlying firm and product characteristics (see the overview in De Loecker and Goldberg 2014).¹

De Loecker and Biesebroeck (2018), De Loecker and Goldberg (2014), and Melitz and Redding (2014) all discuss this development and they emphasise 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 emphasises two possible offsetting responses to import competition. One, the pro-competitive effect, pushes down markups 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; Antoniadou 2015; Dhingra 2013). 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.

The possibility of heterogeneity is however not considered when it comes to the competitive pressure of imports since most studies measure import competition at a national level. Hence, competition is assumed to increase simultaneously and symmetrically within an economy as soon as an imported product crosses the border. Although the spatial dimension within an economy has a minor role in the literature on import competition, it has a crucial role to identify (1) the relevant region size in studies focusing on domestic competition (see e.g. Syverson 2004, 2007), (2) the labour 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. Bernard et al. 2015; Hillberry and Hummels 2008).

Hence, the measurement of import competition at a national level seems to be at odds with the importance of spatial frictions between as well as within countries.³ Instead, the competitive pressure on domestic firms induced by imports is likely to be influenced by

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

²See also Autor et al. (2013b), Autor et al. (2015), Caliendo et al. (2015), and Hakobyan and McLaren (2016). The role of distance in these studies is to localise import effects by relying on trade frictions and spatial heterogeneity to study the impact on wages and employment within local labour markets (see e.g. Goldberg and Pavcnik 2016).

³Anderson 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."

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

Our main contribution is to incorporate distance within a country in the analysis of import competition 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 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 fulfil these contributions, we build on the growing number of studies showing the importance of proximity in buyer-seller networks (see e.g. Bernard et al. 2015; Hillberry and Hummels 2008) 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 location⁴, to spatially map producers’ import competition pattern through the imports of manufacturing firms. Especially since around two-thirds of the total imports of all intermediate goods produced for the manufacturing sector is imported by manufacturing firms (in our sample it is almost 85%) while they are much less prominent as importer of consumer goods (around one-sixth of total imports). In addition, we follow the recent developments in estimating markups, which not only makes 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 with 10%.⁵

Furthermore, we show that the distance between the producers and the importing

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

⁵A 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. An overview of firm- and industry-level evidence that product-market competition increases productivity can be found in Holmes and Schmitz (2010).

manufacturing firms matters for the import exposure, and not only import volumes. Hence, using nation-wide 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 is, on average, more important than changes in imports, since the average distance to the first importing firm during the 2005–2014 period fell by about 8 km, while the average volume of imports 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 by 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 cost) 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.

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 proceed from the following relationship (see De Loecker et al. 2016; De Loecker and Goldberg 2014; De Loecker and Warzynski 2012):

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

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 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.⁶ 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, labour contracts, or the input market. These imperfections create a slack in the organisation, which is only addressed by cost reducing changes and innovations when motivation for this is built up by an increased competition (see Leibenstein 1966).⁷

The ‘trapped-factor model’ of Bloom et al. (2016, 2013) 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 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.⁸ Bloom et al. (2016) 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.⁹

Another perspective on the link between competition and innovation is found in Antoniadou (2015), who argues that firms may escape competition through innovation in a model that incorporates both a pro-competitive effect and an innovation effect.¹⁰ The innovation effect consists of an upgrade (through innovation and R&D investments) to avoid competition, and this upward move on the quality ladder also leads to that firms 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

⁶See 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 influence firms (see e.g. the impact of lower input tariffs in De Loecker et al. 2016).

⁷An additional within-firm response to an increased import competition is the possibility of multi-products to become leaner and meaner by re-directing resources to their core products (see e.g. Bernard et al. 2010b; Liu 2010).

⁸Entrapments within a firm may stem from an inertia when it comes to capital dis-investment or from that workers’ firm/product-specific knowledge is not valued outside the firm.

⁹Additional support of an increased innovation activity due to trade is found in Bustos (2011), who showed that Argentinean firms upgraded their technology as their export opportunities increased.

¹⁰Aghion et al. (2005) also discuss how firms could ‘escape competition’ by upgrading due to a change in the returns to innovation as competition increases.

response is, therefore, driven by two opposing effects, and the net effect depends on the underlying characteristic 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 Antoniadou (2015), Combes et al. (2012), and Melitz and Ottaviano (2008) by incorporating both the spatial and the quality dimension of differentiation across firms and products, and found support for that; although competition has a downward pressure on firms' markup, firms counteract this negative impact of competition by increasing quality and, hence, the markup.¹¹

2.2 Geography and import competition

In addition to a heterogeneous response across firms, the complexity of the competition effect multiplies 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).¹² 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. Ben Yahmed and Dougherty 2012; Criscuolo et al. 2004; Dhyne et al. 2017). There is, however, a growing literature emphasising 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 organisation literature. One such example is Syverson (2004, 2007), who focused on the ready-mixed concrete industry and used a collection of US 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

¹¹Several other recent studies support a 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 a more productive firm is 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) and Bastos et al. (2018) underlined that market experience improves firms' performance when they face global competition on the export market.

¹²This interaction between the market size and trade liberalisation is, for example, captured in Melitz and Ottaviano (2008).

or transport costs, which implies that firms in denser markets are more productive.¹³

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 labour markets within the US to measure the effects of imports on different labour market outcomes such as employment and wages, Ding et al. (2016) focuses on the impact of import penetration on firm performance within Chinese provinces, Bagoulla et al. (2010) focuses on regional production adjustments within the French agro-industry, and Bellone et al. (2016) considers the impact of local competition within France on firm markup and productivity.¹⁴ The underlying assumption in these studies is that trade shocks hit regions within a country differently due to an 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. (2015) used a dataset on the production network in Japan with supplier-customer links between over 950,000 firms, and they showed that 'geographic proximity plays a key role for the matching of suppliers and customers'. The median distance to a supplier was no more than 30 kilometres. Wrona (2015) also studied Japan and found significant 'border effects in the absence of a border' between Western and Eastern Japan. Trade was between 23–51% lower between regions compared to within regions. Hillberry and Hummels (2008) used a survey of 'shipments of individual manufacturing establishments within the US' to show that spatial frictions matter. Shipments 'within the same 5-digit zip code was three times higher than those outside the zip code', and the fall in the value of shipments was highly non-linear and very direct. Their findings suggested that the border of 5-digit zip codes (with an average radius of around 6 km) 'represent a sizeable barrier to trade', and the local bias was explained by a 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

¹³The 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' product.

¹⁴Bellone 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.¹⁵ Figure 2 summarises 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 travels 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 65% of the volume shipped within Sweden survives a median distance of 155 km.

Hence, frictions within a nation is important and if imports surge in one part of the country, the competitive pressure may be more pronounced among firms in proximity compared to those further away. A possibility that we will investigate, and a possibility that has some support in De Loecker et al. (2014). They investigated the possibility of a spatially heterogeneous response in Belgian firms to foreign competition through changes in relative wages, and they found that firms located further away from the German border were less influenced by changes in German wages.

3 Data and empirical approach

3.1 Products, trade, and location

To identify the role of distance within Sweden when it comes to import competition, we focus on intermediate goods producers since they not only tend to sell domestically but also, as shown in the preceding section, locally to manufacturing firms. Imported intermediate goods are also largely imported directly by manufacturing firms. Approximately five-sixth of all imports in our sample is made by manufacturing firms while the same pattern is reversed when it comes to consumer goods since around five-sixth of these goods are imported by wholesalers. This implies that we more readily could calculate the distance from a domestic producer of an intermediate good to potential buyers importing the same good.

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

¹⁵A 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 by the BEC classification system.

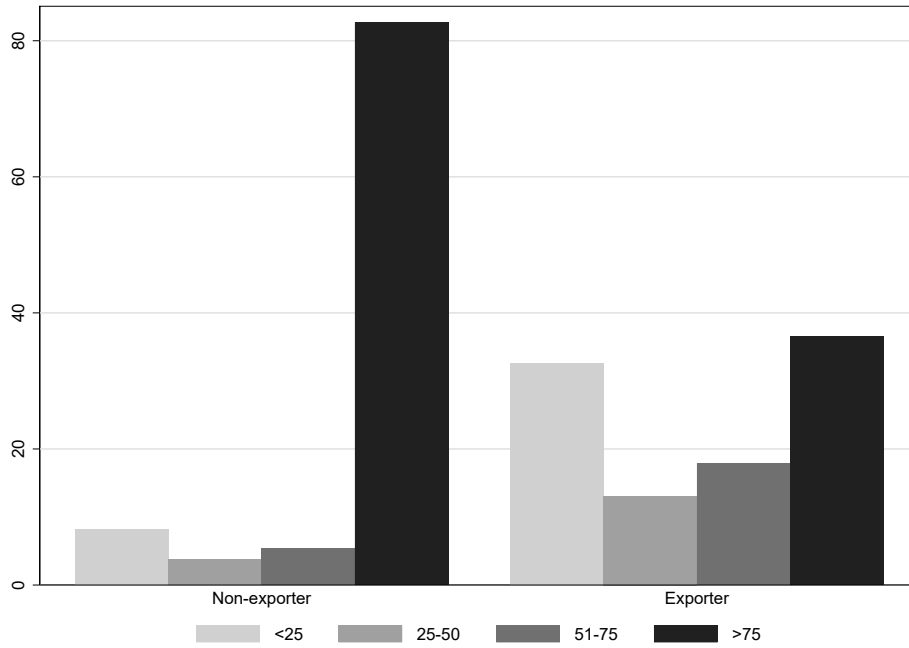


Figure 1: Firms allocation of sales to the local economy, SMEs.

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.

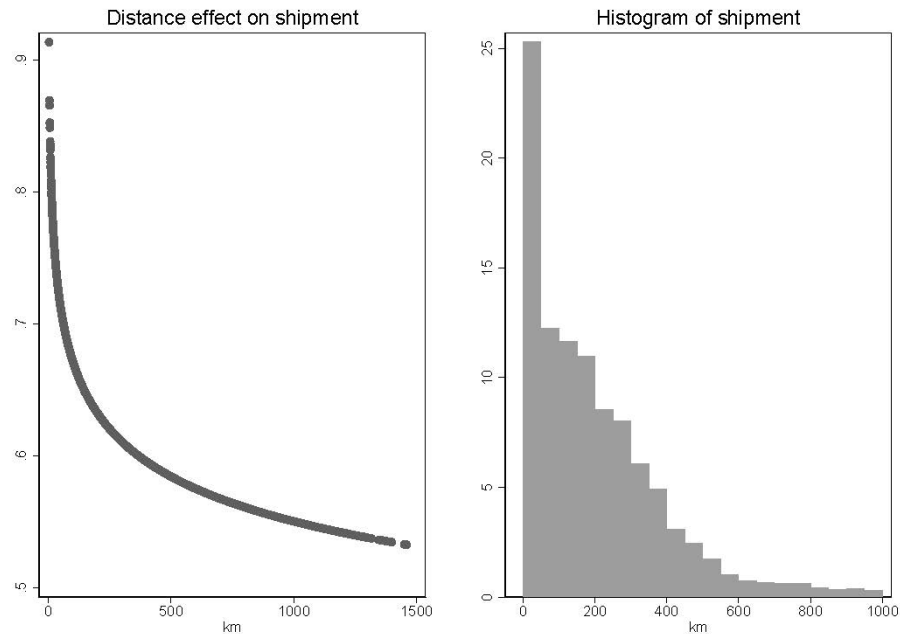


Figure 2: Shipments within Sweden.

Note: Figures are based on a survey from the Transport analysis in Sweden and sample weights are used in the regression and in the histogram. These figures is 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:

$$\ln q_{ij} = \beta \ln distance_{ij} + \lambda_m + \delta_j + \epsilon_{ij} \text{ where } i=\text{shipment}, j=\text{product}, m=\text{shipment municipality}, \beta = -0.086 \text{ (with a robust standard error of } 0.00067 \text{ and } R^2 = 0.60).$$

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 firms. The IVP survey is designed to cover all manufacturing firms in Sweden with at least 20 employees, and it provides various product-level information such as quantities and values of their production. 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 plant-level, while production is at 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.¹⁶ 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. Hence, by merging these datasets we can spatially locate all our firms (both producers and importers), and we distribute import flows according to plant size (using the number of employees) when we allocate imports to plants of multi-plant firms.¹⁷

Figure 3 shows the weighted average (using import weights of importing firms) of the distance between all our producers and their ten closest importers of the goods they produce in 2014, as well as the closest and 10th closest neighbour, respectively.¹⁸ The weighted average distance of all ten importing firms is just under 100 km while the median distance to the closest and the 10th closest is around 20 km and 100 km, respectively. Since the average radius of the Swedish municipalities is around 30 km, producers of intermediate goods have a circle of manufacturing firms importing their product in close proximity of its 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 on 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.

¹⁶Note that detailed intra-EU trade flows are only reported if a firm's total trade flow exceeds 4.5 mln SEK.

¹⁷Our location points are based on the centroids of SAMS areas (Small Areas for Market Statistics), which divide Sweden into approximately 9,200 small geographical units.

¹⁸If a producing firm has more than one importing firm with the same distance from its location, we choose the largest firm of the importing firms.

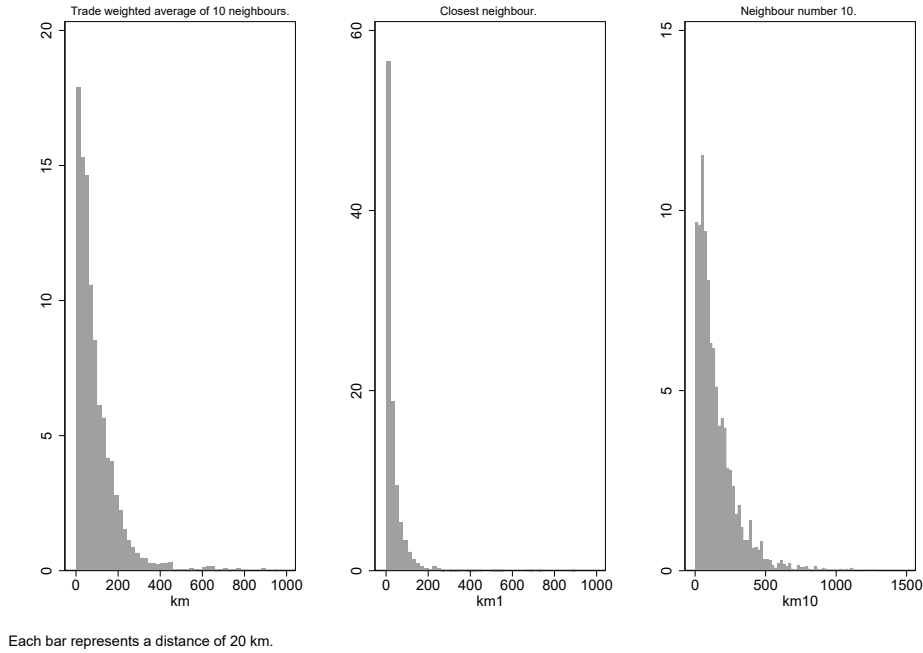


Figure 3: Shipments within Sweden.

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 implies that we will be able to decompose firms' price responses into markup and marginal cost. We will investigate the impact of imports on firms' marginal costs because an increase in competition may force firms to handle x-inefficiency or to change their products and production processes. We will, thereafter, be able to compare these effects with the impact on firms' markups and prices, which will reveal whether possible improvements in firms' marginal costs are transmitted to price changes or whether they are soaked up in markup changes. However, 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 summarised below, while a more detailed overview is given in Appendix B.¹⁹

We start out to define markups as the price-cost margin, and the marginal costs can, therefore, be obtained through the unit price data as soon as the markups have been estimated correctly. 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 (such as materials) and the input's share in total revenue. Although we have to assume that firms minimise costs, this framework is highly flexible because we do not have to impose any other assumptions on the market conduct or the demand system.

¹⁹For further details see De Loecker et al. (2016).

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, 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 to 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 labour 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; 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. We, thereafter, 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 figure 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.²⁰

²⁰See e.g. Bellone et al. (2016), Bernard et al. (2011), Mayer et al. (2014), and Melitz and Ottaviano

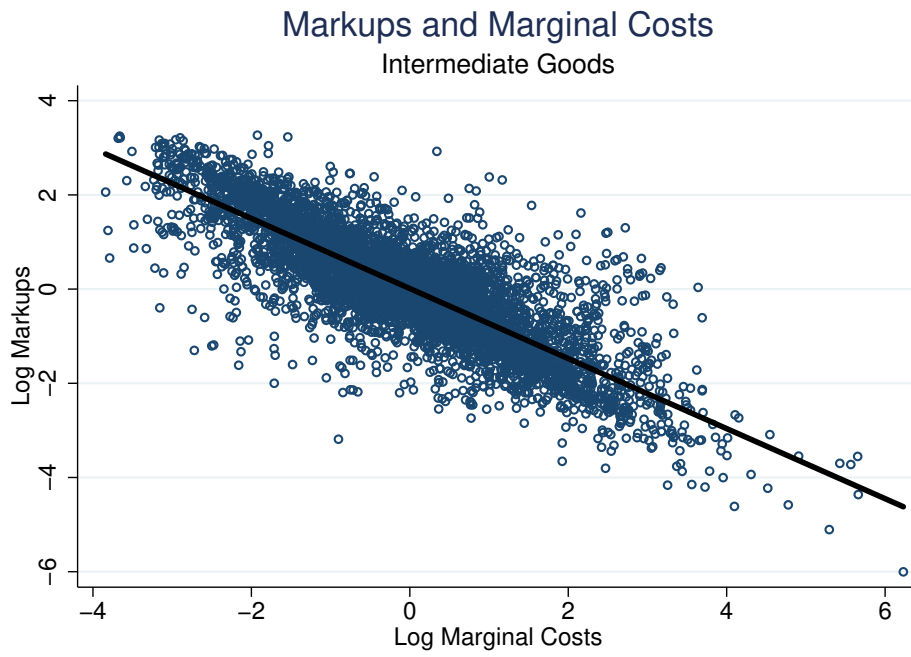


Figure 4: Product-level markups and marginal costs in logs.

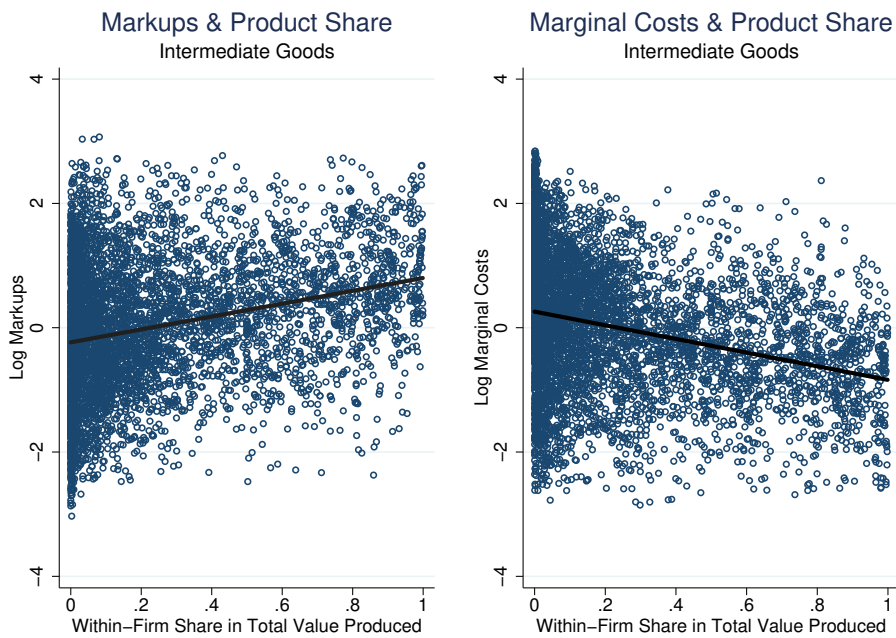


Figure 5: Product-level markups, marginal costs (in logs) and within-firm product shares.

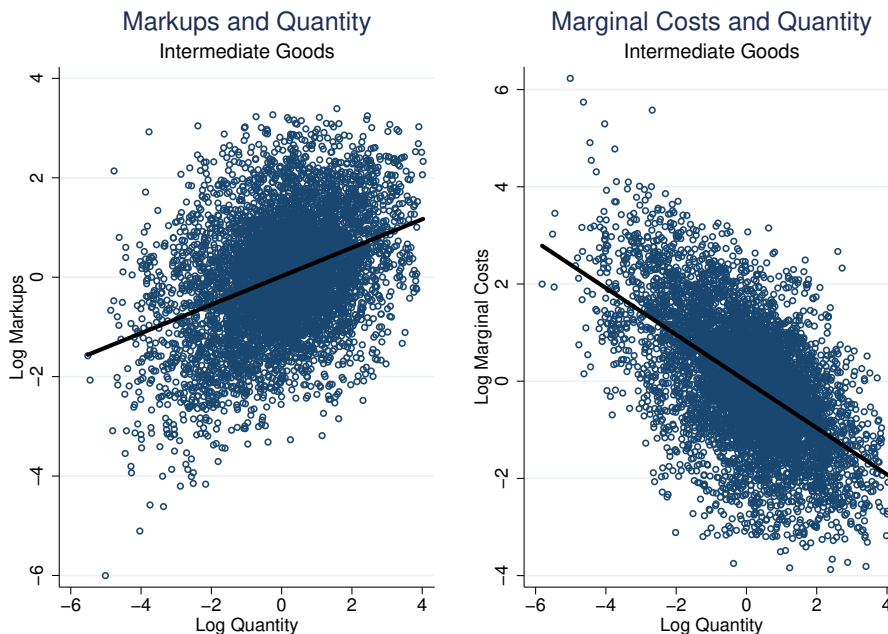


Figure 6: Product-level markups, marginal costs and quantity produced in logs.

3.3 Import competition and the empirical specifications

The measurement of import competition in the empirical literature varies widely. It is however 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. Ben Yahmed and Dougherty 2012; De Loecker et al. 2014; Dhyne et al. 2017; Liu and Rosell 2013; Olper et al. 2014), but 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; Bloom et al. 2016; Liu 2010).

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 defined using different administrative borders (Table 1, Panel I). We start with a national level as our benchmark since national level is the geographical demarcation dominant in previous studies of import competition. Thus, import exposure at 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 (2008).

Table 1: Import competition measures

Panel I. Spatial areas	
National level: $r = \text{Sweden}$	$IC_{rjt} = IC_{jt}^{swe} = \sum_{f \in \Omega_r, f \neq i} m_{fjt}$
Municipality level: $r = \text{Municipality}$	$IC_{rjt} = IC_{jt}^{mun} = \sum_{f \in \Omega_r, f \neq i} m_{fjt}$
SAMS level: $r = \text{SAMS area}$	$IC_{rjt} = IC_{jt}^{sam} = \sum_{f \in \Omega_r, f \neq i} m_{fjt}$
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_{jtf} 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 x imports of product j by x manufacturing firms closest to producer i . The first variable in this category is the sum of imports from x importing neighbours (IC_{jt}^{xm}). Since the distance to importing neighbours 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 neighbours (IC_{jt}^{xd}).²¹ Finally, we do make use of both volume and distance dimensions in one variable and construct another measure of import exposure by deflating the total imports of neighbours with the weighted distance to these firms (IC_{jt}^{xmd}).

For our final measurement, we want to use the information about the order of the n closest neighbours, i.e. we want to distinguish between the first neighbour, the second one, and so on up till the n^{th} neighbour, where n indicates the order of closeness of each neighbour (from 1 to n , where 1 is the closest neighbour). We reshape our sample so that each observation y_{ijt} is expanded to match n neighbours (Table 1, Panel III). As in the second set of our measurements, we use either the total import of (IC_{jt}^{fnm}), and distance to the neighbours (IC_{jt}^{fnd}) or the distance deflated import (IC_{jt}^{fnmd}).

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

²¹We use the import shares of the neighbouring firms as weights.

earlier studies often relate imports to the consumption or production of the same good, but we have the possibility to 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 may be summarised as follows:

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

where y_{ijt} is the performance (price, markup or marginal cost) of product j produced by producer i in year t and IC_{rjt} captures import competition 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(-neighbour) ($\theta_{ij(n)}$) 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.²² In specifications where we use our third set of import exposure measures (Table 1, Panel III), firm-product-neighbour specific effects are used instead. That is, we use θ_{ijn} in equation 1 and n indicates the order of closeness of each neighbour.

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. This may be explained by the fact that wholesalers are not a particular important source of intermediate goods for manufacturing firms in our sample. The mean share of wholesale-imports is around 16% but the 75-percentile is as low as 9%, which suggests that wholesalers are not a particular important distributor of the intermediate goods we focus on.²³ We do however also expand our specification with firm-product

²²Note 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 distance to these producers.

²³Wholesalers formed around 33% of total imports of all intermediate goods devoted to the industry (i.e. BEC code 210 and 220), which is small relative to the share of 81% when it comes to imports of consumer goods (i.e. BEC code 610, 620 and 630).

specific trends (i.e. a random trend model) to capture even finer trends in consumption, production and import patterns, but our results are robust to all 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 due to underlying demand changes that may influence both the importer and the producer simultaneously as well as the possibility that manufacturing firms are encouraged to import if they are located close to low-productive producers (i.e. firms with a high marginal cost).

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. We, therefore, in the same spirit as Hummels et al. (2014), make use of world export supply shocks using both a firm-product-time and a product-time dimension with the help of bilateral trade flows at product level from the COMTRADE database.²⁴

First, for each product j we calculate the world export supply of this product net of the supply to Sweden. Variation in world export supply of j should be positively correlated with the imports of Swedish firms, as it reflects changes in the relative price and quality of the supplied good in the exporting countries. To make the instrument importing firm-product-time specific, we multiply the world export supply of j by the pre-sample share of product j in total imports by the importing firm f . We use pre-sample shares to make sure that the input use of the importing firm is not driven by current technology shocks. If 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 ; the resulting firm-product-time specific instrument is constructed as follows: $I_{fjt} = \sum_c s_{fjc} I_{jct}$. Hence, our instrument has a spatial dimension since it is linked to each importing manufacturing firm through its mix of import source for each imported product.²⁵

Second, 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

²⁴Products are defined at the 6-digit level of the Harmonized System (HS).

²⁵Hence, we use a similar strategy as in Autor et al. (2013a), which link the instrument, growth of Chinese imports in other countries but the US, to each region by summing up industry imports using regional shares of national industry employment as weights.

instrument that lacks information about from where importing firms source their imports. In addition, we not only exclude the Swedish supply to the world market but also the supply of neighbouring 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 the following countries; Denmark, Norway, Finland and Germany).

A potential threat to the validity of the instrument is that the world’s export supply of j and firm i ’s performance (measured by the price, markup, and marginal cost of j) may be influenced by a worldwide shock (e.g. changes in demand, transport costs, or technology) facing all manufacturers of product j . We address this issue in two different ways. Our benchmark solution is to include sector-year fixed effects (i.e. θ_{st}). Our second approach is to contrast our results with a random trend model that allows for a firm-product specific trend by using first-difference to exclude firm-product specific effects and, thereafter, using fixed effects to capture the individual trend.

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 (or the ‘true’ productivity as discussed in De Loecker et al. 2016; Foster et al. 2008). The first set of results are based on the import exposure within the different geographical areas as defined in Table 1. The results are found in Table 2, which compares the most common spatial area, i.e. the national level (see column 1), with finer ones, such as municipalities and SAMS areas (see column 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 with 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 fixed effect model as well as from two different instrumental variable regressions. 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 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 relevance of the effect increases as the spatial area defining the market becomes more localised. The most local measurement is the one using SAMS areas, and the result from this specification indicates that the marginal cost of

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*** (0.030)	-0.316*** (0.030)	-0.316*** (0.030)	-0.316*** (0.030)	-0.317*** (0.030)	-0.318*** (0.030)	-0.313*** (0.030)	-0.317*** (0.030)	-0.319*** (0.030)
IC_{jt}^{swe}	-0.000 (0.000)			-0.000 (0.000)			-0.000 (0.000)		
IC_{jt}^{mun}		-0.006 (0.009)			-0.109 (0.069)			-0.155** (0.070)	
IC_{jt}^{sam}			-0.005 (0.012)			-0.130* (0.073)			-0.193** (0.075)
Observations	11918	11918	11918	11918	11918	11918	11460	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. *** $p < 0.01$, ** $p < 0.5$, * $p < 0.1$

producing an intermediate good fall with 1–2% if imports of these good among potential buyers in the close proximity increase by 10%. In other words, import competition in the 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 instrument that is importing firm-product-time specifics as our benchmark and the alternative instrument 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 firms as a customer 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 easiness of transporting 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 geographical 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 labour 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 neighbours, our benchmark result relates to the five closest neighbours and we use both the total imports of, and the import weighted distance to, these neighbours (see the definitions in Table 1).

Note that the five closest neighbours 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.²⁶

The results from our IV approach are presented in Table 3.²⁷ If we first turn to the total imports of the five nearest neighbours in 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%. This similarity with the geographical areas reflects the fact that these neighbours in most cases constitute the group of importers located within the same administrative border as the producers. If we use the ten closest neighbours instead, the result, presented in the Appendix (Table C2, column 1), supports that a broader measurement becomes less precise. The results are also less precise if we move in the other direction by using only the first importing neighbour, which is indicated by the less significant estimated effects of import exposure from the nearest importer in Table C3 in the Appendix. Hence, distance within rather fine spatial areas seems to matter.

To test for 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.²⁸ 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 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

²⁶If we use labour markets instead of municipalities, the proportion of cases when the sum of imports of the five closest neighbours amount to 40%.

²⁷Note that the OLS approach is not presented in this table, but it underestimates, just as in the case of using geographical areas, 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, which are available upon request.

²⁸We do also control for firm, product and year fixed effects.

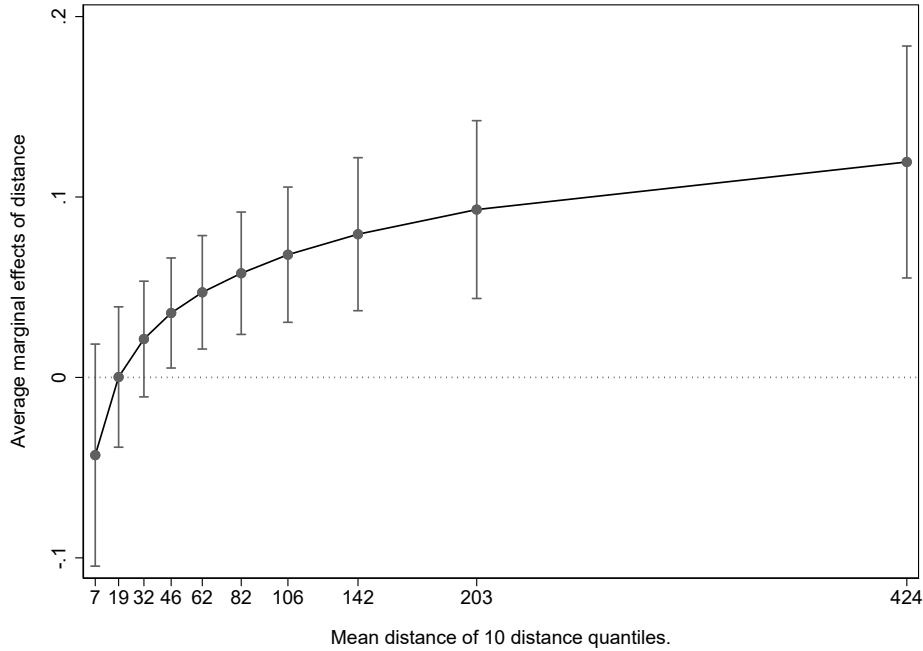


Figure 7: Distance and the error term.

marginal cost is significantly higher compared to those exposed to imports at a closer range.

If we consider the pattern of imports of and distance to the nearest importing neighbours of firms producing intermediate goods, the importance of distance becomes evident. The imports among the ten nearest neighbours 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 neighbours 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 neighbours in our specification. The results in column 2 show that distance matters, and a 10% increase in distance to importers leads to 0.8% higher marginal cost. Put differently, efficiency gains induced by import competition drops with distance to importing firms. One concern is that the distance to neighbouring importers may be determined simultaneously with the performance of production firms, just like the level of imports. If this is the case, the result in column 2 underestimates the impact of distance. We investigate this possibility with three different specifications, which all use the IV approach.

Our first specification focuses on distance alone and the result in column 3 suggests that distances from importing firms are very important since a 10% increase of distance

to importers increases the marginal cost by as much as 8%. Our second, and preferred, specification makes use of the counteracting effects of distance by deflating imports of the closest importing neighbours with the distance to these firms. Hence we focus on the import exposure faced by producing firms. The results are found in Table 3 column 4, and they support our earlier results. A 10% increase of import exposure (by an increase in imports, a decrease in distance or some combination) implies that the marginal cost falls with a bit more than 1%. Our third specification (column 5) investigates the robustness of this result with a random trend model, which controls for firm-product specific trends. However, the result is robust to this demanding specification. To investigate the robustness of these results further, we have also controlled the additional competition variables²⁹ and checked our results on a sample of firms with low levels of imports.³⁰ Our results are robust across these specifications. The results are also robust using the 10 closest neighbours instead (see Table C2 in the Appendix), although an increased size of the relevant market gives us, as before, less precise results.³¹ A final check is to investigate whether past firm performance influence our estimation. Hence, we included lagged (up to three lags) information about total factor productivity, investments in machines and the number of workers. These performance measures had however no impact on our import competition effect (neither as an extra control variable nor as an interaction term).

5 Decomposing import competition effects

Our next step is to decompose the import-competition effect to study whether the fall of firms' 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 4 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 since their output prices are unchanged as import competition increases. Instead, firms,

²⁹We 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 number of importers (Table C1, columns 1-3)

³⁰We restricted the sample to firms with the shares of imports of the goods they produce being, at most, 10% (Table C1, 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.

³¹All results are robust to using the alternative instrument, which are available upon request.

Table 3: Marginal costs and import competition from five nearest neighbours.

	Marginal Cost				
	(1)	(2)	(3)	(4)	(5)
IC_{jt}^{5m}	-0.133** (0.054)	-0.122** (0.051)			
IC_{jt}^{5d}		0.078*** (0.029)	0.891* (0.518)		
IC_{jt}^{5md}				-0.116** (0.047)	-0.140*** (0.049)
Observations	13554	13554	13554	13554	13155
Adjusted R^2	0.93	0.93	0.91	0.93	0.39
F-stat. (1st st.)	62.61	59.16	3.95	49.93	26.24
Firm-product FE	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	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. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

on average, increase markup, which is more in line with the argument of Antoniadis (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 specific I_{jt}^{non}), controlled for firm-specific trends (i.e. random-trend model) and controlled for additional competition variables.³² 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 Antoniadis (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 Antoniadis 2015). Heterogeneous responses are also

³²We 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.

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

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, and the results are presented in Table 5. The non-linearity in firms' responses is captured by interacting their productivity³³ with import exposure, and the result is illustrated in Figure 8.³⁴ 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 is 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 Antoniadou (2015) suggests, we study how firms respond to import competition when it comes to investment in immaterial assets and their expenditure on their own work to improve firms' assets (material or immaterial).³⁵ The results are found in Table C4 in

³³We recover firm-level productivity from the estimation procedure used to obtain marginal costs and markups. The procedure is detailed in Appendix B

³⁴The specification excludes the main effect of TFP, and since it is insignificant and 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.

³⁵Although a change in immaterial assets or own work is not necessarily indication of an 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 a broad sense. 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 on improvement of both tangible and intangible assets, as long as such costs are likely to result in greater returns for the firm.

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

	Marginal Cost (1)	Price (2)	Markup (3)
IC_{jt}^{5md}	-0.035 (0.046)	0.037* (0.021)	0.072 (0.044)
$IC_{jt}^{5md} \times TFP_{jt}$	-0.033*** (0.004)	-0.015*** (0.003)	0.018*** (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. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

the Appendix, and they show that import competition triggers a pro-active response by an increased activity to improve firms' assets. Import competition therefore boosts firms' investment in immaterial assets and effort to improve their own assets, which indirectly support the idea that import competition forces firms to innovate and upgrade their products and production units.

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 found in Table 7, and our first result (see 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 revenue³⁶, the result 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 has the firm-product-time dimension as before, but our import-competition variable has a

³⁶To 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 in 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.

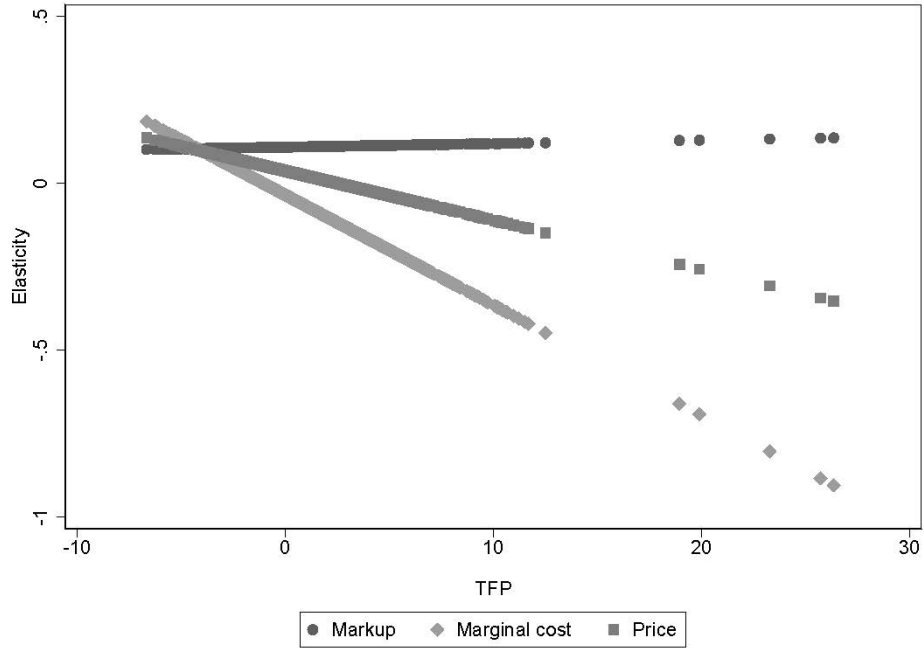


Figure 8: Non-linear responses in productivity (elasticities w.r.t. import competition).

firm-product-neighbour-time dimension (see our definition of IC_{jt}^{nmd} in Table 3.3). 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 6 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 Antoniadis 2015) by climbing the quality ladder for highly efficient products. We investigate this by using an additional dummy that takes the value of one if the product is produced with a relatively low marginal cost compared to other producers. This dummy is then interacted with the one used above, and 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. That is, the results on product level replicate our findings on firm level when it comes to a heterogeneous response pattern.

To sum up, our finding that import competition leads to a decline in marginal costs is in line with the findings by Dhyne et al. (2017). Using data on Belgian producers,

Table 6: 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** (0.006)	0.002 (0.003)	0.014** (0.006)	-0.012* (0.006)	0.002 (0.003)	0.014** (0.006)
$IC_{jt}^{f10md} \times lip_0$	-0.011** (0.005)	-0.007*** (0.003)	0.004 (0.005)	-0.010* (0.005)	-0.007** (0.003)	0.003 (0.005)
$IC_{jt}^{f10md} \times lip_0$ $\times lmc$				-0.093*** (0.005)	-0.025*** (0.002)	0.068*** (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. All specifications include lagged production volume. All standard errors are clustered on firm level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 7: Portfolio adjustment and import competition

	Drop	
	(1)	(2)
IC_{jt}^{5md}	-0.007 (0.011)	-0.061*** (0.022)
$IC_{jt}^{5md} \times \text{Rank}$		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. $\text{Rank} = \{0,1,2,3\}$, where rank 3 indicates lowest revenue share. All specifications include lagged production volume. All standard errors are clustered on firm level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

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 level (see extensive overview of this literature in Holmes and Schmitz 2010). To explore some possible mechanisms behind firms response of improving efficiency when they face more competition from abroad, we focused on the heterogeneity across firms and products.³⁷ First, we have shown that import competition might induce a change in firms' production baskets by dropping fringe products. Second, analogous to how a multi-product firm relocates inputs to the most efficient products within its portfolio (leading to firm-level gains in efficiency), product-level gains in efficiency might occur *within* finer product groups. While our analysis is already on very fine product level (8-digit HS-code), there might still be room for improvements leading to product-level gains in efficiency. These gains may stem from product-level upgrades and/or elimination of X-inefficiencies due to innovations within the firm (e.g. product and/or process innovations and the use of new inputs or materials) as discussed in Dhingra (2013) and Eckel et al. (2015). Our results in

³⁷An additional source of heterogeneity may stem from a 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 C4 provide evidence suggestive of such an upgrade and are, therefore, in line with this argument.

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 revenue figures, 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 with an average of approximately 1%. The importance of the spatial pattern of buyer-seller networks is also emphasised 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.

We do also find a highly heterogeneous response pattern across firms and products. First, the increase in efficiency (i.e. the fall in product-level marginal cost) is larger for more productive firms, and they transmit these improvements to both lower prices and higher markups. Second, firms tend to drop fringe products as import competition increases, while core products are more likely to survive. Third, we find that firms with products undercut by lower import prices in their proximity respond by a greater fall in prices, but that efficiently manufactured products resist this competitive pressure.

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Appendices

A Descriptive Statistics

B Estimation of markups and marginal costs

To estimate markups and marginal costs on product level we closely follow De Loecker et al. (2016).³⁸ 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:

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

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 that require adjustment costs), ω_{ft} is firm's total factor productivity (TFP), and ϵ_{fjt} captures unexpected shocks to 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. Implication of the assumption is that production technology used to manufacture product j is common across all firms, irrespective of whether the firms are single- or multi-product.³⁹ Second, productivity ω_{ft} is firm-specific.⁴⁰ Next, firm-level expenditure is a sum of product-level expenditure. That is, $W_{fjt}^v V_{fjt}^v = \tilde{\rho}_{fjt} \sum_j W_{fjt}^v V_{fjt}^v$, where $\tilde{\rho}_{fjt}$ is the share of firm expenditure on product j , so that $\sum_j \rho_{fjt} = 1$.⁴¹ Note, that this framework imposes no assumptions on market conduct or the demand system.

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

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

³⁸While the main empirical analysis 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.

³⁹Note 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.

⁴⁰For an alternative approach to modelling productivity on product level see Dhyne et al. (2017).

⁴¹Again, a stricter form of this assumption is not new to the literature (De Loecker 2011; Foster et al. 2008).

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

$$\frac{\partial \mathcal{L}_{fjt}}{\partial V_{fjt}^v} = W_{fjt}^v - \lambda_{fjt} \frac{\partial Q_{fjt}}{\partial V_{fjt}^v}. \quad (3)$$

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

$$\frac{\partial Q_{fjt}(\cdot)}{\partial V_{fjt}^v} \frac{V_{fjt}}{Q_{fjt}} = \frac{1}{\lambda} \frac{W_{fjt}^v V_{fjt}}{Q_{fjt}}. \quad (4)$$

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:

$$\mu_{fjt} = \frac{\partial Q_{fjt}}{\partial V_{fjt}^v} \frac{V_{fjt}}{Q_{fjt}} \left(\frac{P_{fjt} Q_{fjt}}{W_{fjt}^v V_{fjt}^v} \right) = \theta_{fjt}^v (\alpha_{fjt}^v)^{-1}, \quad (5)$$

where θ_{fjt}^v is the output elasticity of variable input V_{fjt} and α_{fjt}^v 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 markups:

$$mc_{fjt} = \frac{P_{fjt}}{\mu_{fjt}}. \quad (6)$$

Thus, to obtain the markups and, in turn, marginal costs, we need two terms α_{fjt}^v and θ_{fjt}^v . $P_{fjt} Q_{fjt}$ (denominator of α_{fjt}^v) is available in the data. $W_{fjt}^v V_{fjt}^v$ (numerator of α_{fjt}^v) and θ_{fjt}^v 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:

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

where q, v, k denote logs of correspondingly physical output, variable inputs, and fixed inputs. As it is standard in the literature, we assume that coefficients in the production function are time-invariant, which is reflected in the notation. It is possible to specify ω_{ft} as varying on firm-product-time level. However, this would compromise the ability to recover input allocation shares, which is critical for derivation of product level markups and marginal costs.

Equation (7) relates physical output on product-level q_{fjt} to the product level inputs $\mathbf{x}_{fjt} = \{\mathbf{v}_{fjt}, \mathbf{k}_{fjt}\}$. Physical output q_{fjt} is observed in the data. However, physical inputs \mathbf{x}_{fjt} are unobserved and the best available counterparts to \mathbf{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 \mathbf{x}_{fjt} are related to monetary values for inputs (denoted as \tilde{x}_{ft}) in the following way:

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

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:

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

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

To deal with input allocation bias $A(\cdot)$, 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 inclusion of ρ_{fjt} , nor is product-level index j necessary:

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

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 to 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.⁴² Hence, input quality is recovered with the help of the output prices.

⁴²This idea has found broad support in both theoretical and empirical literature (Kremer 1993; Kugler and Verhoogen 2012; Manova and Yu 2017; Manova and Zhang 2012). De Loecker et al. (2016) further show that this assumption fits a large set of theoretical models.

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 labour market to account for possible effects of imports on input prices.

Productivity ω_{ft} is potentially observed and predicted by firms, but unobserved to 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 Akerberg 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. Production function is then estimated using a two-step GMM as suggested by Akerberg 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 endogenised, 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 $f(\cdot)$. We specify $f(\cdot)$ as

translog.⁴³ 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 labour, intermediate inputs, and capital.⁴⁴

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

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

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 $W_{fjt}^v V_{fjt}^v = \tilde{\rho}_{fjt} \sum_j W_{fjt}^v V_{fjt}^v$. 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 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

⁴³ $f(l, k, m) = \beta_l l + \beta_k k + \beta_m m + \beta_{ll} l^2 + \beta_{kk} k^2 + \beta_{mm} m^2 + \beta_{lk} lk + \beta_{lm} lm + \beta_{km} km + \beta_{lkm} lkm + \omega_f$

⁴⁴We measure labour 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 machine, equipment and buildings. These variables are deflated with the two-digit producer price index.

Table C1: Robustness: Additional controls for competition

	Marginal Cost			
	Whole sample			Imp. Share < 0.1
	(1)	(2)	(3)	(4)
IC_{jt}^{5md}	-0.116** (0.047)	-0.118** (0.047)	-0.115** (0.047)	-0.118*** (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. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

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

	Marginal Cost				
	(1)	(2)	(3)	(4)	(5)
IC_{jt}^{10m}	-0.117** (0.052)	-0.109** (0.048)			
IC_{jt}^{10d}		0.045 (0.031)	0.657* (0.340)		
IC_{jt}^{10md}				-0.099** (0.044)	-0.105** (0.046)
Observations	13554	13554	13554	13554	13155
Adjusted R^2	0.93	0.93	0.92	0.93	0.44
F-stat. (1st st.)	90.44	112.36	17.37	142.64	32.64
Firm-product FE	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	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. *** $p < 0.01$, ** $p < 0.5$, * $p < 0.1$

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

	Marginal Cost				
	(1)	(2)	(3)	(4)	(5)
IC_{jt}^{1m}	-0.057* (0.030)	-0.062* (0.032)			
IC_{jt}^{1d}		0.034** (0.015)	-0.431* (0.243)		
IC_{jt}^{1md}				-0.066* (0.036)	-0.140*** (0.049)
Observations	13554	13554	13554	13554	13155
Adjusted R^2	0.93	0.93	0.92	0.93	0.39
F-stat. (1st st.)	70.24	64.59	12.60	50.69	26.24
Firm-product FE	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	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: 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. *** $p < 0.01$, ** $p < 0.5$, * $p < 0.1$