Trade costs, import penetration, and markups

Li, Yifan and Miao, Zhuang

McGill University

1 April 2018

Trade costs, import penetration and markups

April 3, 2018

Abstract

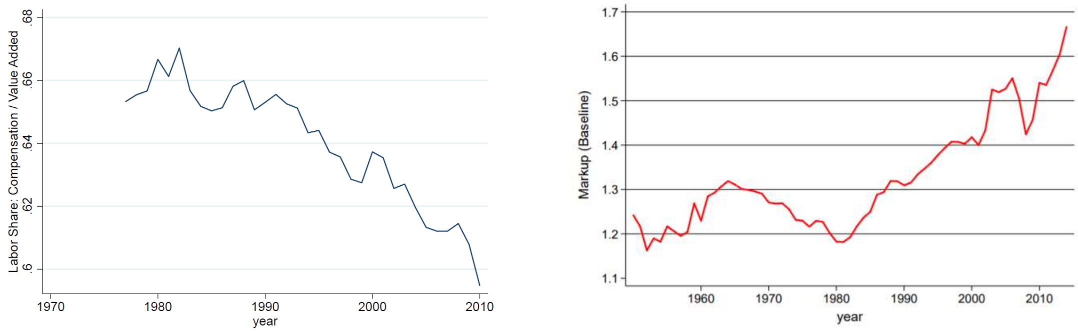
The rise of market power and the decline of labor's share of GDP in the United States in recent decades is well documented and have critical macroeconomic implications, but the determinants of such trends remain unclear. This paper asks how and to what degree increasing import penetration contributes to the more concentrated market structure and the associated rise of mark-ups. We provide a general equilibrium framework linking the change of markup with the extensive margin of foreign-input imports. In the model, a reduction of importing costs induces non-importers to start importing intermediates and existing importing firms to increase the share of imported inputs. But the capability of importing more varieties of inputs depends on productivity as it requires fixed costs to select cost-efficient intermediate inputs to import. We then combine firm-level micro panel data, sector-level trade data and input-output table to present empirical evidence on the relationship between the rise of market power and the increase of imported inputs penetration. At the 6-digit sector level, the rise of imported input penetration induced market concentration, implying that only the most productive firms benefit from trade liberalization. We further test our predictions of heterogeneous firms' decisions on intermediates importing and the implications on the market structure using transaction-level custom data: decreasing trade costs induce non-importing firms to start to import intermediates and allow the existing importing firms to charge higher markups than before.

Key words: trade cost, import penetration, imperfect market competition, market power, markups

JEL classification: F14 F15 L13

1 Introduction

One key trend in the past several decades is trade liberalization and accompanied global sourcing. Dramatic removal of trade barriers, substantial decrease of tariffs as well as advances in communication, information, and transportation technologies have revolutionized how and where firms produce their goods. Indeed, there has been a substantial increase in industry openness and imports in the United States in the last few decades: the ratio of imports to GDP went up from 10 percent in 1993 to around 16 percent in 2010 (see Figure 2a and 2b). Meanwhile, discussion about the rise of market power and its macroeconomic impacts dominate current policy debate. In the last few decades, much has been learned about the fact and impacts of the decline of labor shares. Autor et al. (2017) point to a decline in the labor share in the United States particularly evident since 2000 (see Figure 1a). De Loecker and Eeckhout (2017) document a steady rise of estimated firm markup since 1980, from 18% above cost to 67% (see Figure 1b). These papers point to the rise of concentration in the market and the associated decreasing degree of competitiveness over time. But the determinants of such fall in labor's share and increase in market power remain unclear. Given the transformative impact of trade liberalization, it is natural to consider the effect of import penetration may have had on the market structure and on firms' decisions of markup setting. The conventional wisdom presumes intensified competition as the process of globalization continues, thereby alleviating the distortions associated with monopoly power. This presumption is not however granted, because the change from the economy-wide distribution of markups and the dynamics of firms induced by trade is not an obvious one.

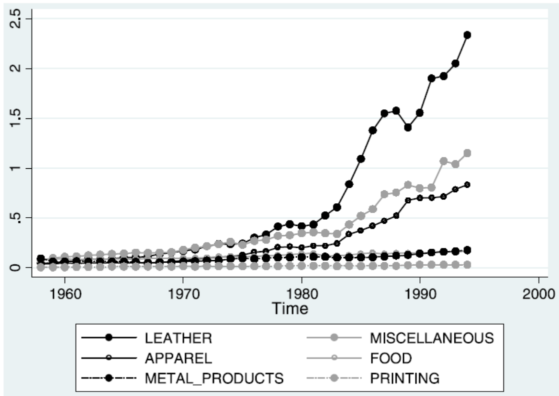


(a) Labor Share to Value Added (1978-2010), from figure 1 in Autor et al. (2017)

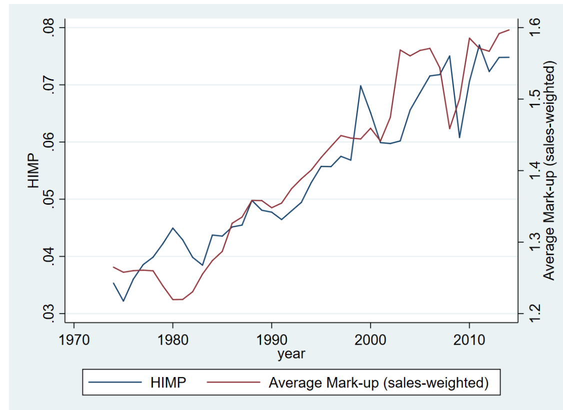
(b) The Evolution of Average Markups (1960 - 2014), from figure 1 in De Loecker and Eeckhout (2017)

Figure 1: Trends of markups and labor share

This paper asks whether increasing import penetration induces market structure towards more concentrated and induces firms to increase average markup. Such a link between trade liberalization and market power is important. On one hand, import penetration increases competition of final products, which implies pressure for the firms to decrease their markup. On the other hand, trade liberalization also led to improved access to imports of foreign-made intermediate inputs. If trade liberalization only benefits the most productive firms in each industry, product market concentration will rise as industries become increasingly dominated by large firms with high profits and a low share of labor in firm value-added and sales. To address this point, we provide a general equilibrium framework which characterizing the change of markup with the change of the extensive margin of sourcing decisions to materialize the mechanisms at work. And we then combine firm-level micro panel data, sector-level trade data and input-output table and present empirical evidence on the relationship between the rise of market power and the increasing trend of imported inputs penetration. At the very detailed 6-digit sector level, the rise of imported input penetration induced market concentration, implying that only the most productive firms benefit from trade liberalization. Decreasing trade costs induce non-importing firms to start to import intermediates and induce existing importing firms to increase the share of imported inputs. Firms that employ more imported inputs in the production are observed to raise the markup of their products.



(a) Trade openness across US industries, from figure 1 in Epifani and Gancia (2011)



(b) The Evolution of Average Markups and Horizontal Import Penetration Ratio (1972 - 2014)

Figure 2: Trade openess and markups

In this paper, we first produce the stylized fact of import penetration and match it with replicated stylized fact regarding the trend of markup since 1970. We show that the rise of imported input penetration ratio based on 2-digit sector code highly correlates with weighted average markup across the economy based on firm-level sales, while the import penetration ratio shows ambiguous relation with the change of markup. Because import penetration ratio mixed the effect of competition from the final goods with the effect of employment of cheaper/better inputs on market structure. Making use of imported inputs contributes to the decrease of firm's marginal cost and increase firm's potential of higher markup. But it may requires some level of firm ability to take advantage of imported inputs.

We explain these facts by a general equilibrium model with the linkage of the rising market concentration to firms' capabilities of global sourcing. Our model is based on an extension of Melitz and Ottaviano (2008), with variable markup as in the work of Amiti et al. (2014), the change of markup with the change of the extensive margin of sourcing decisions. The model generates linear equations that relate changes in the markup and changes in the vertical import penetration ratio. The capability of importing more varieties of inputs comes from higher productivity because it requires a fixed cost to select more cost-efficient intermediate inputs to import. Thereby magnifying their cost advantage relative to less productive firms.

We then test the predictions of our model first using US firm-level panel data for public firms, input-output table and trade data over the period 1997 to 2014. Identification strategy involves exploiting some supply shocks in the US's trading partners like variation in exchange rates or reductions in external tariffs. Thus we could provide causal evidence that the increase in imports (induced by foreign supply shocks) from either more countries or countries with lower costs to a substantial increase in the markups over the sample period, which give rise to a decline to the labor share income. Next, we further test our predictions of heterogeneous firms' decisions on intermediates importing and the implications on the market structure using transaction level custom data, the Longitudinal Firm Trade Transactions Database (LFTTD) which links individual import and export transactions to the U.S. firms.

Our coefficient estimates confirm the main predictions of our model.

The rest of the paper is organized as follows. Section 2 provides a key literature review. Section 3 presents a general theoretical framework that encompass monopolistic competition and variable mark-up to examine the impact of trade cost reductions on firms' mark-ups and associated intra-industry reallocation. Section 4 describes the identification strategy as well as the estimation method for firm-product mark-ups. Section 5 describes data-sets and measurement used. Section 6 presents our econometric specifications and report the main results, followed by an interpretation of the underlying mechanisms.

2 Literature Review

Our paper contributes to a vibrant literature that look at the rise of market power and the decline of labor share to GDP in the US. De Loecker and Eeckhout (2017) document that the average mark-up among the U.S. firms have been increasing dramatically since 1980s and provide several macroeconomic implications of this trend such as the decline in labor and capital share, the decrease of low skill labor wage, and the slow down in aggregate output. Elsby et al. (2013) consider the potential impact of globalization and the rising imports on the decline of labor share. They provide a set of simple cross-industry regressions and graphs and show that the variation in the change in import exposure explains 22 percent of the cross-industry variation in payroll-share changes. Autor et al. (2017) reassess the secular trend of labor share through micro panel data since 1982 and interpret the fall in the labor share to be the result of the rise of "superstar firms" who dominate the market with high profits and low share of labor in firm value-added and sales. They also notice the potential role that globalization and technological changes might have played but are skeptic as the fall in labor's share also appears in non-traded sectors like retail and wholesale, not just in traded sectors like manufacturing.

While also focused on the explanation and implication of the rise of market power, our paper differs from the existing literature along several dimensions. Firstly, while they focus in the study of the decline of labor share, our research is focus on the effect of import penetration on the rise of mark-up, though it finally speaks to the reasons of this secular trend in labor share. Secondly, while they notice the trend of increasing import, our paper looks not only at the direct impact, i.e the substitution effect, which depresses labor share of domestic income and reduces the marginal cost of firms who employ cheap foreign inputs; but also the indirect impact, i.e the competition effect, which changes the market structure to be more concentrated as only some of the firms could pay the fixed cost and utilize global opportunities. Thirdly, while they try to link the rise of market power of superstar firms as the cause for the decline of labor share, our purpose is to propose a mechanism that drives this rising market concentration and to illustrate how less-frictional international trade enables more efficient firms to be rewarded with higher market shares today than in the past. Finally, existing empirical assessments of import typically have relied on industry or macro data, obscuring heterogeneity among firms. Our paper combines firm-level micro panel data, sector-level trade data and input-output table to first present empirical evidence on the relationship between the rise of market power and the increasing trend of imported inputs penetration. And we further look at transaction-level data to flesh out the detailed mechanism at work.

Our paper is also related to a literature that looks at heterogeneous firm and firm performance in the context of trade liberalization. Within this literature, our paper is closely related to Melitz and Ottaviano (2008) and Halpern et al. (2015). Melitz and Ottaviano (2008)develop a monopolistic competition model of trade with firm heterogeneity who has been a workhorse model that predicts intra-industry reallocation between firms with different mark-ups following trade liberalization. Halpern et al. (2015) estimate the productivity gain from improved access of foreign input. They assume a constant elasticity of substitution (CES) utility function and provide a static model of industry equilibrium where firms use both domestic and imported intermediates goods for production. However, CES utility directly implies constant mark-up and make it unsatisfactory to analyze variable mark-up changes with respect to aggregate shocks. Our contribution to this literature is that we trace in detail how imported input penetration plays a role in the pricing of firms who have better ability to utilize sourcing opportunities. In a world in which firm heterogeneity interacts with fixed sourcing costs, the firm's decision to import from one market will also affect the market structure in the end. In our model, a reduction in global sourcing costs induces a firm to increase imports of low-cost input and to increase the markup but the access to foreign inputs is restricted to the firms who could pay the fixed importing cost and use imported intermediates. Our model predicts that with great importing cost reduction, existing importing firms will import more foreign intermediate varieties, leading to even better advantages in both product quality and production cost. These two effects will thereby magnify existing advantages more productivity firms have relative to less productive firms. Thus in turn implies that the trade liberalization have asymmetric impacts on the market share of existing market players which feature more positive skewness to forerunner.

Our paper also complements to a large body of literature that evaluates welfare gains from trade by estimating mark-up heterogeneity and allocative efficiency. Epifani and Gancia (2011) documents several stylized facts about mark-ups dispersion across industry over time with exposure to trade. They provide a oligopoly framework with CES utility and find that markup heterogeneity entails significant costs and that asymmetric trade liberalization may reduce welfare when there exists restricted entry. Holmes et al. (2014) considers a similar model with decomposition of welfare effects of trade into cost-change and price-change channels. The key difference between both of these papers and ours are (i) our paper adopts monopolistic competition with linear demand system who allows mark-up variability to depend not only on market share but with imported input substitution and product/industry characteristics, (ii) In our framework, a change in the trade costs induces marginal cost change directly and induces price change indirectly through both general equilibrium effects (the number of active firms) that shift or rotate the firm's demand curve.

Finally, this paper contributes to the literature of movements in international prices and aggregate shocks such as exchange-rate fluctuations or trade cost variation (Burstein and Gopinath (2014); Arkolakis and Morlacco, 2017). We examine how the changes in variable and fixed trade cost are passed through to the mark-ups. Amiti et al. (2014) develop a oligopoly framework with variable markups and imported inputs, which predicts that firms with high import shares and high market shares have low exchange rate pass-through. In equilibrium, the more productive firms end up having greater market shares and choose to source a larger share of their inputs internationally, which in turn further amplifies the productivity advantages of these firms. However, Amiti et al. (2014) link mark-up variation exclusively to market share of the firm, neglecting the the effect that exogenous change of variable cost have on industry reallocation. And this framework also lacks the potential connection between product characteristics and mark-up. Ludema and Yu (2016) explain the incomplete pass-through of foreign tariff reductions by firms' quality-upgrading strategy, which is estimated to be greater for high productivity firms.

In our paper, we would like to clarify the mechanism that the globalization process results in the increasing trend of firms' markups during the last three decades. The main contributions of our paper rely on two points: firstly, we construct a theoretical model which links the relationship between the rise of the outsourcing process and the increase of firms' average markups, and also distinguishes the changes of the market structures during this process, e.g. the entry-exit decision, outsourcing decision, and price strategies made by heterogeneous firms; secondly, we practice some empirical tests to our theoretical predictions, and the relation between the outsourcing and markups is empirically tested for the first time.

With these features, we estimate our model using panel data for the U.S. firms. We have the following hypothesis and we provide empirical links for these conjectures:

Conjecture 1. *A decrease in variable trade costs increases the share of imported inputs and increases the number of importing firms: new importers are drawn from the most productive non-importers.*

Conjecture 2. *A decrease in variable trade costs raises the probability of firm exit; And it increases the market share of existing importers.*

This is because only most productive firms could benefit from the potential imported-input cost reduction at the margin, because of the fixed cost of intermediates importing; With the marginal decrease of marginal cost, high productivity firms (with high markup) capture more market share (inter-firm effect);

Conjecture 3. *A decrease in variable trade costs increases the markup of existing importers, due to: 1) Cost-Reduction Effect; 2) Competition Effect; While it decreases the markup of non-importers due to competition effect.*

Conjecture 4. *A decrease in variable trade costs induce firm dynamics as in 1 &2, which leads to an increase of aggregate industry productivity and average mark-ups.*

3 Theoretical Framework

In this section, we develop our quantifiable multi-country model of global sourcing and markup. Our model is based on an extension of Melitz and Ottaviano (2008). Building upon Halpern et al. (2015), we incorporate Amiti et al. (2014)'s way to model the firm's cost structure and its choice to import intermediate inputs. We extend the model by adding sequential choice of importing associated with productivity and analyze its comparative statistics both in the short equilibrium and in the long equilibrium. In sections below, we present the model and derive equilibrium prices, sourcing strategies, marginal cost and markups. Considering our model is similar as Amiti et al. (2014), we relegate derivations to the Appendix and examine in more detail the impact of increasing import penetration on markups.

3.1 Consumers and demand

Preferences are defined over a continuum of differentiated varieties indexed by $i \in \Omega$, and a homogeneous good chosen as numeraire. All consumers share the same quasi-linear utility function given by

$$U = q_0^c + \alpha \int_{i\in\Omega} q_i^c di - \frac{1}{2}\gamma \int_{i\in\Omega} (q_i^c)^2 di - \frac{1}{2}\eta(\int q_i^c di)^2 \tag{1}$$

where q_0^c and q_i^c represent the quantities of the numeraire good and the differentiated variety i respectively. The demand parameters α, η, and γ are all positive. The parameters α and η index the substitution pattern between the differentiated varieties and the numeraire good, and the level of competition intensity among differentiated varieties. The parameter γ indexes the decreasing rate of the marginal utility for each variety. Given the price for variety i , consumers decide their quantity demand as followings.

$$q_i \equiv Lq_i^c = \frac{\alpha L}{\eta N + \gamma} - \frac{L}{\gamma} p_i + \frac{\eta N}{\eta N + \gamma} \frac{L}{\gamma} \bar{P} \tag{2}$$

where L denotes the population of the economy, N measures the mass of varieties in Ω (which is also the number of active firms) and $\bar{P} = \frac{1}{N} \int_{i\in\Omega^*} p_i di$ is the average price of all varieties existing in the market. The set $\Omega^*$is the collection of the varieties that exist in the market. In another words, the variety which belongs to the set Ω^* must satisfy

$$p_i \leq \frac{1}{\eta N + \gamma}(\gamma\alpha + \eta N\bar{P}) \equiv p_{max} \tag{3}$$

[1]

3.2 Producers

For simplicity, we assume that final-good varieties are prohibitively costly to trade across borders. Similar to Amiti et al. (2014), we model the cost structure of the firm and its choice to import intermediate inputs. Consider firm i, indexed by its productivity A_i, uses labor L_i and a composite intermediate input X_i to produce output Y_i according to the production function:

$$Y_i = A_i {X_i}^{\phi} {L_i}^{1-\phi} \tag{4}$$

The composite intermediate input X_i consist of a bundle of intermediate goods X_{ij} indexed by j $\in$ [0,1] aggregated according to a Cobb-Douglas technology:

$$X_i = \prod_j X_{ij}^{\delta_j} \tag{5}$$

We denote the relative importance of each type of intermediate input X_{ij} by δ_j, and it is normalized to $\sum_0^1 \delta_j = 1$. Each intermediate good X_{ij} that being used by firm i can be procured within and/or beyond the border. To simplify our analysis, we assume that each firm uses only one type of intermediate which could be purchased domestically or imported from the foreign market. D_i represents the quantity of the domestic-specific inputs which can only be purchased domestically, and M_i represents the quantity of intermediate inputs which could be sourced from both the domestic and foreign markets. The

[1]The set Ω^* is also endogenously determined by this equation.

elasticity of substitution between D_i and M_i is assumed as ξ.

$$X_i = \left[D_i^{\frac{\xi}{1+\xi}} + aZ_i^{\frac{\xi}{1+\xi}} \right]^{\frac{1+\xi}{\xi}} \tag{6}$$

Intuitively, a measures the productivity advantage of the foreign variety. Although production is still possible without the use of imported inputs, imported inputs are useful due to (i) their potential productivity advantage a, and (ii) the love-of-variety feature of the production function. The prices of imported inputs and domestic inputs are demoted by P_M and P_D respectively, and we assume the firms are price takers in these input markets.

A firm i needs to pay fixed costs f_i in order to import intermediate j. The presence of fixed costs have been founded empirically and have been widely assumed (Amiti et al. 2014; Antras et al. (2017); Gopinath and Neiman (2014); Halpern et al. (2015)). Following this setting, we compute the variable cost index for the importers and non-importers as followings.

$$V_i = \begin{cases} \left[1 + \left(\frac{\tau_m P_{Mf}}{a} \right)^{\frac{1}{1+\xi}} \right]^{1+\xi} & importer \\ \left[1 + (P_{Md})^{\frac{1}{1+\xi}} \right]^{1+\xi} & non-importer \end{cases} \tag{7}$$

where P_{Mf} and P_{Md} are the prices for the foreign and domestic intermediates respectively; τ_m captures the trade cost from purchasing the foreign intermediates.

Let $B_i \equiv \left[1 + a \left(\frac{\tau_m P_{\mathrm{Mf}}}{P_{\mathrm{Md}}} \right)^{1-\xi} \right]^{\frac{1}{1-\xi}}$, which represents the relative-cost-adjusted quality-enhancing factor of importing type-j intermediates, and $\bar{D} \equiv (\frac{W}{1-\phi})^{1-\phi}(\frac{1}{\phi})^{\phi}$, the marginal cost for firm i is computed as:

$$c_i = \varphi_i(\frac{W}{1-\phi})^{1-\phi}(\frac{1}{\phi})^{\phi} V_i^{\phi} = \varphi_i V_i^{\phi} \bar{D}$$

where W measures the domestic wage rate, and φ_i is inverse productivity of firm i, which is assumed to follow a Pareto distribution, i.e. $\varphi \sim \left(\frac{\varphi}{\overline{\varphi}} \right)^k$ with support $[0, \overline{\varphi}]$. [2]

[2]Recall that the producvitivity level for firm i is denoted as A_i, thus $\varphi_i = \frac{1}{A_i}$.

As the term $\bar{D}$ is identical across all the firms, thus the firms only differ in their productivity levels and the term V_i, depending on how much the foreign inputs they use.

In a closed economy, firm i only sources from the domestic market so the profit maximization problem is:

$$Max_{p_i}\,\pi^D = (p_i - c_i) * q_i$$

Profit maximization implies the following results (see the derivation details in Appendix):

$$\begin{aligned} p_{\text{iD}} &= \tfrac{1}{2}\left(c_i + c_d\right) \\ \mu_{\text{iD}} &= \tfrac{(c_i+c_d)}{2c_i} \\ q_{\text{iD}} &= \tfrac{L(c_d-c_i)}{2\gamma} \\ r_{\text{iD}} &= \tfrac{L(c_d-c_i)(c_d+c_i)}{4\gamma} \\ \pi_{\text{iD}} &= \tfrac{L(c_d-c_i)^2}{4\gamma} \end{aligned} \tag{8}$$

where $p_i\left(c_d\right) = p_{\max} = \frac{1}{2}\left(c_{\max} + p_{\max}\right)$, therefore, $p_{\max} = c_d$, and c_d is the cut-off cost value for the firms to decide whether to exit the market after knowing their exact variable cost, i.e. all the firms whose variable cost is higher than this value will exit the market.

Assume the firm's variable cost c is drawn from a known distribution $G(c)$. [3] The cost (productivity) cut-off is thus determined by the free-entry condition:

$$\int_o^{c_d} \pi(c_i)dG(c) = f_E \tag{9}$$

Mass of surviving firms is determined using c_D and the zero demand price condition:

$$c_d = \frac{\gamma\alpha + \eta N\bar{P}}{\eta N + \gamma} \tag{10}$$

[3]Under the case of closed economy, the variable c follows the same type of distribution as the inverse productivity.

This gives that

$$N = \frac{\gamma}{\eta} \frac{\alpha - c_d}{c_d - \bar{P}} \tag{11}$$

and the mass of entrants is

$$N_E = \frac{N}{G(c_d)} \tag{12}$$

The productivity distribution gives that

$$\bar{P} = \int_{\omega\in\Omega} p(\omega) d\omega = \int_0^{c_d} \frac{c_i + c_d}{2} d\mathrm{G}(c_i)/G(c_d) \tag{13}$$

3.3 Open Economy Equilibrium

3.3.1 a short run equilibrium

In the short run, we keep the number of entrants N_E and the productivity distribution $G(.)$ fixed. The number of survived firms is thus $N = N_E G(\varphi_d)$, where φ_d is the cut-off value of productivity, i.e. $c_d = \varphi_d V_i^{\phi} \bar{D}$. Recall that the inverse productivity is assumed to be drawn from a Pareto distribution, $\varphi \sim \left(\frac{\varphi}{\overline{\varphi}}\right)^k$ with support $[0, \overline{\varphi}]$. Following Antras et al. (2017), we assume that it incurs fixed cost from importing intermediates from the foreign market and the importing fixed cost $f_m(\varphi_i)$ increases in φ_i . Obviously, firm i decides whether to import the intermediates based on the expected profits it faces. Simply, the firm will import the inputs if the following formula is greater than zero: $H(\varphi_i) \equiv \pi(\varphi_i|importer) - \pi(\varphi_i|non-importer)$, where $\pi(\varphi_i|importer) = \left(p_i^f - \varphi_i V_i^{\phi} \bar{D}\right) * q_i^f - f_m(\varphi_i)$ with $V_i^{\phi} < 1$ and $\pi(\varphi_i|non-importer) = \left(p_i^d - \varphi_i \bar{D}\right) * q_i^d$. As we assume that the firm only import one type of input from one foreign country, the index V_i^{ϕ} should be identical across all importing firms, i.e. $V_i^{\phi} = V^{\phi}$, and normalize $V_i^{\phi} = 1$ for all the firms which are not importing inputs. Assume the formula $f_m(\varphi_i)$ satisfies that $H(\varphi_i)$ decreases in φ_i . Assume the firm m is indifferent in importing inputs or purchasing the inputs domestically, i.e. $H(\varphi_m) = 0$, $H(\varphi_i) > 0$ for $\varphi_i < \varphi_m$ and $H(\varphi_i) < 0$ for $\varphi_i > \varphi_m$. In this case, the survived firm who has lowest productivity won't choose to import the intermediates, i.e. $c_d = \varphi_d \bar{D}$. Then the value of φ_m is determined by $H(\varphi_m) = 0$. Without losses of generality and get the closed form solution, we assume that $f_m(\varphi_i) = \kappa\varphi_i$. Then the formula $H(\varphi_i)$ is solved as $H(\varphi_i) = \frac{L\left(\varphi_d \bar{D} - \varphi_i V^{\phi} \bar{D}\right)^2}{4\gamma} - \frac{L\left(\varphi_d \bar{D} - \varphi_i \bar{D}\right)^2}{4\gamma} - \kappa\varphi_i = \frac{\left[2\varphi_d - \left(V^{\phi}+1\right)\varphi_i\right]\left(1-V^{\phi}\right)\varphi_i \bar{D}^2}{4\gamma} - \kappa\varphi_i$. Then the critical value φ_m is solved as:

$$\varphi_m = \frac{2\varphi_d - \frac{4\gamma\kappa}{(1-V^{\phi})\bar{D}^2}}{1+V^{\phi}} \tag{14}$$

Obviously, for the firms whose inverse productivity is lower than φ_m will choose to import the inputs and the firms with higher inverse productivity will choose to use domestic inputs only.

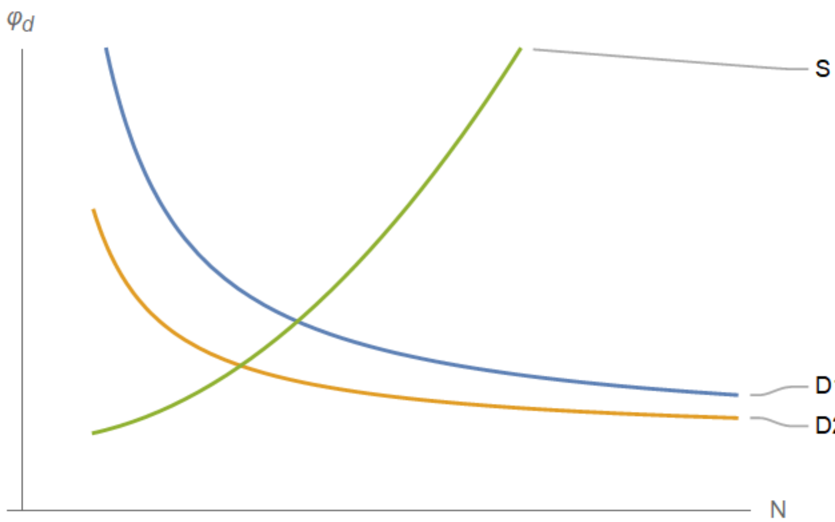


Figure 3

Determination of N and φ_d

In the open economy case, the equation (13) is written as:

$$\bar{P} = \int_0^{\varphi_m} \left(\frac{\varphi_i + \varphi_m}{2}\right) V^{\phi} \bar{D} d\mathrm{G}(\varphi_i)/G(\varphi_d) + \int_{\varphi_m}^{\varphi_d} \left(\frac{\varphi_i + \varphi_d}{2}\right) \bar{D} d\mathrm{G}(\varphi_i)/G(\varphi_d) \tag{15}$$

As $\varphi \sim \left(\frac{\varphi}{\bar{\varphi}}\right)^k$, we can simplify the equation above as:

$$\bar{P} = \frac{(2k+1)\left[\varphi_d^{k+1} + \left(V^{\phi} - 1\right)\varphi_m^{k+1}\right]\bar{D}}{2(k+1)\varphi_d^k} \tag{16}$$

Substitute the equation above into the equation (11), we can get:

$$N = \frac{\gamma}{\eta} \frac{\alpha - \varphi_d \bar{D}}{\varphi_d \bar{D} - \frac{(2k+1)\left[\varphi_d^{k+1} + (V^{\phi}-1)\varphi_m^{k+1}\right]\bar{D}}{2(k+1)\varphi_d^k}} \tag{17}$$

Combining equations (14) and (17) , we could get the following equation:

$$N = \frac{\gamma}{\eta} \frac{2(k+1)\left(\frac{\alpha}{\varphi_d} - \bar{D}\right)}{2(k+1)\bar{D} - (2k+1)\left[1 - (1 - V^{\phi})\left(\frac{2 - \frac{4\gamma\kappa}{(1-V^{\phi})\bar{D}^2 \varphi_d}}{1+V^{\phi}}\right)^{k+1}\right]\bar{D}} \tag{18}$$

Equation18 shows that the number of survived firms N is negatively correlated with the cut-off value φ_d. Recall that we have another relation between N and φ_d , i.e. $N_E = \frac{N}{G(\varphi_d)}$, which demonstrates a positive relation between N and φ_d. Thus, equations 18 and $N_E = \frac{N}{G(\varphi_d)}$ uniquely determine the inverse productivity cut-off φ_d and firm number N , which is illustrated in Figure 4 below. When the trade cost V^{ϕ} decreases, the curve D1 shifts down (equation 18), then the new equilibrium solves a lower level of both N and φ_d .

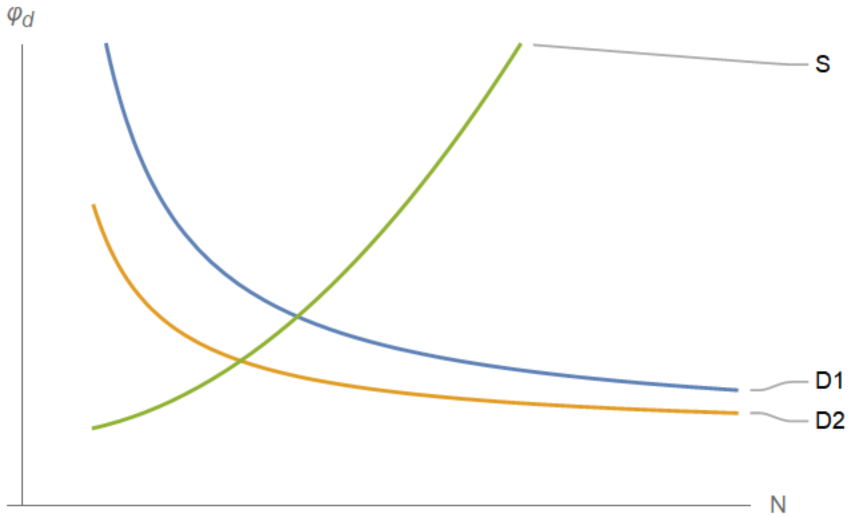


Figure 4: Inverse productivity and the firm number, short run

Claim 1. A decrease in variable trade costs raises the probability of firm exit.

The average markup across all the survived firms is computed as:

$$\bar{M} = \frac{\frac{1}{2} + \frac{k}{2(k-1)} + \frac{k}{2(k-1)}\left(\frac{1}{V^{\phi}} - 1\right)\left(\frac{\varphi_m}{\varphi_d}\right)^{k-1}}{\left(\frac{\varphi_d}{\bar{\varphi}}\right)^{k}} \tag{19}$$

It's easy to prove that if the condition $\left|\frac{\partial ln\varphi_d}{\partial ln(1-V^{\phi})}\right| \leq 1$ holds, then the average markup $\bar{M}$ is decreasing in V^{ϕ} . In another words, when the trade cost decreases, the average markup increases. [4]

3.3.2 a long run equilibrium

In long run, the entry mass N_E is endogenously determined by the entry condition and supply of the entry firms, i.e.

$$\begin{cases} \int_o^{\varphi_m} \frac{L\bar{D}^2\left(\varphi_d - V^{\phi}\varphi_i\right)^2}{4\gamma} dG(\varphi_i) + \int_{\varphi_m}^{\varphi_d} \frac{L\bar{D}^2\left(\varphi_d - \varphi_i\right)^2}{4\gamma} dG(\varphi_i) = f_E \\ N = N_E G\left(\varphi_d\right) \end{cases} \tag{20}$$

[4]In the Appendix, we will check whether the condition $\left|\frac{\partial ln\varphi_d}{\partial ln(1-V^{\phi})}\right| \leq 1$ is possible to hold with a numerical example.

Both equations together determine the supply side of the entry firms. From equation 14, we know that φ_m is an increasing function of φ_d, given the value of V^{ϕ}. In this way, the value of φ_d is determined by the entry cost f_E and independent of the firm number N . In this case the curve which illustrates the supply side of the entry firms is drawn as a horizontal line in the Figure 5 below (the curve S_1). It is easy to prove that when the trade cost V^{ϕ} decreases, the demand curve D_1 shifts down to the position of the curve D_2 , and the supply curve S_1 shifts down to the position of the curve S_2. In this case, the inverse productivity φ_d decreases but the changes of the cut-off value for the firm number N is ambiguous. Furthermore, we cannot determine the changes of the importing critical value φ_m and average markup $\bar{M}$.

According to our data set, the ratio of the entry firms out of the whole firms doesn't change a lot over the observation period. In this case, we will empirically test the predictions from the short-run model in next section.

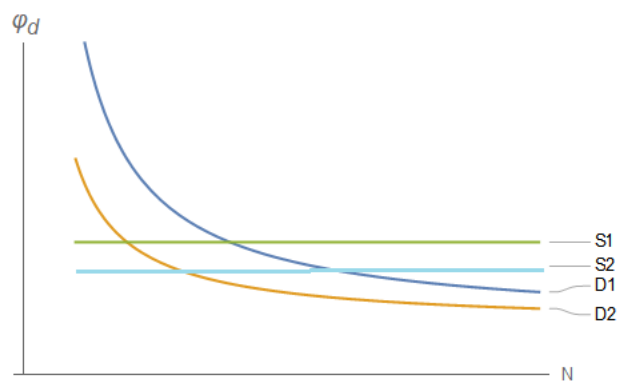


Figure 5: Inverse productivity and firm number, long run

4 Identification and Measurement

4.1 Identification strategy

With the import penetrations and industry level markup measures in hand, we can now move to the econometric model used to test the baseline relationship. We use the following empirical specification to relate horizontal and vertical import penetration to productivity (see Acemoglu et al. (2016) and Olper et al. (2017)):

$$y_{st} = \beta_0 + \beta_1 lnHIMP_{st} + \beta_2 lnVIMP_{st} + \sigma_s + \delta_t + \varepsilon_{st} \tag{21}$$

where y_{st} is the log of our measures of markup of the sector s at year t and is regressed on the 6-digit 2007 US Input-Output commodity sectors lagged logs of horizontal and vertical import penetration. σ_s and $\delta_t$are sector and time fixed effects, respectively, and ε_{st} is an iid error term.

4.2 Measuring horizontal and vertical imports penetration

This section describes how our key trade integration variables are measured. We look at the impact of global sourcing both horizontally and vertically. Horizontal import penetration deals with final product and within-sector competition. By contrast, vertical import penetration captures the input composition of each sector by disentangling its foreign vs. domestic content. Horizontal and vertical import penetration are measured for the period xxxx–20xx, for each of the xx manufacturing sectors, using the NACE Rev.2 classification at the xx-digit level of disaggregation.

The horizontal import penetration for industry z in year t has been calculated as follows:

$$himp_{st} = \frac{imp_{st}}{imp_{st} + prod_{st} - exp_{st}}$$

where imp_{zt} is the imports from the World in industry z at time t, and $prod_{zt}$ is the production value of industry z in year t. Vertical import penetration is a measure of the foreign presence in the industry z that is supplied by sector j. Following Acemoglu et al. (2016) and Olper et al. (2017), this vertical import penetration of industry z can be measured as the weighted average of the import penetration of its inputs:

$$vimp_{st} = \sum_{j \in s} d_{js} himp^*_{jt}$$

where the weight d_{js} represents the value share of the input used by industry z from industry j of the total inputs utilized by industry z, i.e., $d_{js} = \frac{use_{js}}{\sum_{j \in s} use_{js}}$, while $himp^*_{jt}$ is the horizontal import penetration of intermediate inputs coming from industry j whose goods are used as inputs in the production processes of industry s. The weights d_{js} are computed from the I-O tables provided by the Bureau of Economic Analysis. The US I-O tables show how industries interact with each other at a high level of dis-aggregation, namely at six-digit I-O industry codes. In particular, we rely on the 'Use table', which reports the value of each input of commodity j used in the production of industry z.

Horizontal and vertical import penetrations have a different impact on both firms' marginal costs and markup. It is worth noting that horizontal import penetration involves product for the final consumption (output), while vertical import penetration involves intermediate goods (input). On the one hand, higher horizontal import penetration leads domestic firms to face a tougher competition. This implies that, assuming constant marginal costs, an increase in horizontal import penetration leads domestic firms to lower their production and prices, and thus to reduce their markup. On the other hand, higher vertical import penetration will not affect the competitive environment faced by domestic firms, and at the same time it leads to a reduction in firms' marginal costs, and thus allowing firms having a higher markup.

5 Data

We use WRDS-COMPUSTAT data to test the model predictions regarding imported inputs penetration and markup. This study is based on four types of data for the empirical analysis: firm balance-sheet data, trade data, and industry input-output table.

Table 1: Summary Statistics

	N	Mean	SD	Min	Max
Mu_OLS	3139	1.476711	.5388044	.0017906	5.767589
Mu_OP	3139	1.438996	.5250434	.0017449	5.620286
Mu_ACF	3139	1.757911	.6414049	.0021316	6.865868
Himp	4428	1.610059	77.7715	1.42e-06	5156.202
Vimp	4448	1.54599	31.41287	1.22e-06	1255.586

5.1 Firm Balance-Sheet Data

The Compustat data contains information on publicly traded firms balance sheet information. We then obtain deflated measures of firms' annual output, labor in use, capital stock, as well as material inputs. The common GDP deflator comes from Bureau of Economic Analysis's National Income and Product Accounts (NIPA) tables of the United States. By applying the production approach (De Loecker and Warzynski, 2012), we obtain firm level markup from 1950 to 2014. Although we are interested in how imported inputs penetration is related to markup at firm level, Copmustat does not contain information on how much each firm employ foreign inputs. Therefore we compute the sale-weighted markup by sector at very detail six-digit NAICS 2012 version. It is then converted to six-digit BEA Input-Output commodity code to match with industry-level usage of inputs. While Compustat only includes publicly traded companies,

5.2 Trade Data

The trade data is divided into three parts: 1972-1988; 1989-2003; and 2003-2016. The first two parts of data comes from U.S. trade data assembled by Feenstra (1996). For the period 1972 to 1988, the data are by year by four-digit, 1972-revision SIC industry. I use the concordance between 1972 and 1987 versions of the SIC provided by Bartelsman, Becker and Gray (2000) to convert the 1972 SIC categories in Feenstra (1996, 1997) to their 1987-version counterparts. However, concordance provided for SIC 72 to SIC 87 by Bartelsman, Becker and Gray (2000) only contain industry codes for manufacturing sectors. Therefore, SIC 72 are kept for those not converted to SIC 87. And it is converted from SIC87 to NAICS 02 first, then from NAICS 02 to NAICS 07 finally by the concordance provided in United States Census website. The second trade data comes from USA Trade Online, which contains data on US (down to district-level) export, import, and total trade value at six-digit NAICS level for different versions covering from 2003-2016. The trade data are used to compute horizontal and vertical import ratios. USA Trade Online always start using the new NAICS revision the year after the revision. So, for 2003-2007 they use the NAICS 2002 revision; for 2008-2012 they use the NAICS 2007 revision and for 2013-2017 we use 2012 and so on. And they do not apply the new naics revision to prior years. So the USA Trade Online data is then converted from their original codes to NAICS 2007 version by the concordance provided in United States Census website.

5.3 Input-Output Table

Input-Output Table are used in this study to calculate the weights of input-use that each industry relies on the other, in order to calculate the vertical import penetration ratio for each inudustry. The industry economic accounts, presented both in an input-output framework and as annual output by each industry, provide a detailed view of the interrelationships between U.S. producers and users and the contribution to production across industries. Estimates in the Industry Economic Accounts of the Bureau of Economic Analysis (BEA) are generally available at three levels of detail: sector (15 industry groups), summary (71 industry groups), and detail (389 industry groups). BEA only provides detailed level IO table for the benchmark years in every 5 years: 1982, 1987, 1992, 1997, 2002, 2007. To keep the potential impact of the change of relative input use between different industry due to the change of trade policy to the minimum, we keep using the earlist year as the benchmark for the calculation of such weights.

5.4 Gross Output by Industry

BEA provides summary-level (iocodes, 71 industries) gross output by industry data, as well as corresponding quantity and price indexes (2009=100), for the years 1947-2016. These data are from the GDP by Industry accounts, released on November 2, 2017, as part of the quarterly and annual of the industry economic accounts (IEAs).

BEA also provides detail-level (iocodes, up to 403 Industries) gross output by industry data for 1997-2016.

In order to match the data level of grossoutput, the final dataset is compiled at first in very detail level (6 digits iocodes, for 389 industries) for the years 1997-2014. And the second set of matched data are in the summary-level (iocodes, 71 industries), for the years between 1972-2014 (tbd).

6 Results

Table (2) reports the baseline results of the analysis performed by regressing the log of sector level markup on our two indicators of horizontal and vertical import penetration, plus firm and time fixed effects.

Table 2: Import Penetration and Markup: Baseline Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES			lnMark-up			
lnHimp	0.00834		0.00639			
	(0.00853)		(0.00831)			
lnVimp		0.00908**	0.00859***			
		(0.00385)	(0.00322)			
lnHimp$_{t-1}$				0.00626		0.00476
				(0.00726)		(0.00820)
lnVimp$_{t-1}$					0.00769**	0.00746**
					(0.00316)	(0.00370)
Constant	0.856	0.811***	0.861	0.743***	0.852	0.713***
	(366.5)	(0.00295)	(232.4)	(1.55e-07)	(81.53)	(0.00762)
Observations	5,981	5,972	5,953	5,631	5,640	5,612
R-squared	0.817	0.817	0.817	0.826	0.826	0.826
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses

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

All in logs

Table 3: Import Penetration and Markup: Baseline Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES			lnMark-up			
lnHimp	0.04812***		0.04790***			
	(0.01257)		(0.01259)			
lnVimp		0.00552	0.00345			
		(0.01038)	(0.01039)			
$lnHimp_{t-1}$				0.06237***		0.05864***
				(0.01316)		(0.01318)
$lnVimp_{t-1}$					0.05948***	0.05685***
					(0.01087)	(0.01089)
Observations	115,499	115,499	115,499	102,993	102,993	102,993
R-squared	0.742	0.684	0.793	0.768	0.800	0.800
Firm FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

All in logs

Table 4: Import Penetration and Market Concentration

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	HHI	HHI	HHI	HHI	HHI	HHI
Himp	-0.18825***		-0.20736***			
	(0.04007)		(0.04495)			
Vimp		0.18628***	0.22343***			
		(0.04826)	(0.05075)			
L.Himp				-0.17043***		-0.18935***
				(0.04096)		(0.04636)
L.Vimp					0.19439***	0.22832***
					(0.03853)	(0.03976)
Constant	-1.21612***	-1.24802***	-1.23649***	-1.20136***	-0.98391***	-1.224709***
	(0.000063)	(0.0261)	(0.0261)	(0.00065)	(0.00673)	(0.00383)
Observations	5,985	5,976	5,957	5,645	5,636	5,617
R-squared	0.0180	0.0143	0.0229	0.0157	0.0136	0.0209
Industry FE	NO	NO	NO	NO	NO	NO
Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Productivity of Exited Firms

VARIABLES	(1) TFP	(2) TFP	(3) TFP	(4) TFP
Exit	-0.08105***	-0.08075***		
	(0.02695)	(0.02525)		
Himp		0.03864		
		(0.01817)		
Vimp		0.00034***		
		(0.00836)		
L.Himp				
L.Vimp				
Constant	-6.74338***	-6.19981***		
	(0.00460)	(0.05291)		
Observations	121,548	120,001		
R-squared	0.1237	0.1245		
Industry FE	NO	NO		
Year FE	YES	YES		

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Industry Firm Exit Rate and Import Penetration

VARIABLES	(1) Exit_Rate	(2) Exit_Rate	(3) Exit_Rate	(4) log(Exit_Rate)	(5) log(Exit_Rate)	(6) log(Exit_Rate)
Himp_{t-1}	0.05159*		0.05044*			
	(0.03046)		(0.03048)			
Vimp_{t-1}		0.04983**	0.04892**			
		(0.02298)	(0.02307)			
lnHimp_{t-1}				0.05607*		0.05434
				(0.03307)		(0.03305)
lnVimp_{t-1}					0.06039**	0.05919**
					(0.02670)	(0.02677)
Observations	5,115	5,115	5,115	5,115	5,115	5,115
R-squared	0.150	0.150	0.150	0.156	0.157	0.157
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix

To be added.

References

Acemoglu, D., D. Autor, D. Dorn, G. H. Hanson, and B. Price (2016). Import competition and the great us employment sag of the 2000s. *Journal of Labor Economics 34*(S1), S141–S198.

Amiti, M., O. Itskhoki, and J. Konings (2014). Importers, exporters, and exchange rate disconnect. *American Economic Review 104*(7), 1942–78.

Antras, P., T. C. Fort, and F. Tintelnot (2017). The margins of global sourcing: theory and evidence from us firms. *American Economic Review 107*(9), 2514–64.

Arkolakis, C., A. Costinot, D. Donaldson, and A. RodrÃguez-Clare (2018). The elusive pro-competitive effects of trade. *The Review of Economic Studies*, rdx075.

Autor, D., D. Dorn, L. F. Katz, C. Patterson, J. Van Reenen, et al. (2017). *The fall of the labor share and the rise of superstar firms.* National Bureau of Economic Research.

Bas, M. and V. Strauss-Kahn (2015). Input-trade liberalization, export prices and quality upgrading. *Journal of International Economics 95*(2), 250 – 262.

Bernard, A. B., J. B. Jensen, and P. K. Schott (2006). Trade costs, firms and productivity. *Journal of Monetary Economics 53*(5), 917 – 937.

Blaum, J., C. Lelarge, and M. Peters (2016). The Gains from Input Trade with Heterogeneous Importers. Working papers 612, Banque de France.

Burstein, A. and G. Gopinath (2014). *International Prices and Exchange Rates*, Volume 4, pp. 391–451. Elsevier. Preliminary January 2013. Prepared for the Handbook of International Economics, Vol. IV.

Chen, N., J. Imbs, and A. Scott (2009). The dynamics of trade and competition. *Journal of International Economics 77*(1), 50 – 62.

De Loecker, J. and J. Eeckhout (2017). The rise of market power and the macroeconomic implications. Technical report, National Bureau of Economic Research.

De Loecker, J., P. K. Goldberg, A. K. Khandelwal, and N. Pavcnik (2016). Prices, markups, and trade reform. *Econometrica 84*(2), 445–510.

Edmond, C., V. Midrigan, and D. Y. Xu (2015, October). Competition, markups, and the gains from international trade. *American Economic Review 105*(10), 3183–3221.

Elsby, M. W., B. Hobijn, and A. Şahin (2013). The decline of the us labor share. *Brookings Papers on Economic Activity 2013*(2), 1–63.

Epifani, P. and G. Gancia (2011). Trade, markup heterogeneity and misallocations. *Journal of International Economics 83*(1), 1 – 13.

Fan, H., X. Gao, Y. A. Li, and T. A. Luong (2018). Trade liberalization and markups: Micro evidence from china. *Journal of Comparative Economics 46*(1), 103 – 130.

Fan, H., Y. A. Li, and S. R. Yeaple (2015). Trade liberalization, quality, and export prices. *The Review of Economics and Statistics 97*(5), 1033–1051.

Feng, L., Z. Li, and D. L. Swenson (2016). The connection between imported intermediate inputs and exports: Evidence from chinese firms. *Journal of International Economics 101*, 86 – 101.

Gopinath, G. and B. Neiman (2014, March). Trade adjustment and productivity in large crises. *American Economic Review 104*(3), 793–831.

Halpern, L., M. Koren, and A. Szeidl (2015). Imported inputs and productivity. *American Economic Review 105*(12), 3660–3703.

Holmes, T. J., W.-T. Hsu, and S. Lee (2014). Allocative efficiency, mark-ups, and the welfare gains from trade. *Journal of International Economics 94*(2), 195 – 206.

Konings, J., P. V. Cayseele, and F. Warzynski (2001). The dynamics of industrial mark-ups in two small open economies: does national competition policy matter? *International Journal of Industrial Organization 19*(5), 841 – 859. Competition Policy in Dynamic Markets.

Ludema, R. D. and Z. Yu (2016). Tariff pass-through, firm heterogeneity and product quality. *Journal of International Economics 103*, 234 – 249.

Melitz, M. J. and G. I. Ottaviano (2008). Market size, trade, and productivity. *The Review of Economic Studies 75*(1), 295–316.

Olper, A., D. Curzi, and V. Raimondi (2017). Imported intermediate inputs and firmsâ productivity growth: Evidence from the food industry. *Journal of Agricultural Economics 68*(1), 280–300.

Ramanarayanan, A. (2012). Imported Inputs and the Gains from Trade. 2012 Meeting Papers 612, Society for Economic Dynamics.