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# Labor-share dynamics:

## The role of import competition

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# Labor-share dynamics: The role of import competition[a]

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**Abstract**

Does increasing product-market competition from foreign firms affect domestic labor shares? By combining detailed Swedish firm-level data with an instrumental variable design, I show that an increase in import penetration caused by increased global competition results in a decrease in domestic industry-level labor shares. The decrease comes both from a reallocation of firms' market shares and a fall in labor shares at the firm level. The analysis shows that the negative effect of competition on firm-level labor shares is driven by an increase in productivity that is not met by a corresponding increase in compensation to labor. I use these findings to calibrate a heterogeneous-firm model where domestic and foreign firms compete on the domestic product market. The calibrated model predicts that an increase in foreign competition corresponding to a one standard deviation increase in import penetration results in a 1.12 percentage point increase in welfare.

**Keywords**: Labor Share, Competition, International Trade, Welfare.
**JEL codes**: E25, L11, F10.

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# Contents

# 1 Introduction

The share of value added paid as compensation to labor is a key statistic for understanding the distribution of income. For a long time, the consensus view among economists, first formulated by Kaldor (1957), was that this share is constant over time. However, recent studies such as Karabarbounis and Neiman (2014) have challenged this view by documenting a decline in the labor share across the world. In light of this, there is a need for understanding what forces shape the long-term dynamics of the labor share. One potentially important cause for changes in labor shares is changes in product-market competition. Despite theoretical predictions of changes in competition on labor shares, there is a lack of evidence on how labor shares are affected by competition. In this paper, I investigate the empirical relationship between increasing product-market competition and changes in labor shares using Swedish micro-level data on manufacturing firms. Specifically, I investigate 1) Does higher competition affect labor shares by inducing a reallocation of market shares between firms? 2) Does competition affect the labor share within firms? 3) Does it affect labor shares through the exiting and entering of firms? and 4) What role do relative changes in labor productivity and compensation play? Furthermore, I use the empirical findings to calibrate a heterogeneous-firm model, enabling me to quantify the effect of increased product-market competition on welfare. The results show that an increase in product-market competition causes a fall in industry-level labor shares and an increase in welfare.

The first part of this paper thus contributes with direct empirical evidence on the relationship between competition and labor shares. Several studies have documented a positive correlation between increasing market concentration and falling labor shares (see, e.g., Autor et al., 2020; Lashkari et al., 2019), raising the question of the role of competition. However, there is a lack of direct evidence of the relationship between competition and labor shares. In this study, looking at changes in import competition using an instrument variable approach, I analyze the effect of exogenous changes in competition on labor shares using a more direct measure of competition than previously used.[1]

Furthermore, the paper contributes to a better understanding of the mechanism behind the relationship between labor shares and product-market competition by looking separately at how competition affects labor shares within firms and how it affects the market allocation across firms. How competition affects labor shares is theoretically ambiguous. On the one

[1] Indeed, previous studies have interpreted observations of increases in market concentration as a fall in competition (e.g. Barkai, 2020; Gutiérrez and Philippon, 2017) as well as a rise in competition (e.g. Autor et al., 2020). Hence, it is not clear what changes in competition the changes in market concentration actually reflect.

hand, there is a tight theoretical connection between markups and labor shares, suggesting a positive relationship between competition and firm-level labor shares. In more competitive environments, firms have lower market power since they face a higher elasticity of demand, resulting in lower markups (price over marginal cost) and higher labor shares among firms. Hence, falling labor shares could be an indication of lower competitive pressure and an increasing ability of firms to extract high rents (markups) at the expense of labor. On the other hand, in more competitive environments, a higher demand elasticity may result in a reallocation of production toward high-productivity firms. Since high-productivity firms generally have low labor shares, a reallocation of market shares toward these firms results in a decrease in the aggregate labor share. This mechanism has been proposed as an important cause behind falling labor shares by e.g., Autor et al. (2020). Other studies have shown that competition has positive effects on firm-level productivity, e.g., Backus (2020), which could potentially affect labor shares. What relative importance these different factors play for the effect of competition on labor shares is an empirical question that has not yet been resolved.

Clarifying the effect of competition on labor shares is motivated by the importance of understanding welfare implications and potential policy interventions. If a decrease in labor shares is the result of a decrease in competition, this could imply a less efficient economy and call for policy interventions. In contrast, if a decrease in labor shares is the result of higher competition and a reallocation of production towards the most productive firms, this could reflect a more efficient economy.

The variation used in the analysis is differences in changes in import penetration between 4-digit industries. I identify changes in import penetration that reflect exogenous increases in foreign competition using an instrument-variable (IV) approach. Specifically, following Autor et al. (2013), changes in domestic import penetration are instrumented with changes in industry-level imports to other countries, which are assumed to face the same increase in global competition, such as the increasing competition from China. Hence, the focus lies on changes in import penetration stemming from exogenous increases in the supply of foreign goods to the domestic market, which I interpret as increased import competition. The results show that an exogenous increase in import penetration causes a fall in industry-level labor shares. Specifically, the analysis shows that a one percentage point increase in import penetration causes a decrease in the industry-level labor share of around one percentage point. This fall is partly due to a reallocation of market shares between existing firms within the industry. However, the analysis also shows that an increase in import competition causes a fall in the labor share at the firm level.

To better understand the channels through which competition affects the labor share, the labor share is decomposed into two sub-components: labor costs and labor (revenue) productivity. With firm-level data on value added, labor costs and the number of employees, I show that an increase in import competition has a significant positive effect on productivity, both within firms and through reallocation, but no effect on wages.

To interpret the empirical results and evaluate the welfare implications, the second part of the paper presents a two-country trade model with heterogeneous firms in the spirit of Melitz and Ottaviano (2008). The key elements of the model are 1) that there are three sectors, one of which produces intermediate inputs, and labor is fully mobile across sectors; 2) in the intermediate-good sector heterogeneous firms are exposed to international trade and face a Melitz and Ottaviano (2008) demand schedule, yielding a demand elasticity that is decreasing in firm size, which translates into markups that increase with the size of the firm; and, importantly, 3) intermediate-good firms have the possibility to invest in productivity improvements. This last feature is a main deviation from the standard model, where the only source of productivity improvements is reallocation of production across heterogeneous firms. The reason for including a possibility for firms to invest in productivity improvements is motivated by the empirical findings of a positive effect of competition on firm-level productivity. I calibrate the model to match features of the productivity distribution and the estimated responses in productivity from changes in import penetration in the Swedish firm-level data.

When comparing my model to a more standard Melitz and Ottaviano (2008) model, I show that the inclusion of a possibility for firms to increase productivity is essential for explaining labor productivity improvements within firms and has important implications for welfare. In the model, a higher import penetration is generated by an increase in foreign productivity, which results in higher competitive pressure on the domestic product market. To interpret my empirical findings in the model environment, I evaluate the welfare consequences of exogenously increasing the productivity of foreign firms. When evaluating the effect on welfare, comparing a low and high import-penetration state, welfare is positively affected by an increase in foreign productivity. Specifically, an increase in foreign productivity corresponding to a one standard deviation increase in import penetration (a 6 percentage point increase) results in a 1.12 percentage point increase in welfare. The welfare effect in the baseline model could be compared to a model without investment possibilities for firms, in line with the standard Melitz and Ottaviano (2008) model, where a higher import competition results in a small welfare loss.

In sum, the paper shows that a rise in import penetration causes a fall in industry-level labor shares, both within firms and through reallocation of market shares across firms. My findings confirm the hypothesis that an increase in competition causes a reallocation of market shares toward low labor share firms. However, the theoretical prediction of an increase in labor share within firms is rejected by the empirical analysis. This is explained by an increase in productivity without an increase in wages. I suggest a model where firms respond to changes in competition by learning from their competitors, and thereby become more productive, which allows firms to increase markups despite an increase in the demand elasticity. The calibrated model shows that incorporating this channel is first-order important for understanding the welfare consequences of increased product-market competition.

The following section provides a background and an overview of the previous literature. Section 3 presents the empirical strategy and data. Section 4 presents the empirical results. Sections 5 and 6 present the theoretical model and outcome, and Section 7 concludes.

## 2 Relation to previous literature

A key contribution of this paper is to provide a better understanding of the underlying mechanisms behind the relationship between industry-level labor shares and import competition. Essentially, industry-level labor shares can change in two ways. First, labor shares can change through changes in labor shares within firms. Second, industry-level labor shares can change through the process of market selection in the presence of differences in labor shares between firms. It is well established that firms differ in terms of productivity, pricing and wages, even within narrowly defined industries (Bartelsman and Doms, 2000; Lach, 2002). Indeed, studies using firm-level data show that understanding changes in the composition of firms within industries is important for understanding the fall in industry-level labor shares (Kehrig and Vincent, 2021; Autor et al., 2020). By analyzing the reallocation of production across firms and firm-level changes separately, this paper sheds light on the relative importance of these components for the effect of import competition on industry-level labor shares.

To further understand the effect of import competition on labor shares, it is useful to recognize that firm-level labor shares can change for several reasons. The labor share, defined as total labor cost over value added, can be expressed as the ratio between labor cost per employee over labor revenue productivity (value added per employee), which can further be split into physical labor productivity and the price. When describing the labor share in terms of cost per unit of labor, physical labor productivity or the price of products, it is clear that a movement in the labor share requires a disproportional change in any of these components. For example, the labor share falls if there is an increase in prices without a proportional increase in labor costs or decrease in productivity (as in the case when markups go up).

Similarly, an increase in labor productivity without a corresponding increase in wages or fall in prices implies a fall in the labor share. The previous literature is inconclusive regarding the relative role that changes in these components play for changes in labor shares. Most of the recent literature focuses mainly on one of the components, trying to find explanations in changes in firm markups, technological changes or a weakening of the bargaining power of labor. For example, Acemoglu and Restrepo (2018) and Karabarbounis and Neiman (2014) emphasize the role of capital as an increasingly important factor in production[2], Elsby et al. (2013) present globalization, and more specifically off-shoring of labor-intensive activities, as a main cause, and Autor et al. (2020) and Gutiérrez and Philippon (2017) argue that changes in product-market competition are an important factor. The contribution of this paper is to provide additional input to the understanding of the effect of competition as one potential factor affecting labor shares. By decomposing changes in labor shares following an increase in import penetration to effects on revenue productivity and labor costs, this paper contributes to a better understanding of which role these different components play.[3]

There are several reasons why competition might play an important role in changes in labor shares. On the theoretical side, changes in competition are expected to affect the elasticity of demand, resulting in changes in both markups and the allocation of market shares across firms. On the empirical side, a common finding is a tight association between falling labor shares and a rise in market concentration, a measure often used as a proxy for competition. This paper contributes to this empirical literature by using a more direct measure of competition. Instead of focusing on changes in market concentration, this study analyzes if the effect of tougher competition, in the form of higher import penetration, is associated with a change in labor shares. The disadvantage of using concentration as a measure of competition is that it is ambiguously related to competition. Indeed, several studies have interpreted observations of increasingly concentrated markets, where a few large firms are capturing an increasing share of the market, as a decrease in competition. One example is Barkai (2020), who argues using data on concentration that it is a decrease in competition that enables firms to increase their markups and retain higher profits at the expense of the labor share. Gutiérrez and Philippon (2017), Gutiérrez and Philippon (2018) and Grullon et al. (2019) argue that domestic competition has declined in many U.S. industries because of increasing entry costs, lax antitrust enforcement, and lobbying. Akerman (2018) finds that markets have also become more concentrated in the manufacturing industries in Sweden. At the same time, international trade has increased in importance and world markets have be-

[2]The argument of a capital-augmenting technological change causing a fall in labor shares hinges on on the assumptions of an elasticity of substitution between effective capital and labor above one, which is not an unquestioned assumption.

[3]Optimally, we would also have data on product prices at firm level to distinguish between the role of physical labor productivity and pricing.

come more integrated.[4] These changes are expected to increase product-market competition. An increase in competition is highlighted in Autor et al. (2020), who attribute the decrease in labor share to an increase in market concentration caused by tougher product-market competition. They argue that the increase in competition raises the demand elasticity that firms face, which enables the most productive firms to increase their market share at the expense of less productive competitors. Hence, as the discussion above makes clear, there is no consensus on how concentration relates to competition, which makes it a poor measure of competition. It is therefore also unclear what the observed correlation between increasing market concentration and falling labor shares tells us about how labor shares are affected by competition. This paper contributes to this empirical literature by using a more direct measure of competition in the form of import penetration.

As described in the introduction, it is unclear what effect a change in competition has on the labor share and through what microeconomic channel it may affect the labor share. The analysis of the decomposition of changes in labor shares into revenue productivity and labor costs shows that an increase in productivity is a driving factor of the effect of import competition on labor shares in the empirical analysis. Specifically, tougher import competition causes an increase in labor productivity, but no increase in the compensation to labor. An effect of changes in import competition on productivity is not a new finding, and the relationship between import competition and productivity is an old subject. For a review of theories and empirical evidence on the relationship between innovation, competition and market structure see, e.g., Cohen (2010) or Gilbert (2006). However, despite extensive research, the previous literature provides neither a consensus on the exact mechanism through which foreign competition affects domestic productivity nor what the size of the effect is. Levinsohn (1993) provides the imports-as-market-discipline hypothesis explaining the disciplinary affect of imports on markets, pushing down markups by extension increasing productivity. A recent empirical study showing a significant positive effect of competition on firm-level productivity is Backus (2020). Other studies emphasize the role of reallocation and market selection as drivers behind a positive association between competition and productivity (see, e.g., Eslava et al., 2013) or the combination of firm-level effects and reallocation (see, e.g., Pavcnik, 2002). The empirical analysis of this paper shows that productivity is positively affected by competition both through changes within firms and through a reallocation of market shares across firms.

In the model presented, I therefore allow productivity to be affected by competition both at the firm level and through reallocation. Further, firms are assumed to produce at an efficient

[4] In Sweden, imports and exports as a share of GDP have increased from about 30 percent in the early 1990s to around 45 percent in 2018 (SCB, Nationalrakenskaperna).

level, but the potential to increase efficiency increases with the average productivity of the stock of competitors. This type of technology diffusion is inspired by the set-up in Lucas and Moll (2014), where agents allocate time between producing and searching for new ideas from the pool of productivities among other agents in the economy. When the overall productivity in the economy increases, firms have a larger potential to increase their own productivity by learning from their competitors. The theoretical contribution of this paper is to highlight the role of productivity changes in understanding changes in labor shares and to introduce a channel of productivity improvements at the firm level in a Melitz and Ottaviano (2008) type of model.[5]

# 3 Empirical strategy

The aim of the empirical analysis is to understand what effect increased competitive pressure on the domestic product market, caused by foreign firms, has on industry-level labor shares. The following section presents the strategy and data used answer this question.

## 3.1 Decomposition: Shift-share analysis

To analyze the effect of competitive pressure on labor shares, aggregate industry-level labor shares are decomposed into four different components. Specifically, the decomposition is done, at the industry level, following the generalized Olley-Pakes decomposition by Melitz and Polanec (2015):

$$\underbrace{\Delta LS}_{\Delta LS^{tot}} = \underbrace{\Delta \bar{LS}_I}_{\Delta LS^{within}} + \underbrace{\Delta \Big[ \sum_i^I (\omega_i - \bar{\omega}_I) \cdot (LS_i - \bar{LS}_I) \Big]_I}_{\Delta LS^{reallocation}} + \underbrace{S_{X,t-1}(LS_{I,t-1} - LS_{X,t-1})}_{\Delta LS^{exit}} + \underbrace{S_{E,t}(LS_{E,t} - LS_{I,t})}_{\Delta LS^{entry}}, \quad (1)$$

where $\Delta LS$ is the total change in industry-level labor share, $LS_i$ is the firm-level labor share and $\omega_i$ is the firm-level market share out of total industry value added.[6] The subscript $I$ stands for incumbents, $X$ for exiting firms, $E$ for entering firms, and $S_X$ and $S_E$ stands for the market share of exiting and entering firms, respectively. Variables with a bar represent industry averages. The first two terms capture the change in labor share among firms that

[5] In the standard Melitz and Ottaviano (2008) model, competition only affects productivity though firm selection and reallocation of market shares across firms.

[6] The decomposition was originally developed to study productivity but has been also applied to study changes in labor shares in e.g., Autor et al. (2020)

are active both at the start and the end of the period. The first term is the change in the unweighted average firm-level labor share among incumbents. The second term captures the change in the covariance between firm size and firm labor share for incumbents, generally thought of as capturing the effect of reallocation. This reallocation component affects the labor share negatively if firms with a labor share below the industry-average labor share grow in market size or large firms decrease their labor share more than the average firm. The two last terms capture the effect of exiting and entering firms on the aggregate industry-level labor share, respectively.

Hence, the decomposition gives us industry-level measures of each separate component that can contribute to a change in the aggregate industry-level labor share. The effect of changes in import competition is then analyzed by separately running regressions with changes in import penetration as explanatory the variable on the total change in labor share as well as the within, reallocation, exit and entry components using the cross-section and time variation of the data at the 4-digit industry level. Specifically, the following regression is run:

$$\Delta y_{s,t} = \beta \Delta IPR_{s,t} + \gamma_t + u_{s,t}, \tag{2}$$

where $\Delta y = \{\Delta LS^{tot}, \Delta LS^{within}, \Delta LS^{reallocation}, \Delta LS^{exit}, \Delta LS^{entry}\}$, $\gamma_t$ is a time dummy, and $\Delta IPR_{s,t}$ is the change in import penetration used to capture changes in foreign competitive pressure as will be discussed further below.[7] Thus the identifying variation comes from differences in changes in import competition across industries over time. The regressions are run separately on five-, eight- and ten-year changes using a rolling regression approach, i.e., for the ten-year horizon, one observation will be the difference in labor share and import penetration between years 1998 and 2008 and the next observation will be the difference between 1999 and 2009.[8] As this approach introduces correlations between observations within industries, standard errors are clustered at the 4-digit industry level. The same decomposition analysis is performed on the labor cost and labor productivity components where instead of the labor share in equation (1) we look at labor revenue productivity and labor cost.

[7] Because the regression is run on differenced variables, there is no need to include industry dummies to control for potential effects driven by industry-specific differences in levels.

[8] Although the focus is on long-term changes, the eight- and five-year horizons are included in the analysis to also show the effect in shorter horizons. The reason for not using a longer time horizon is that it results in few time periods to analyze.

### 3.2 Measure of import competition

Foreign competitive pressure is captured by industry-specific import penetration ratios, measuring the extent of competition from imports. The import penetration ratio is defined as

$$IPR_{t,s} = \frac{M_{t,s}}{(Y_{t,s} + M_{t,s} - X_{t,s})} * 100, \tag{3}$$

where $M_{t,s}$ is total imports of goods produced in industry $s$ in year $t$. $Y_{t,s}$ and $X_{t,s}$ are the production and exports in industry $s$ in year $t$, respectively. The ratio shows to what extent demand for goods on the domestic market is met by foreign rather than domestic production.

A country whose domestic consumption to a large extent is met by foreign imports will have a high import penetration, while a country whose domestic consumption is met by domestic goods will have a low import penetration. Industries with high relative productivity and high international competitiveness are expected to have high domestic consumption and low imports and, hence, low import penetration ratios. The import penetration ratio can also reflect differences in trade policies or trade costs. Through all these channels, the import penetration can be interpreted as a measure of the degree of competitive pressure from abroad. This latter aspect, when import penetration captures the competitive pressure, is the reason for using it in this study. To make statements about the causal effect of changes in product-market competitive pressure from imports on domestic labor shares, we need to purge the changes in import penetration from other factors unrelated to foreign competition. To be more specific, we only want to capture the part of changes in import penetration that is driven by an increase in productivity of trading partners or reduced trade costs. To isolate the exogenous effect of competition, an instrumental variable approach is used, which is described next.

### 3.3 Instrumental variable approach

Before presenting the choice of instrument, we take a closer look at the threats to identifying the impact of import competition on domestic labor shares using changes in domestic import penetration ratios directly. In particular, we want to know the impact of changes in competitive pressure from imports on changes in labor shares at the industry level. To this end, we could estimate equation (2) using OLS, where $u$ may contain unobserved domestic shocks and $\Delta IPR$ is aimed to capture changes in foreign competitive pressure. However, consider a case with local industry labor-market shocks affecting domestic wages. A rise in wages, which would be captured by the error term in equation (2), could lead to an increase in demand for cheaper imported goods, implying an increase in import penetration, and the necessary assumption of $\text{Cov}(\Delta IPR, u) = 0$ for the OLS estimates to be valid fails. In this example, we would have a positive bias in the OLS estimate of changes in import competition on the labor share, $\beta_1$. The presence of any such domestic unobserved industry-level shock is potentially problematic.

Hence, to identify the international supply-driven component of changes in imports and isolate the exogenous effect of import penetration stemming from a trade-induced increase in competition, we need to purge the effects from domestic shocks. To do this we need an instrument that is correlated with changes in domestic import penetration but uncorrelated with domestic shocks. Here, I follow Autor, Dorn and Hanson (2013) and consider imports to other countries. More specifically, my instrument is changes in industry-level imports to other high-income countries. The motivation for instrumenting with imports to other high-income economies is that these countries are expected to be exposed to the same intensification in world trade as Sweden, but face different domestic shocks. In other words, if imports increase because of increased productivity in other countries and/or market access to them, and not because of domestic factors, industry-level imports should also increase to other industrialized countries. For example, tougher global competition as a result of the increasing presence of China in world markets should induce a supply shock and rising imports to all trading partners, and not only to Sweden.

For the instrument to be valid, it should affect domestic import penetration only through increasing global competitive pressure and not have any independent effect on domestic industry-level labor shares. Following Autor, Dorn and Hanson (2013), the list of potential instrumenting countries are other developed countries with a similar economic standard. For example, import flows to neighboring countries could be good candidates as instruments, considering the similar production structure giving rise to a large coverage of Swedish industries. However, demand shocks in these countries are likely to be too similar to those in Sweden through e.g., trade and policy inter-linkages. It is also likely that industry shocks to neighboring countries have direct effects on Swedish labor shares by influencing the wage setting in Sweden. For the same reason, countries within the European Union are problematic.[9] Imports to all direct neighbors and countries closely connected with Swedish policies and markets, such as other European Union members, are therefore excluded as potential instruments. The countries that remains are Canada, Japan, New Zealand, Australia, and

[9]Potential direct links between wage changes in Sweden and Germany and other European countries are confirmed in e.g. Westermark (2019).

Switzerland.[10] This reasoning follows that in Dauth et al. (2014), who study trade exposures in Germany using an instrument group consisting of developed, non-neighboring countries with a similar income level. Specifically, a linear combination of changes in industry-level log imports in the above mentioned countries is used as an instrument for changes in Swedish industry-level import penetration ratios. The F-statistic in the first-stage regression confirms that the instrument is relevant in the sense that it has explanatory power for changes in domestic import penetration.[11] The results are robust to using varying subsets of these countries.

Changes in domestic import penetration ratios are instrumented with changes in imports to other countries rather than using measures of their import penetration ratios, because of data limitations. Using import penetration ratios for the instrumenting countries requires data on imports, exports and production. Due to poor production data at the detailed industry level for the whole sample period, this measure is not possible for the set of candidate countries discussed above. Therefore, I rely on changes in imports instead.

## 3.4 Data

The empirical analysis requires firm-level production data (value added, labor input, labor cost) and industry-level data on trade flows. The particular data and sources are described in the following section.

### 3.4.1 Firm-level data

The firm-level data is based on register data on all Swedish private-sector manufacturing firms between 1997 and 2016.[12] The data contains financial statements and production data obtained from administrative records together with industrial belonging up to a 5-digit level. In this paper the analysis is performed on the 4-digit level, consistent with the highest level of disaggregation feasible in the trade data.[13] The variables used to compute labor shares at

[10] The U.S. is excluded as a potential candidate due to its high significance in the international market.

[11] The first-stage F-statistic is 14.80, 11.15 and 11.66 for the 5-, 8- and 10-year changes, respectively.

[12] Although firm-level data is available for the entire private sector, the analysis is restricted to the manufacturing industry. This restriction is made because the available industry-level data on imports that is needed for the analysis is not good enough for other industries. Specifically, trade data from service industries are available from UN Comtrade, but the coverage and quality are too poor to use for a decent analysis.

[13] The trade data is reported at product level and could in theory be converted to a more detailed industry level. However, the available correspondence tables used to convert product-level observations to industry

the firm level are the sum of total labor costs and value added. Measures of labor (revenue) productivity and wages are computed as firms' value added over number of employees and total labor costs over number of employees, respectively. Industry-level measures are computed as the weighted sum of firm-level measures, where the weights represent firms' share of value added within the 4-digit industry.

A few restriction are made to the raw data. First, only employing firms with at least two employees are included. This restriction is applied because labor shares in firms with only one employee, such as sole traders or self-employed, are likely to reflect other factors, such as tax incentives, rather than the forces affecting the underlying fundamental divisions between labor and capital that I aim to capture. Second, firms with a labor share (or value added) below 0 and firms with a labor share above 4 are dropped to exclude the possibility of influence from extreme observations.[14]

### 3.4.2 Sector-level data

Data on imports and exports at the industry level comes from UN Comtrade. Industry-level production data for Sweden is aggregated from the firm-level data. The analysis is restricted to only include data on products for which imports and/or exports are reported in both time periods, i.e., only trade at the intensive margin is considered. This restriction is applied since it is not possible distinguish a new product appearing in the data as a new product being traded from a change in the detail level of the reporting. When using data from countries other than Sweden, only products that are also traded in Sweden are considered to avoid industry-level changes in import penetration ratios that are due to products not traded in the Swedish market. The data from Comtrade is in USD while the Swedish firm-level data is in the national currency, Swedish kronor (SEK). For consistency, the data on Swedish trade flows has been converted to SEK.

The data sources report data by different classification systems: production data by SNI codes and trade data by HS 6-digit product codes. To convert the data to a common classification system, 4-digit SNI 2002 (equivalent to NACE rev.1.1), available correspondence tables have been used.[15] More specifically, the conversion is made as follows: HS02→ SIC87→

categories set the limit of the analysis to the 4-digit level.

[14] In the data, the labor share of some firms tends to be very high due to very low value added. This is a well-known phenomenon when using firm-level data, and to avoid these observations influencing the results, they are excluded in the analysis.

[15] Most of the correspondence tables are available at the Eurostat Reference And Management Of Nomenclatures (RAMON); the HS02 to SIC87 is available at David Dorns website (https://www.ddorn.net/data.

NAICS2002→ NACE1.1→ SNI2002. A problem with the conversion between different classifications is the loss of some industries. In the final matched sample, about 90 out of 115 manufacturing industries are covered. Out of the matched sample, the sectors that do not trade during the whole sample period or have fewer than 10 active firms in each year are excluded.[16] Although this means that some industries are dropped, the sample has a large coverage in terms of value added and employment. In the end, the final sample consists of 70 manufacturing sectors, covering about 68 percent of total value added in the manufacturing sector and 63 percent of manufacturing employment.

#### 3.4.3 Descriptive statistics

Table 1 shows summary statistics of the import penetration ratio and labor share at the industry level as well as of ten-year changes in industry-level import penetration, labor shares, and the different components of changes in labor shares. To reduce the risk of relying on short-term variations in import penetration ratios and labor shares, each yearly observation at the industry level is computed as a three-year moving average when computing changes over time.[17] The numbers in Table 1 show the mean and distributional moments across industries (averaged over time). Looking at the first panel (A), we can see that the industry-level import penetration is on average about 25 percent but with substantial variation across sectors. When it comes to labor shares, the average (unweighted) labor share tends to be higher than the industry aggregate (weighted) labor shares. The difference indicates that large firms tend to have lower labor shares. For the empirical analysis in this paper, it is the changes in the second panel (B) that are of relevance. As can be seen, there is large variation across sectors when it comes to changes in import penetration and labor shares as well as the sub-components of labor shares.

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htm).

[16]The reason for excluding industries with fewer than 10 firms is to avoid the reallocation term to capture changes between single firms, for example as would happen with the entrance of a new firm in a single-firm industry. The results are robust to also including industries with fewer firms.

[17]The overall results remain intact when looking at observations for single years.

**Table 1:** Industry-level labor share and import penetration (level and changes)

| | **Mean** | **Median** | **p25** | **p75** | **Min** | **Max** | **Sd** |
|---|---|---|---|---|---|---|---|
| *A. Level (average across sectors)* | | | | | | | |
| IPR | 24.57 | 18.74 | 8.80 | 34.57 | 0.05 | 97.47 | 20.65 |
| LS (weighted) | 73.99 | 75.28 | 68.09 | 80.88 | 21.67 | 207.98 | 13.49 |
| LS (unweighed) | 82.65 | 82.63 | 78.20 | 86.71 | 58.76 | 132.31 | 7.58 |
| *B. 10-year change (average across sectors)* | | | | | | | |
| $\Delta$ IPR | 2.89 | 2.12 | -.82 | 8.04 | -34.92 | 31.49 | 9.66 |
| $\Delta$ LS$^{Total}$ | -1.59 | -1.64 | -6.80 | 3.76 | -63.55 | 48.48 | 10.73 |
| $\Delta$ LS$^{reallocation}$ | -2.58 | -1.66 | -6.14 | 1.96 | -71.67 | 56.70 | 9.92 |
| $\Delta$ LS$^{within}$ | 1.21 | 0.81 | -2.37 | 4.23 | -18.57 | 44.45 | 7.05 |
| $\Delta$ LS$^{entry}$ | 0.04 | 0.01 | -0.03 | 0.06 | -9.37 | 5.74 | 0.79 |
| $\Delta$ LS$^{exit}$ | -0.26 | 0.11 | -0.47 | 0.11 | -27.71 | 16.09 | 2.33 |

Panel A. shows how industry-level import penetration and aggregate industry-level labor shares are distributed in data (for in total 70 manufacturing sectors between the years 1998–2016). Panel B shows the average change in industry-level import penetration and labor share. Change in labor share is presented both as the total change (total) and changes in firm-level averages within sectors (within) the covariance terms (reallocation) and the exit and entry components. All numbers are computed on an annual basis and then averaged over the sample period

# 4 Results

## 4.1 OLS

The result from the OLS regressions are displayed in Table 2. All entries correspond to a separate regression. The columns give the dependent variable, changes in total labor shares or any of the sub-components. The rows represent the time horizon that changes are computed at, five-, eight- or ten-year changes. Looking at the first column (1), the coefficient for changes in total labor share on the change in import penetration is negative at all time horizons, but only significant for the eight- and ten-year changes. At a ten-year horizon a change in import penetration by one percentage point is predicted to decrease the labor share by about 0.5 percentage points. The negative association between labor shares and import intensity at the industry level is in line with the findings in Elsby et al. (2013) for the U.S. However, focusing only on imports from China, Autor et al. (2020) instead find a rise in labor shares following an increase in import exposure.[18] Neither of theses studies look at the association between changes in import exposure and changes in labor shares decomposed to components within the industry.

Going to the decomposition, column 2 shows that the same negative association between import penetration and labor shares holds when considering changes in labor share due to the reallocation component. When the reallocation component is the dependent variable, the size of the coefficients is somewhat smaller and only significant at the ten-year horizon. For the shift component, the coefficients are negative but insignificant at all horizons (column 3). In the two last columns, the regression on the exit and entry component, there is no significant effect, and the size of the coefficients is small. As argued in section 3.2, the OLS regression is potentially biased because changes in import penetration may be endogenous. If, for example, an increase in import penetration is caused by an increase in wages following successful wage bargaining from the workers' perspective, a positive bias of the coefficient of import penetration is expected. To tackle this potential issue, I therefore turn to the IV estimation in the next section.

[18] Although, both Elsby et al. (2013) and Autor et al. (2020) use U.S. data, they differ not only in the measure of exposure to imports but also in data coverage, where Elsby et al. (2013) consider both manufacturing and non-manufacturing industries while Autor et al. (2020) only consider the former.

**Table 2:** OLS regression results

| | (1) $\Delta LS_{total}$ | (2) $\Delta LS_{reallocation}$ | (3) $\Delta LS_{within}$ | (4) $\Delta LS_{entry}$ | (5) $\Delta LS_{exit}$ |
|---|---|---|---|---|---|
| $\Delta_5$ IPR | -0.615 | -0.558 | -0.163 | 0.025 | 0.081 |
| | (0.400) | (0.376) | (0.125) | (0.019) | (0.051) |
| $\Delta_8$ IPR | -0.713* | -0.563 | -0.221 | 0.001 | 0.069 |
| | (0.340) | (0.305) | (0.152) | (0.001) | (0.049) |
| $\Delta_{10}$ IPR | -0.509* | -0.309* | -0.238 | -0.001 | 0.040 |
| | (0.207) | (0.129) | (0.156) | (0.001) | (0.037) |
| N clusters | 70 | 70 | 70 | 70 | 70 |

The table shows the results from running OLS regressions of changes in total labor share and its subcomponents on changes in import penetration at five-, eight- and ten-year horizons using a rolling regression approach. The number of observations is given by the number of clusters times the number of years of data. Hence, for the 10(8)[5] year horizon, the numbers of observations are $70 \times 9(11)[14]$. All regressions include time dummies and are weighted by initial industry value added shares. Standard errors (in parentheses) are clustered at 4-digit industry level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

## 4.2 IV

When looking at the results from the IV regressions, the coefficients are larger and more precise. In Table 3, the effect of changes in import penetration have an unambiguously negative effect on industry-level labor shares (column 1). The effect of a one percentage point increase in import penetration is associated with a fall in the labor share ranging from about 1.5 to 1.1 percentage points between the five- and ten-year horizon. Looking at the different components of the change in labor share, the main channel through which the labor share falls seems to be the reallocation component. However, the within component is also significant in both a statistical and economic sense at all horizons. Again, the coefficients from the regression on the exit and entry components are small and insignificant.[19] For results on the first-stage regression, see Appendix A.

[19] Note that the coefficients of the sub-components do not exactly add up to the total effect. This result is not unexpected given the fact that the GMM estimation approach results in different weighting matrices for the instrumentation. However, the results are qualitatively robust to using an approach where the coefficients of the sub-components do exactly add up to the total effect (by disregarding differences in time dummies and using the same (identity) matrix in all regression models), see Table B1 in Appendix B.

**Table 3:** IV regression results

| | (1) $\Delta LS_{total}$ | (2) $\Delta LS_{reallocation}$ | (3) $\Delta LS_{within}$ | (4) $\Delta LS_{entry}$ | (5) $\Delta LS_{exit}$ |
|---|---|---|---|---|---|
| $\Delta_5$ IPR | -1.516*** | -0.915*** | -0.592*** | -0.001 | 0.057 |
| | (0.230) | (0.210) | (0.135) | (0.008) | (0.035) |
| $\Delta_8$ IPR | -1.230*** | -0.891*** | -0.404*** | 0.004 | 0.060 |
| | (0.176) | (0.140) | (0.108) | (0.004) | (0.049) |
| $\Delta_{10}$ IPR | -1.088*** | -0.842*** | -0.477*** | -0.000 | 0.031 |
| | (0.187) | (0.147) | (0.095) | (0.003) | (0.053) |
| N clusters | 70 | 70 | 70 | 70 | 70 |

The table shows the results from running IV regressions of changes in total labor share and its subcomponents on changes in import penetration at five-, eight- and ten-year horizons using a rolling regression approach. The number of observations are given by the number of clusters times the number of years of data. Hence, for the 10(8)[5] year horizon, the numbers of observations are $70 \times 9(11)[14]$. All regressions include time dummies and are weighted by initial industry value added shares. The first-stage F-statistic is 14.80, 11.15, and 11.66 for the five-,eight- and ten-year changes, respectively. Standard errors (in parentheses) are clustered at 4-digit industry level, $^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

To better understand what is behind the results in Table 3, the next section looks at changes in labor shares decomposed to a productivity and a labor cost component to see how these are affected by a change in import penetration.

## 4.3 Decomposition: Changes in costs and productivity

As described earlier, the labor share can be decomposed into two principal parts: changes in productivity and changes in labor compensation. If labor in an industry becomes more productive without being compensated by a corresponding increase in wages (or other forms of labor compensation), the labor share will naturally fall. To explore the relative importance of the two margins, the regression analysis above is repeated but with changes in compensation per employee and labor (revenue) productivity (value added per employee) as dependent variables.[20] Table 4 reveals that an increase in import penetration predicts a rise in productivity that is not met by a comparable increase in wages. This result suggests a mechanism through which the labor share falls following an increase in import penetrations. More specifically, Table 4 shows that an increase in import penetration is associated with

[20]The analysis is also run using TFP as a measure of productivity with the direction of the results on productivity unchanged.

a rise in productivity, but there seems to be no effect of a change in import penetration on labor costs. In all time horizons, the overall effect on industry-level labor cost per employee is insignificant. Looking at the different components, there seems to be a tendency of the reallocation component to affect the wage negatively counteracted by a positive effect from the shift component. However, all coefficients but the five-year horizon reallocation component are insignificant.

**Table 4:** IV regression results on labor compensation and productivity

| | (1) $\Delta_{total}$ | (2) $\Delta_{reallocation}$ | (3) $\Delta_{within}$ | (4) $\Delta_{entry}$ | (5) $\Delta_{exit}$ |
|---|---|---|---|---|---|
| *A. Δ log Wage (payroll/number of employees)* | | | | | |
| $\Delta_5$ IPR | 0.000 | -0.004** | 0.003 | -0.000 | 0.000 |
| | (0.001) | (0.001) | (0.002) | (0.000) | (0.000) |
| $\Delta_8$ IPR | 0.001 | -0.002 | 0.003 | -0.000 | -0.000 |
| | (0.001) | (0.003) | (0.002) | (0.000) | (0.000) |
| $\Delta_{10}$ IPR | 0.001 | -0.000 | 0.002 | 0.000 | -0.000 |
| | (0.002) | (0.003) | (0.003) | (0.000) | (0.000) |
| *B. Δ log Labor Productivity (value added/number of employees)* | | | | | |
| $\Delta_5$ IPR | 0.017* | 0.011*** | 0.008* | -0.000 | -0.000 |
| | (0.007) | (0.003) | (0.003) | (0.000) | (0.000) |
| $\Delta_8$ IPR | 0.021** | 0.016** | 0.008** | -0.000 | -0.000 |
| | (0.007) | (0.005) | (0.003) | (0.000) | (0.000) |
| $\Delta_{10}$ IPR | 0.015 | 0.019* | 0.007* | 0.000* | -0.000 |
| | (0.009) | (0.008) | (0.003) | (0.000) | (0.000) |
| N clusters | 70 | 70 | 70 | 70 | 70 |

The table shows the results from running IV regressions of changes in average labor compensation and average labor productivity on changes in import penetration at five-, eight- and ten-year horizons using a rolling regression approach. The number of observations is given by the number of clusters times the number of years of data. Hence, for the 10(8)[5] year horizon, the numbers of observations are $70 \times 9(11)[14]$. All regressions include time dummies and are weighted by initial industry value added shares. The first-stage F-statistic is is 14.80, 11.15, and 11.66 for the five-, eight- and teen-year changes, respectively. Standard errors (in parentheses) are clustered at 4-digit industry level, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

If we instead look at the productivity regressions, the effect of a change in import penetration on labor productivity is positive and significant at all horizons but the ten-year horizon.[21]

[21] The insignificance of the ten-year horizon should be interpreted with care. Looking at either a nine or

In other words, an increase in import competition seems to be associated with an increase in productivity, but there is no effect on labor compensation.

The analysis above says nothing about the source of productivity enhancement within firms following an increase in import competition. It could be that firms in industries exposed to more competition adapt better technologies. It could also be that the increase in competition encourages firms to shift production to their best-performing products, as shown to be the case with tougher competition in export markets in Mayer et al. (2014). Considering the lack of data on prices, it also cannot be excluded that the positive effect on productivity is the result of an increase in markups since we only observe revenue productivity. However, an increase in markups following tougher competition goes against the theoretic implications of many standard economic models. Section 5 presents a theoretical model suggesting that import competition affects productivity by increasing incentives to adapt better technologies when import competition rises.

## 4.4 Extensions

### 4.4.1 Controlling for exports and imports of intermediate input

When sectors experience an increase in import penetration due to an opening to trade or reduced trade costs, possibilities to export are expected to change simultaneously. Hence, the effect of changes in import penetration could to some extent capture the effects of exporting. To distinguish the effect of changes in import penetration from the effect of export possibilities, industry-level export shares out of total production are included as controls, leaving the effects on the labor share components essentially unchanged. This analysis controls for aggregate industry-level exports. A threat that remains to the identification in the empirical analysis of this paper is if the increase in import penetration is correlated with a few high-productivity (low labor share) firms expanding through exports, which increases their value added shares within the industry. This would lead to a reduction in labor share caused by a reallocation of market shares that is correlated to but not caused by an increase in import competition. As a robustness test, I re-run the baseline analysis on a sample where firms' value added is adjusted by excluding the share of value added corresponding to firm-specific export shares out of total firm sales. The results are robust to this adjustment.

Another potential concern is if the import penetration is associated with a change in access

eleven-year horizon, the effect is significant and has a similar size as the ten-year horizon.

to intermediate inputs from abroad. If an increase in import penetration is correlated with a fall in prices of intermediate inputs without a corresponding fall in output prices, one could expect to see an increase in value added not necessarily accompanied by an increase in labor costs. However, when controlling for changes in industry-level imports (i.e., imports made by firms within an industry rather than imports of the products produced in a sector), the results are qualitatively unchanged.

### 4.5 Summing up the empirical findings

To sum up the empirical results, an increase in import competition has been shown to be associated with a fall in labor shares. The fall is to a large extent due to a reallocation of market shares across firms. But, labor shares fall also within firms. Relating the results above to the theoretical hypothesis presented in the introduction, the results give some mixed support. An increase in import penetration, and hence competition, is expected to favor large, low labor share firms contributing to downward pressure on the industry-level labor share through a reallocation of market shares. This mechanism is supported by the results in Table 3, in line with the empirical findings of e.g., Autor et al. (2020), and can be explained in a theoretical framework following common trade competition models such as Melitz and Ottaviano (2008).

However, the increase in import penetration, and hence competition, is also expected to lead to an increase in the price elasticity of demand and subsequently a downward push on firm-level markups, increasing firm-level labor shares. A positive relationship between competition and firm-level labor share is not found here. Instead, the relationships seem to be negative. The negative effect on labor shares within firms is hard to explain by models where only selection and reallocation is at work. Building on the empirical finding that the fall in labor share comes from an increase in productivity (also within firms) without an increase in labor costs, the next part of this paper presents a theoretical model consistent with these findings. The model includes possibilities to improve productivity at the firm level, and it will be shown that this feature is necessary to replicate the empirical results. The model will also be used to analyze the welfare effects and contrast these to the welfare effect of an increase in import penetration in a more standard-like model without within-firm productivity effects.

# 5 Theoretical framework

This section provides a theoretical model that contextualizes the empirical results and enables an analysis on what the empirical results imply for welfare. The model relies heavily on the model in Melitz and Ottaviano (2008) but with a few deviations to better apply to the analysis in this paper. First, an intermediate-good sector is introduced to the model. The intermediate goods are used as inputs in the production of a final good. An intermediate-good sector is introduced to be in line with the data of manufacturing firms that is used in this study. The intermediate-good sector is the focus of the analysis, and it is in this sector that labor shares are considered.[22] By assuming a linear demand for intermediate inputs, the model stays close the Melitz and Ottaviano (2008) model.

As a second deviation, a second homogeneous final good is introduced. More specifically, consumers derive utility from two homogeneous goods where preferences are described by a Cobb-Douglas function. The reason for having an additional homogeneous good is partly to create room for a final good that uses intermediate goods as inputs but also to keep the attractive feature of a simple CRS good that only uses labor as input, and acts as a numeraire and fixes the wage to unity. Having a fixed wage is an attractive feature both for its simplicity and considering the insignificant effect of import competition on wages presented in the empirical analysis. The Cobb-Douglas feature is motivated by the need for altering the substitutability between the simple homogeneous good and other goods. In the Melitz and Ottaviano model, the utility function exhibits decreasing marginal utility in the differentiated goods while the marginal utility is constant in the homogeneous good. In this setting, a relative increase in the price of the homogeneous good results in a shift in expenditure toward the homogeneous good and a decrease in expenditures on other goods. Hence, an increase in competition in the homogeneous-good sector results in a reduction in the relative market size of this sector. A reduction in market share of sectors experiencing increasing competition is not supported by the data in this study and not an unquestionable assumption. Therefore, I instead assume a Cobb-Douglas feature that implies a constant expenditure share on each of the final goods.

A third deviation from the Melitz and Ottaviano (2008) model is the introduction of a possibility for intermediate-good producers to invest in productivity improvements. This is motivated by previous empirical findings of import competition being associated with changes in productivity and investments in new technology (see, e.g., Bloom et al., 2016)

[22]Other sectors in the model (two final good sectors) have a constant labor share equal to 1 and 0, respectively.

and supported by the empirical results in this paper. In the standard Melitz and Ottaviano model, firms are not able to invest in productivity improvements. The way productivity improvements are modeled here is market share neutral in the sense that two firms that invest increase their revenue by the same proportion. To simplify the model, only domestic intermediate-good firms face the opportunity to upgrade their technology. Productivity of foreign firms is instead taken as exogenous. It is also the exogenous rate of productivity enhancements among foreign firms that are driving the increase in import penetration that is the focus of the analysis.

The main purpose of the model is to illustrate how small adjustments to the standard model of Melitz and Ottaviano (2008) can bring the model more in line with the empirical findings and evaluate the welfare effects from changes in import penetration. The proposed exercise that is preformed using the model is to vary the degree of import penetration and see how it affects the labor share and welfare. Specifically, the variation in import penetration is achieved by altering the exogenous cost distribution of foreign firms. When foreign firms become more productive, competition in the home market increases, import penetration rises and the elasticity of demand for firms at a given marginal cost level goes up. The implied changes in the pool of productivities among competitions also alter firms' investment decisions. The effect that an increase in import penetration has on the labor share in the intermediate-good sector and total welfare will be analyzed using both the model with investment possibilities and a more "standard" version of the model without investment possibilities.

Below, an outline of the structure of the model is presented, followed by a discussion of its mechanisms and effects on the labor share and welfare.

## 5.1 The model

The following section describes the model, beginning with the three major components: 1) consumers deriving utility from consuming final goods; 2) two final goods-producing sectors: one "simple" good using labor only that absorbs any excess labor supply, which fixes the wage, and one "advanced" good that demands intermediate input; and 3) intermediate-goods producers.

### Consumers

The economy consists of two countries: Home and Foreign. Each country has a measure $L$ of consumers that inelastically supply one unit of labor in a competitive labor market where labor is mobile across sectors. A representative consumer derives utility from consuming two types of final goods: a simple good, $H$, and an advanced good, $Q$. Specifically, the utility of a representative consumer is given by

$$U = H^{1-\beta} Q^{\beta}. \tag{4}$$

The representative household maximizes utility with respect to its budget constraint $WL = P_H H + P_Q Q$, where $P_H$ and $P_Q$ are the price of the simple and the advanced good, respectively. The utility maximization implies that a fixed share of income is spent on the simple good, $P_H H = (1-\beta)WL$, and the advanced good, $P_Q Q = \beta WL$.

**Final-good producers**

The simple good, $H$, is a homogeneous and freely traded good produced under a CRS technology that converts one unit of labor into one unit of output. When $\beta$ is sufficiently low, both countries consume the simple good such that it serves as the numeraire, $P_H = 1$ , and fixes wages to unity, $W = 1$.

The advanced good, $Q$, is homogeneous and produced domestically. It is produced using intermediate inputs and a technology given by

$$Q = \alpha \int_{i\in\Omega} q_i di - \frac{1}{2}\gamma \int_{i\in\Omega} (q_i^2) di - \frac{1}{2}\eta \left( \int_{i\in\Omega} q_i di \right)^2, \tag{5}$$

where $q_i$ is the intermediate input of variety $i \in \Omega$ of a differentiated input. The intermediate inputs can be bought from both domestic and foreign input-producers. Hence, the set $\Omega$ contains both domestic and foreign varieties. The parameters $\alpha$, $\gamma$ and $\eta$ are all positive. The parameters $\eta$ and $\alpha$ capture the efficiency of turning inputs into outputs (which increases in $\alpha$ and decreases in $\eta$). The parameter $\gamma$ captures the degree of differentiation between the input varieties. In the limit, with $\gamma = 0$, inputs are perfect substitutes, and only the total amount of inputs matters for production. An increase in $\gamma$ implies a higher desire to smooth inputs across varieties.

The advanced-good sector is characterized by perfect competition, implying that firms are price takers. Hence, there is a market price for the inputs they buy and the outputs they sell, and firms only decide how much inputs to buy and how much to produce. The firms' problem is to choose an output and input level. The output of the advanced-good firms is given by the output level that equalizes the marginal cost of producing one unit with the marginal revenue, $P_X$. A representative producer of the advanced good chooses inputs, given the technology in equation (5) and the cost of input, by maximizing profits:

$$\max_{q_i} \pi = P_Q Q - \int q_i p_i di, \tag{6}$$

which results in a linear demand for individual inputs given by

$$q_i = \frac{\alpha}{\gamma + \eta N} + \frac{\eta N \bar{p}}{P_Q \gamma(\gamma + \eta N)} - \frac{p_i}{\gamma P_Q}. \tag{7}$$

**Intermediate-good producers**

The intermediate-input market, which is the focus in this study, is characterized by monopolistic competition. Each intermediate-input producer, $i$, produces a unique variety using CRS technology: $q_i = a_i L_i$. Firms are heterogeneous in terms of productivity, $a_i$. Given the competitive labor market, all firms face the same wage rate and, hence, firm heterogeneity can be defined by differences in marginal costs, $c_i = \frac{W}{a_i}$. The intermediate-input producers face competition from both domestic and foreign firms. In this study, I disregard the possibility of domestic intermediate-input producers to export. This is done in order to isolate the effect on the labor share from an increase in import competition and motivated by the empirical result where the effect on the labor share from an increase in import competition is not driven by changes in exports.[23]

Entry is free, but firms have to pay a fixed cost, $f$, before drawing a marginal cost, $c_i$, from a given distribution $G(c) = \left(\frac{c}{c_M}\right)^{\kappa}$, where $c_M$ is an upper bound for costs and $\kappa$ is a shape parameter.[24] The larger $\kappa$ is, the smaller the degree of firm heterogeneity as firms become increasingly concentrated at a high cost level. With $\kappa = 1$, the distribution is uniform on $[0, c_M]$. Firms enter the industry as long as the expected operational profit equals the fixed cost:

$$E(\pi) = \int_0^{c_D} \pi(c) d\tilde{G}(c) = f, \tag{8}$$

where $\tilde{G}(c)$ is the distribution of producing firms taking the investment decision into account and $c_D = p_{max} = \frac{P_Q \gamma \alpha + \eta N \bar{p}}{\gamma + \eta N}$ is a cost cut-off representing the maximum feasible break-even price. $c_D$ is given by the marginal firm for which demand is zero derived from equation (7).

[23]The empirical analysis only rules out exports as a potential channel though which changes in competition affect labor shares. The analysis does not rule out any effect of changes in competition on exports, with potential implications for welfare. However, the potential welfare effect from changes in exports following an increase in competition is left out in the current model.

[24]As firms face the same wage rate, this is equivalent to firms drawing a productivity level from a given distribution.

After paying the fixed cost and the marginal cost has been revealed, the firms choose to produce or exit. Firms choose to exit if their cost exceeds a cost cut-off, i.e., $c_i > c_D$. The timing of firms' decisions is summarized by the time line in Figure 1.

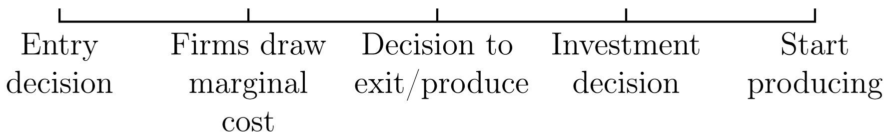


**Figure 1:** Timing of firms' decisions

As illustrated in Figure 1, firms make decisions about entering/exiting and investment before starting production. The firms' decisions are best understood by looking at their problem backwards, starting with the choice of pricing and quantity. If firms decide to start producing, they maximize profits as

$$\max_{q_i} \pi_i = \max_{q_i} p_i q_i - c_i q_i,$$

subject to demand

$$q_i = \frac{\alpha}{\gamma + \eta N} + \frac{\eta N \bar{p}}{P_Q \gamma (\gamma + \eta N)} - \frac{p_i}{\gamma P_Q},$$

where all aggregate variables are taken as given.

The solution to the maximization problem gives us the firm-level price, output, revenue and elasticity of demand:

$$p_i = \frac{1}{2}\left(c_D + c_i\right) \tag{9}$$

$$q_i = \frac{1}{P_Q 2\gamma}\left(c_D - c_i\right) \tag{10}$$

$$r_i = \frac{1}{P_Q 4\gamma}\left(c_D^2 - c_i^2\right) \tag{11}$$

$$\sigma_i = \left|\frac{\partial q_i}{\partial p_i}\frac{p_i}{q_i}\right| = [\frac{p_{max}}{p_i} - 1]^{-1}. \tag{12}$$

The expressions above are very similar to the solutions in the original Meltiz and Ottaviano (2008) model. The only difference is the presence of the price index of the advanced good, $P_Q$, in the expression for output and revenue. The reason for $P_Q$ is that consumers' preferences for the simple and advanced goods are of Cobb-Douglas type, resulting in a fixed share of expenditure on each good. In contrast, in the Meltiz and Ottaviano (2008) model, an increase in the relative price of the homogeneous good (here equivalent to the simple good, $H$) results in an increase in the share of expenditure on that good. Since the cost cut-off level, $c_D$, and the price index of the advanced good, $P_Q$, always move in the same direction, an increase in competition that pushes down the cut-off, also implies a lower $P_Q$ and hence results in a lower loss of revenue for a firm at a given cost level compared to in a standard Meltiz and Ottaviano model. Given the expressions in (9) to (12), lower-cost firms will be larger in terms of output and revenue, charge lower prices and face a lower elasticity of demand. The lower elasticity of low-cost firms implies that these firms charge higher markups, $\frac{p}{c}$, and have lower labor shares.[25] Hence, the economy will be characterized by a concentration of market shares in low-cost firms with high markups and low labor shares.

Before choosing output and prices, domestic firms face the opportunity to invest in a lower marginal cost. Specifically, if a domestic firm decides to produce, it can choose to upgrade its technology and thereby reduce its marginal cost by paying a fixed cost.[26] Each firm faces the same cost (in terms of labor), given by $\phi$, to reduce its marginal cost by $f(\bar{c_f})$, where $\bar{c_f}$ is the average marginal cost draw of foreign firms.[27] We assume $\frac{\partial f(\bar{c_f})}{\partial \bar{c_f}} < 0$ so that the marginal-cost reduction is decreasing in the average of foreign competitors' marginal cost draws.

The investment in a marginal-cost reduction can be thought of as the possibility of firms, for a fixed cost, to observe and learn from their foreign competitors. When foreign competitors become more productive, a decrease in $\bar{c_f}$, there is more to gain by learning from them. The functional form of $f(\bar{c_f})$ is chosen to keep the ratio of firms' revenue constant so that there is no reallocation of market shares between two firms that both choose to invest. In this way, the only reallocation that occurs in the model is the standard reallocation mechanism in the Melitz and Ottaviano model resulting from changes in elasticity of demand plus the reallocation caused by differences in investment decisions between firms. In order to achieve market share-preserving investments, the functional form of the marginal-cost reduction is given by: $f(\bar{c_f}) = c_i^{pre} - \sqrt{((c_i^{pre})^2) - (\rho - 1) * (c_D^2 - (c_i^{pre})^2)}$ for a firm with initial marginal cost $c_i^{pre}$. The parameter $\rho$ is the common proportional gain in revenue from making the investment and depends on the average marginal-cost draw of foreign competitors,

[25]The markup is given by $\mu = \frac{p}{c} = \frac{\sigma}{\sigma - 1}$. As lower-cost firms face a lower demand elasticity, $\sigma$, they charge higher markups.

[26]If firms were instead allowed to make the upgrading decision before (or simultaneously) as the exit decision, this would not affect the outcome in this analysis. This is because the firms with the highest cost (i.e., the exiting firms) would never choose to upgrade their technology and therefore always choose to exit the market.

[27]Assuming the investment cost is in terms of labor, it does not substantially change the results of the paper about labor share. This is because the cost is very low and therefore only comprises a small part of firms' labor cost.

$\rho = \bar{c_f}^{-\Psi} > 1$.[28] The implied new marginal cost for a firm that chooses to invest is given by $c_i^{post} = c_i^{pre} - f(\bar{c_f}) = \sqrt{((c_i^{pre})^2 - (\rho - 1) * (c_D^2 - (c_i^{pre})^2)}$. In terms of marginal-cost reductions, the functional form implies a larger marginal-cost reduction the more productive the firm is before the investment. Hence, high-productivity firms are not only more productive in terms of turning input into output but also more efficient in learning and adopting new technologies. However, for the most productive firms, the marginal-cost reduction is limited to a fixed proportion of their marginal cost. This limit is set mainly for practical reasons. Specifically, for firms with very low marginal costs, $f(\bar{c_f})$ implies a cost reduction resulting in a close to zero post-investment marginal cost. To overcome this, we identify a marginal firm, call it $c_m$, for which $f(\bar{c_f})$ results in a positive marginal cost, and assume that firms with $c < c_m$, get a post-investment marginal cost of $\psi c_i$, where $\psi$ is set to the relative marginal-cost reduction of the marginal firm, $\psi = \frac{c_m^{post}}{c_m^{pre}}$. Hence, for the most productive firms, the proportional marginal-cost reduction from investment is fixed and equal to the relative marginal-cost reduction of the marginal firm for which the post-investment marginal cost is positive. This implies that the most productive firms can never reduce their marginal cost by more but, importantly, the reduction is big enough to prevent them from losing their rank in the productivity distribution. The firms that meet this condition, however, will lose some of their relative market share but still be in the top in terms of revenue.[29] Both in the model and in reality, however, these firm can still raise their market shares (by increasing their absolute revenue by more than less productive firms and firms that choose not to invest).[30] Hence, domestic firms choose their marginal cost to be

$$c_i = \begin{cases} c_i^{pre}, & \text{if not investing} \\ c_i^{pre} - f(\bar{c_f}), & \text{if investing} \end{cases}$$

[28]For a derivation of $f(\bar{c_f})$, see Appendix C.

[29]Specifically, in the calibrated model of this paper, the most productive firms will only raise their revenue by around 10% from investing compared to other firms that can raise their revenue by around 40% from investing. The reason for the smaller increase in revenue is an inherent feature of the model. To understand this, consider the function for firm revenue given in equation (11). A firm that has a marginal cost close to zero finds it hard to increase its revenue further by cutting costs. In reality we can think of these as high-productivity firms that already capture a large share of the market and find it hard to further increase their sales by large amounts.

[30]The assumed structure of marginal-cost reductions at the top inevitably results in a reallocation of market shares at the top. This could potentially result in a positive bias of the effect of reallocation on the labor share.

The decision to invest in a lower marginal cost or not is made by maximizing profits:[31]

$$\pi_i = \text{Max}\Bigg(\pi_i^{initial}, \pi_i^{investing}\Bigg), \tag{13}$$

where

$$\pi_i^{initial} = p_i q_i - c_i^{initial} * q_i, \quad \text{(profit without investment)}$$
$$\pi_i^{investing} = p_i q_i - (c_i^{initial} - f(\bar{c_f})) * q_i - \phi, \quad \text{(profit with investment)}.$$

Given the larger potential gain from reducing the marginal cost for already low-cost firms, the most productive firms will be the first to invest, and there will be a marginal firm for which the gain from investing equals the cost of the investment.

The resulting firm-level labor share of firm $i$ is given by

$$LS_i = \frac{\text{total labor cost}}{\text{total revenue}} = \frac{w(l_i + \phi * I)}{r_i}, \tag{14}$$

where $I$ is an indication variable that equals one if the firm invests in a lower marginal cost.[32] The aggregate sector-level labor share is then given by the weighted sum of firm-level labor shares

$$LS = \sum_i \omega_i LS_i, \tag{15}$$

where $\omega_i$ is firm $i$'s share of total revenue of domestic firms.

## 5.2 Welfare

Welfare in the model is given by the utility of the representative household defined in equation (4) and repeated below:

$$U = H^{1-\beta} Q^{\beta}. \tag{16}$$

[31] The firm profit can be shown to be given by $\frac{1}{4P_Q\gamma}(c_D - (c_i^{pre} - I * f(\bar{c_f})))^2 - I * \phi$, where $I$ is an indicator that equals one if investing and zero otherwise. Hence, the choice of investment for different levels of import competition will depend on how the cost compares to the values of the cost cut-off, $c_D$, and the marginal-cost reduction, $f(\bar{c_f})$. Since $c_D$ and $f(\bar{c_f})$ move in the opposite direction when foreign firms become more productive, the direction of investment is ambiguous.

[32] Because production of the intermediate goods only uses labor as input, value added equals revenue in this setting.

The experiment run in this paper aims to increase foreign firms' productivity, which implies an increase in import penetration. This affects welfare by reducing the cost of good $Q$, enabling the household to afford a higher level of consumption. The cost reduction is mainly a consequence of the lower production cost of $Q$ when input prices go down since the inputs are produced at lower marginal costs and markups are lower for given costs. Because we assume that all excess labor in the model is absorbed by the $H$-sector, the change in import penetration has no effect on employment or labor income and the only effect on welfare in the model comes from changes in prices. The welfare analysis in this paper relies on the equivalent variation (EV) as an indirect measure of changes in welfare. Specifically, EV is a measure of the monetary change required in the initial state to obtain the same level of utility as after the price change and is defined as

$$EV(\mathbf{p}, v) = e(\mathbf{p}_{pre}, v_{post}) - e(\mathbf{p}_{post}, v_{post}), \tag{17}$$

where $e(\mathbf{p}, v)$ is the expenditure function and $v$ the indirect utility function given by

$$e(\mathbf{p}, v) = v\left(\frac{P_Q}{\beta}\right)^{\beta}\left(\frac{P_H}{(1-\beta)}\right)^{(1-\beta)} \tag{18}$$

and

$$v(\mathbf{p}, WL) = WL\left(\frac{\beta}{P_Q}\right)^{\beta}\left(\frac{(1-\beta)}{P_H}\right)^{(1-\beta)}, \tag{19}$$

respectively, and $\mathbf{p}$ a price vector containing $P_Q$ and $P_H$.

Changes in welfare following an increase in import penetration are analyzed both in the baseline model of this paper and a reduced-form model without investment possibilities to enable a comparison to a more "standard" Melitz and Ottaviano (2008) model.[33] Comparing the baseline model to a model without investment possibilities, where only the selection effect is at work, also gives an indication of the relative size that selection accounts for.[34]

[33] This version is not identical to the standard Melitz and Ottaviano (2008) due to the introduction of Cobb-Douglas preferences, but the overall results are consistent with the original Melitz and Ottaviano model.

[34] The reallocation in a model without investment possibilities understates the reallocation of the baseline model. This is because some reallocation in the baseline model occurs as a consequence of differences in investment decisions.

## 5.3 Mechanisms at work

In the model, higher import competition affects sector-level labor shares through two main channels. The first channel is related to how import competition affects the elasticity of demand that firms face. When foreign firms become more productive, in the model achieved by lowering the upper cost bound ($c_M^f$) from which foreign firms draw their marginal costs, domestic producers of the advanced good shift their input use away from domestic inputs and use more imported inputs. This shift raises the import penetration ratio. At the same time, the increase in competition pushes down the maximum price that firms are able to charge, $p_{max}$, and increases the elasticity of demand given in equation (12). As a result, firms must reduce their markup for a given cost level, pushing labor shares up. However, the higher elasticity of demand also results in larger potential sales from charging low prices. Hence, consumption shifts towards low-cost (low labor share) firms. The reallocation of market shares results in a downward push on the aggregate sector labor share. This is the mechanism suggested in e.g., Autor et al. (2020).

The second channel through which labor shares are affected by an increase in import penetration is changes in the relative gains from investing in productivity improvements. When productivity of foreign firms increases, the potential for domestic firms to reduce their marginal costs is larger. Hence, more firms choose to make the marginal-cost reducing investment. Looking at the effect on firm-level labor shares, the labor share goes down for firms that choose to invest (they can charge higher markups and increase their revenue) but goes up for those that choose not to invest since firms now face a higher elasticity resulting in lower markups. The effect on the average firm-level labor share depends on the number of firms that makes the investment and the size of the marginal-cost reduction. At low levels of import penetration, incentives to invest in marginal-cost reductions are low, and few firms make the investment, instead experiencing an increase in their labor share. At high levels of import penetration, most firms have already made the investment, and further increases in import penetration have little effect on investments. However, their labor shares still decrease as a result of the larger cost reductions that are available. For this analysis, we consider the intermediate case where neither all nor none of the firms invest to stay close to the actual import penetration rate in Sweden.

Hence, both positive and negative effects on the labor share following an increase in import penetration are present in the model, and it is not obvious which one dominates. In a next step, the model is calibrated to match features in the data. Thereafter we look at the overall effect on labor shares from an increase in import penetration and then turn to the effect on welfare.

## 5.4 Parameters

The model has 12 parameters: $\theta = \{\beta, c_M^h, c_M^f, \kappa, \alpha, \gamma, \eta, \Psi, \phi, \psi, W, L\}$, some of which are set using external sources, some are calibrated internally to match moments in data, and three are normalized to one. Table 5 summarizes the parameters, and the following sections motivate their assigned values.

**Table 5:** Parameters

| Parameter | Value | Description |
|---|---|---|
| *A. Calibrated to external data sources* | | |
| $\beta$ | 0.2 | Share of manufacturing in total value added |
| $c_M^h$ | 0.5 | Distribution bound home |
| $c_M^f$ | 0.8486/0.7255$^{\star}$ | Distribution bound foreign |
| *B. Calibrated using simulated method of moments* | | |
| $\kappa$ | 3.1 | Distribution (shape) |
| $\eta$ | 0.0127 | Technology (decreasing return to input) |
| $\gamma$ | 1.1111 | Technology (degree of differentiation) |
| $\phi$ | $2.7083e-04$ | Investment cost |
| $\Psi$ | 0.7786 | Investment function parameter |
| *C. Normalized* | | |
| $L$ | 1 | Labor supply |
| W | 1 | Wage rate |
| $\alpha$ | 1 | Technology (return to input) |
| $\psi$ | 0.5159/0.6283$^{\star\star}$ | Investment function parameter high prod. (endogenous) |

$^{\star}$ $c_M^f$ is set to 0.8486 in the low import penetration state and 0.7255 in the high import penetration state.
$^{\star\star}$ $\psi$ is determined endogenously as described in Section 5.1. In the current calibration of the model, $\psi$ =0.6283 in the low import penetration state and $\psi$ =0.5159 in the high import penetration state.

**Normalized/endogenous parameters** Four parameters belong to this category $(L, W, \alpha, \psi)$.

For the normalized parameters, we have $L$ representing the number of consumers, the technology parameter $\alpha$ that is normalized to one without loss of generality (further described below) and the wage parameter $W$ that is fixed to one capturing the assumption of all excess supply of labor being absorbed by the homogeneous good sector and in line with the empirical finding of no changes in wages. The parameter $\psi$, governing the marginal cost reduction from investment for the most productive firms, is determined endogenously as described in section 5.1.

**Calibrated to external data sources** Three parameters are set externally $(\beta, c_M^h, c_M^f)$. The utility parameter, $\beta$, which determines the expenditure shares on the two final goods, is set to 0.2, resulting in a 20 percent expenditure share on the advanced final good (Q) that is produced using intermediate inputs. The value 0.2 is set to capture that the manufacturing industry in Sweden accounts for almost 20 percent of the value added in business and industry.

The parameters $c_M^h$ and $c_M^f$ represent the upper bound of marginal-cost draws for domestic and foreign firms, respectively. In the model experiment, the value of $c_M^h$ itself is not an important factor as long as it takes on a reasonable value such that firms will draw positive but finite marginal costs. What is important for the experiment is how it relates to the upper bound for marginal-cost draws of foreign firms, $c_M^f$. With $c_M^h = c_M^f$, foreign and domestic firms are equally productive upon entry. With $c_M^f > c_M^h$, domestic firms are more productive and a larger share of domestic consumption consists of domestic goods. In this exercise, $c_M^f$ is set for a given $c_M^h$ to match the import penetration in the Swedish manufacturing sector. Specifically, $c_M^f$ will take on two different values since the experiment performed using the model is to compare a low and high import-penetration state. Specifically, the values are set to match the change in the median import penetration in the Swedish manufacturing sector over the sample period. The low import penetration case $c_M^f = 0.8486$ results in an import penetration ratio of 14.95, and the high import penetration case $c_M^f = 0.7255$ results in an import penetration ratio of 19.95. The corresponding ratios in data for the start and end year are 15.50 and 20.00, respectively.

**Calibrated using simulated method of moments** Five parameters are calibrated internally $(\gamma, \eta, \kappa, \phi, \Psi)$. These parameters all speak to the marginal-cost distribution of firms. In the model, the marginal-cost distribution is primarily determined by $\kappa$ and the technology parameters in the $Q$ sector that determine the demand and substitutability of intermediate goods. The technology parameters ($\eta$, $\gamma$ and $\alpha$) determine the substitutability between and return to inputs in the production of the advanced good, $Q$. What influences the model is not the specific values of these parameters but their size relative to each other. Instead of calibrating three parameters, one of the parameters is set to one and the other parameters are calibrated as a scaling of the set parameter. Specifically, $\alpha$ is set to one, as described earlier, and $\eta$ and $\gamma$ are calibrated as ratios to $\alpha$.

The other parameter with main implications for the distribution of marginal costs is $\kappa$. A $\kappa$ of one gives a uniform distribution of marginal-cost draws, and a high $\kappa$ implies a concentration of firms at high marginal-cost draws. Although $\kappa$ has direct implications on the distribution of which firms draw their initial marginal costs, the underlying distribution of productivities is unobservable in data where only producing firms are observed and therefore lacks a direct correspondence in data. In the literature, $\kappa$ is often set between two and four. Here, $\kappa$ is calibrated together with $\eta$ and $\gamma$ to match targeted features of the labor productivity distribution in the data. The matching targets are 1) the ratio between median labor productivity and aggregate labor productivity (aggregating firm-level labor productivity using value added weights); 2) the ratio between median and mean labor productivity; and 3) the interquartile range of log labor productivity in the data.[35]

The parameters determining the investment decision, the cost of investment ($\phi$) and the return to investment ($\Psi$) are calibrated to match the change in average and aggregate log labor productivity in the data from an equivalent change in import penetration as in the model.[36]

The assigned parameter values are given in Table 5, and the resulting model moments are shown in Table 6 together with the targeted moments in the data. From Table 6 we can see that the model matches moments of the productivity distribution fairly well. What can be noted is that the model tends to overpredict the change in weighted labor productivity and underpredict the change in unweighted labor productivity somewhat.

[35] Alternative targets to match to could be the skewness and kurtosis of the labor productivity in data. However, since these moments are sensitive to outliers, they are disregarded in this exercise. The resulting skewness and kurtosis are lower in the model than in the data.

[36] In practice, these parameters also influence the final distribution of firm productivities, and all parameters are calibrated together.

**Table 6:** Targeted moments: model versus data

| **Moment** | **Model** | **Data** | **Source** |
|---|---|---|---|
| Change weighted productivity | 0.018 | 0.015 | Regression output |
| Change unweighted productivity | 0.006 | 0.007 | Regression output |
| Interquartile range of labor productivity | 0.535 | 0.501 | Micro data |
| Ratio of median and aggregate labor productivity | 0.655 | 0.681 | Micro data |
| Ratio of average and median labor productivity | 1.264 | 1.247 | Micro data |

All data moments refer to the Swedish manufacturing sector.

# 6 Model results

This section presents the results from a model with and without investment possibilities. I refer to the model with investment possibilities as the baseline model. The model without investment, which is closer to the original Meltiz Ottaviano (MO), is referred to as the no-investment model. The comparison between the models is based on an equivalent change in import penetration ratios (going from around 14 to 19 percent). In order to achieve comparable import penetration ratios in the two models, the upper-cost bound of the foreign firm distribution is slightly adjusted. Specifically, in the no-investment model, the upper-cost bound of the foreign firm distribution is set to a somewhat higher value. This is because the baseline model inevitably results in higher domestic productivity as long as some firms choose to invest compared to a no-investment model. Therefore, without adjusting the upper-cost bound for foreign firms, the no-investment model will result in a higher import penetration ratio. The results from the two models are presented below.

## 6.1 Labor shares

### 6.1.1 Baseline model

Table 7 shows the relationship between import penetration, productivity and labor shares. Specifically, it shows the change in log labor productivity and change in labor shares associated with a one percentage point increase in import penetration. The first two rows in Panel (A) are just repeating the results on productivity changes from Table 6 and represent moments that are directly matched to the data. The last row in panel (A) shows the change in log labor productivity due to a reallocation of market shares among incumbents. The residual between the total effect and the sum of the within and reallocation effect accrues to the change in stock of producing firms (denoted exiting firms in the empirical analysis). The second panel (B) shows the change in aggregate labor share (total), average labor share (within) and the contribution from reallocation in the model (column 2) and the corresponding changes in data (column 3). As can be seen, the model is able to match the relative changes in the aggregate labor share and the reallocation and within components fairly well when import penetration increases.[37] However, the model under-predicts the change in labor share somewhat.The within-firm change and reallocation components in the model correspond to the average labor share among incumbents and reallocation among incumbents (consistent with the measure in the empirical analysis). The effect of higher import penetration on the average labor share among incumbents is driven by investing firms becoming more productive and able to charge higher markups, resulting in lower labor shares. However, there is also a positive force on the average labor share from the increase in import penetration driven by an increase in demand elasticity resulting in lower markups and higher labor shares for firms at given marginal-cost levels. Hence, firms that choose not to invest will have higher labor shares when import penetration is higher. When enough firms choose to invest and the marginal-cost reduction from the investment is large enough, the negative effect on the average labor share dominates.

[37] Again, the residual between the total effect and the sum of the within and reallocation effects accrues to the change in stock of producing firms (denoted exiting firms in the empirical analysis).

**Table 7:** Relationship between import penetration, productivity and labor shares

| | Model | Data | 95% confidence intervals |
|---|---|---|---|
| | | ***A. Baseline*** | |
| $\Delta LP_{total}$ | 0.018 | 0.015 | $(0.000, 0.030)$ |
| $\Delta LP_{within}$ | 0.006 | 0.007 | $(0.001, 0.013)$ |
| $\Delta LP_{reallocation}$ | 0.010 | 0.019 | $(0.001, 0.038)$ |
| $\Delta LS_{total}$ | −0.954 | −1.088 | $(-1.416, -0.760)$ |
| $\Delta LS_{within}$ | −0.224 | −0.477 | $(-0.675, -0.279)$ |
| $\Delta LS_{reallocation}$ | −0.621 | −0.842 | $(-1.077, -0.607)$ |
| | | ***B. No investment*** | |
| $\Delta LP_{total}$ | 0.001 | 0.015 | $(0.000, 0.030)$ |
| $\Delta LP_{within}$ | −0.003 | 0.007 | $(0.001, 0.013)$ |
| $\Delta LP_{reallocation}$ | 0.003 | 0.019 | $(0.001, 0.038)$ |
| $\Delta LS_{total}$ | −0.059 | −1.088 | $(-1.416, -0.760)$ |
| $\Delta LS_{within}$ | 0.236 | −0.477 | $(-0.675, -0.279)$ |
| $\Delta LS_{reallocation}$ | −0.273 | −0.842 | $(-1.077, -0.607)$ |

The table shows the change in aggregate and average change in productivity (percent) and labor share (percentage point) associated with a one percentage point change in import penetration. The measure of within change represents the change in mean among incumbents, and the reallocation change represents changes in the covariance between market shares and productivity (labor shares) among incumbents.

As is clear from Table 7, despite the under-prediction of changes in labor shares, the model does a decent job of replicating the patterns found in the data. Specifically, it predicts a fall in the aggregate labor share that exceeds the fall in the average labor share and an important contribution from the reallocation component. In addition, the within-firm and reallocation component are central in explaining the total change in labor share while the extensive margin is less important. In the data, neither entry nor exit had a significant effect on the labor share. In the model, the extensive margin is captured by the change in firms that choose to enter the market and start producing. With higher import penetration there will be a larger number of firms that choose to enter the market because of higher potential profits from the improved investment possibilities. However, fewer firms will choose to start producing as the cut-off is higher following the higher level of competition, and the least productive firms will not choose to start producing. The effect of the change in stock of producing firms is captured by the residual between the total change in Table 7 and the sum of the within and reallocation components. This effect turns out to be small in comparison to the within and reallocation components (0.954-0.224-0.621=0.109).

#### 6.1.2 No-investment model

Panel (B) in Table 7 shows the corresponding changes in productivity and the labor share for a no-investment model. Clearly, the model is not able to predict the observed fall in the labor share following an increase in import penetration. Although the reallocation component predicts a fall in the labor share, this is offset by a rise in the average labor share. The rise in average labor share is the result of only the positive force on firm-level labor shares, stemming from an increase in demand elasticity resulting in lower markups and higher labor shares, being present in this case.

When it comes to changes in productivity in the no-investment model, some further comments are required. At first sight, the observed decrease in the average labor productivity and close to zero effect on the aggregate labor productivity from the change in import penetration in the no-investment model could appear odd. This model is close to the standard Melitz and Ottaviano (2008) model where an increase in competition is known to lead to an increase in aggregate productivity due to market selection. However, the experiment here is one similar to a unilateral trade liberalization. As shown by Melitz and Ottaviano (2008), a unilateral trade liberalization induces an increase in the cost cut-off and a decrease in overall competition in the liberalizing country. This decrease in competition comes from a decrease in the number of entering domestic firms, induced by lower expected profits.

In the next section we take the model one step further by looking at the welfare implications of changes in import penetration.

## 6.2 Welfare implications

### 6.2.1 Baseline model

The change in import penetration, as shown, is associated with an increase in productivity, both in aggregate terms and at the firm level. This increase in productivity results in an increase in utility. Looking at the equivalent variation measure, the increase in welfare following a one standard deviation increase in import penetration is equivalent to increasing the income in the initial (low import penetration) state by about 1.12 percent (see Table 8). The reason for the positive effect on welfare, despite a fall in the labor share reflecting higher markups, is that consumers meet lower prices and hence can afford a higher level of consumption. At first, it can appear odd that the economy can have a higher level of productivity and welfare at the same time as it has higher markups since as markups are usually viewed as reflecting inefficiencies in the economy. To understand the reason behind the results, it is important to remember the source behind higher markups. Higher markups are generally thought to reflect lower competition, enabling firms to raise their prices without losing costumers. In the context of the experiment run in this paper, increases in markups are entirely driven by firms becoming more productive. Although firms that become more productive can charge higher markups, they also reduce their price with direct benefits for consumers.

**Table 8:** Welfare change

| Model | Equivalent variation |
|---|---|
| Baseline | 1.121% |
| No-investment | -0.185% |

The table shows the equivalent variation of a one standard deviation increase in import penetration, i.e., the percentage change in income necessary to make the consumer as well off as the change in import penetration, for a model with and without investment possibilities.

### 6.2.2 No-investment model

Also, in the no-investment model, the increase in import penetration is associated with a productivity-enhancing reallocation. However, there is also a decrease in productivity within firms, and the total effect on domestic productivity is close to zero. The equivalent variation measure total welfare is lower following the increase in import penetration. The welfare loss from a one standard deviation increase in import penetration is equivalent to decreasing the income in the initial (low import penetration) state by 0.185 percent. The negative effect on welfare is mainly driven by a change in the pool of entering firms. When foreign competition increases, the expected profit from entering the market goes down, resulting in fewer firms choosing to enter. The smaller pool of entering firms results in a less productive pool of producing firms and an increase in the cut-off and price of the $Q$ good. The higher price of the $Q$ good has direct negative implications for welfare. Related to the role of markups, we can also see a small increase in markups in this case. However, in contrast to the baseline, higher markups are not accompanied by lower prices here.

# 7 Concluding Remarks

To sum up, the objective of this paper has been to investigate the empirical relationship between increasing product-market competition and changes in labor shares and analyze potential welfare effects. The empirical analysis shows that an increase in competition is associated with a fall in the labor share at the industry level. The fall is to a large extent due to a reallocation of market shares across firms, but labor shares fall also within firms. Furthermore, the fall in labor shares is shown to stem from an increase in productivity without a corresponding increase in labor costs. These empirical findings are hard to explain using a standard Melitz and Ottaviano (2008) model. Instead, to explain the empirical findings, it is necessary to allow firms to invest in productivity improvements. Allowing for productivity improvements at the firm level leads to a larger increase in productivity when import competition increases than in a model without investments possibilities. The introduction of investment possibilities does not only help the model to better fit the data but also has important implications for welfare. In a model without investment possibilities, an increase in foreign competition results in a decrease in overall competition and a small welfare loss. This fall in competition comes from a reduction in the number of entering firms induced by lower expected profits. In contrast, in a model with investments, expected profits go up as better investment possibilities are available and the overall effect on welfare is positive.

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# Appendices

## Appendix A First-stage results

Using an instrumental variable (IV) approach instead of relying on an ordinary least squares (OLS) regression inevitably results in a loss of efficiency and is only motivated if the OLS estimator is biased and inconsistent. If the import penetration ratio is not endogenous, the OLS estimation is more efficient than the IV estimation. Using the Hausman test we can reject the null hypothesis that the OLS estimator is consistent and fully efficient, and we cannot rule out systematic difference between OLS and IV estimates.

Having confirmed that an IV approach is motivated, it is essential that the used instruments are 1) relevant and 2) fulfill the condition of being exogenous. In this context, the relevance of the instrument means that it is correlated with the import penetration ratio in the Swedish industries of concern. To test the relevance of the instrument, we use the Kleibergen-Paap (2006) F-statistic. The Kleibergen–Paap test for weak identification is at all horizons above the rule-of-thumb F-value of 10, which confirms the relevance of the instrument for the first stage. Specifically, the F-statistics are 14.80, 11.15 and 11.66 for the five-, eight- and ten-year horizon respectively. The correlation between the ten-year changes in domestic import penetration ratio and the predicted values from the first-stage regression are shown in Figure A1.[38]

The instrument exogeneity condition implies that the instrumental variable ($z$) should be correlated with the error term in equation 2), i.e., $\mathrm{E}(u|z) = 0$. Or, in other words, it should not have a direct impact on the left-hand side variable (here change in labor share, labor cost, and productivity or its subcomponents included in equation 2). Hence, any effect of change in imports in the instrumenting countries on the outcome variable is exclusively through its potential effect on changes in domestic import penetration. This assumption is not verifiable.

[38]The first-stage regression being the regression of changes in domestic import penetration on changes in log imports in the instrumenting countries.

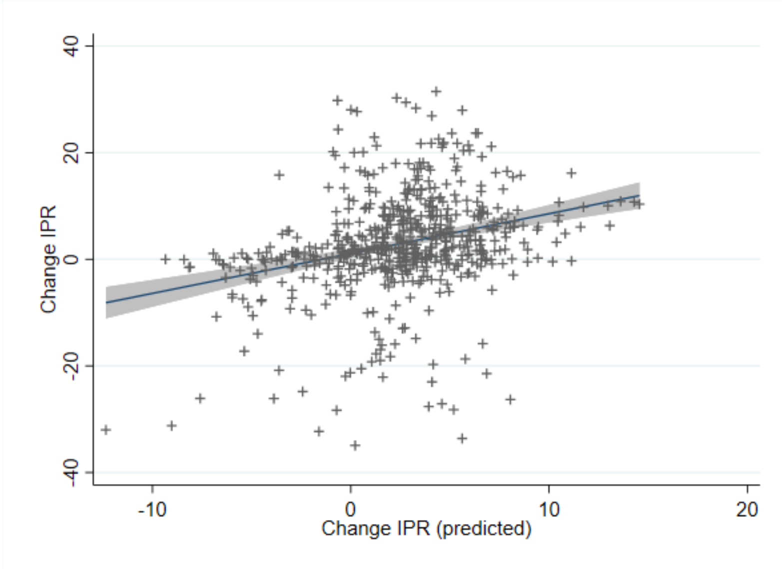


**Figure A1:** correlation between ten-year changes in import penetration and predicted changes.

# Appendix B IV estimates using two-stage least squares

**Table B1:** IV regression results (2sls)

| | (1) $\Delta LS_{total}$ | (2) $\Delta LS_{reallocation}$ | (3) $\Delta LS_{within}$ | (4) $\Delta LS_{entry}$ | (5) $\Delta LS_{exit}$ |
|---|---|---|---|---|---|
| $\Delta_5$ IPR | -1.720*** | -1.090*** | -0.729*** | -0.026 | 0.126* |
| | (0.315) | (0.287) | (0.171) | (0.026) | (0.063) |
| $\Delta_8$ IPR | -1.509*** | -1.036*** | -0.604** | 0.004 | 0.126 |
| | (0.277) | (0.262) | (0.186) | (0.004) | (0.080) |
| $\Delta_{10}$ IPR | -1.264*** | -0.812*** | -0.567*** | 0.000 | 0.115 |
| | (0.229) | (0.204) | (0.155) | (0.004) | (0.079) |
| N clusters | 70 | 70 | 70 | 70 | 70 |

The table shows the results from running IV regressions of changes in total labor share and its subcomponents on changes in import penetration at five-, eight- and 10 year horizons using a rolling regression approach. The number of observations is given by the number of clusters times the number of years of data. Hence, for the 10(8)[5] year horizon, the numbers of observations are $70 \times 9(11)[14]$. All regressions include time dummies and are weighted by initial industry value added shares. Standard errors (in parentheses) are clustered at 4-digit industry level, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

# Appendix C Revenue share-preserving investment function

For a firm that chooses to invest in a marginal-cost reduction of $\Delta$, the proportional increase in revenue is given by

$$\rho_i = \frac{c_D^2 - (c_i - \Delta)^2}{c_D^2 - c_i^2}. \tag{C.1}$$

Assuming all firms that choose to invest in a marginal-cost reduction grow by the same proportion, $\rho_i = \rho$, equation (C.1) has to hold for all firms $i$ in $\Omega_i$. Hence, we must have

$$\rho = \frac{c_D^2 - (c - \Delta)^2}{c_D^2 - c^2}.$$

Rearranging we have

$$c_D^2 - (c - \Delta)^2 = \rho = (c_D^2 - c^2).$$

Solving for $\Delta$ as a function of $c$, we have

$$c_D^2 - c^2 + 2c\Delta - \Delta^2 = \rho(c_D^2 - c^2),$$

$$\Delta^2 - 2c\Delta + (\rho - 1)(c_D^2 - c^2),$$

$$\Delta = c \pm \sqrt{c^2 - (\rho - 1)(c_D^2 - c^2)}.$$

Since the square root is positive if real, the cases relevant for a marginal-cost reduction gives $\Delta$ as a function of $c$ given by

$$\Delta(c) = c - \sqrt{c^2 - (\rho - 1)(c_D^2 - c^2)}.$$

# Appendix D Solving the model

The model is solved using an iterative procedure starting with an initial guess for the cost cut-off, $c_D$. With a given $c_D$, we can then solve for the firms' production and pricing decisions and aggregate consumption. The procedure is repeated for new initial values of the cost cut-off until the model converge and the budget constrain of the household holds. Specifically, the following steps are performed:

- Guess an initial level of $c_D^0$.
- Draw firm-level costs for domestic and foreign firms from given (but different) distributions, $G(c) = \left(\frac{c}{c_M}\right)^{\kappa}$ and $G^f(c) = \left(\frac{c}{c_M^f}\right)^{\kappa}$.
- Firms decide to exit or produce.
- Solve for firm prices $(p_i)$ and derive $P_Q$.
- Given $c_D^0$ and $P_Q$, solve for firm's innovation decision and output $(q_i) \rightarrow Q$.
- Iterate on $c_D$ until the budget constraint, $(1-\beta)WL = P_Q Q$, holds.
- Repeat the above steps for different levels of foreign competitiveness and hence different levels of import penetration (IPR) and solve for domestic labor share (at firm level and aggregate) and welfare.