

The Asymmetric Effects of Tariffs on Offshoring Industries: How North/South Tariffs Affect Intra-Firm Trade

JOB MARKET PAPER

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Abstract

This paper studies the effects of tariffs on outsourcing and offshoring. Building on the Antràs and Helpman (2004) North-South theoretical framework, I show that higher Northern tariffs reduce the incentives for both outsourcing and offshoring. Conversely, higher Southern tariffs increase incentives for both phenomena. I also show that increased offshoring and outsourcing imply an increase in the ratio of Northern intra-firm imports to total Northern imports, which is an empirically testable prediction. Using a highly disaggregated dataset of U.S. imports and relevant tariffs, I find robust evidence to support the following predictions of the model: (i) higher U.S. tariffs increase the ratio of American intra-firm imports to total imports; (ii) higher foreign tariffs decrease the same ratio. In the baseline results, I find that a one percentage point increase in the American tariff is associated with a one percentage point increase in the ratio, while a one percentage point increase in the foreign tariff implies a 0.3 percentage point decrease in the ratio.

Keywords: outsourcing, offshoring, intra-firm trade, tariffs.

JEL Classification: F10, F23, L22, L23.

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1 Introduction

International trade and foreign direct investment (FDI) are among the fastest growing economic activities (Helpman, 2006). Additionally, roughly 44% of American imports are intra-firm imports. These aggregate phenomena result from the organizational strategies of individual firms. Offshoring and outsourcing are two of the most dynamic features of these strategies. The former term refers to the movement of production activities overseas, while the latter takes place when some activity is done by an agent outside the firm's boundaries.^{1,2} Offshoring clearly involves international trade. However, the specific type of trade depends on the outsourcing decision: vertically-integrated, offshoring firms perform intra-firm trade, while firms doing foreign outsourcing engage in arms'-length trade.

At the same time, recent policy developments have actively encouraged international trade. These efforts include the successive trade liberalization rounds at the GATT/WTO level; the expansion of the WTO membership and the concessions granted/obtained for the acceding countries; and the growth of preferential trade agreements, such as the European Union, NAFTA/CAFTA and Mercosur.³

In this paper I connect these phenomena, linking firms' organizational choices to trade policies. The work complements and extends the existing (theoretical and empirical) literature on offshoring, outsourcing and intra-firm trade. Specifically, I build on the Antràs and Helpman (2004) model of offshoring and outsourcing by incorporating tariffs into their framework and I empirically test my theoretical predictions. Highlighting the importance of this link is one of my main contributions. Indeed, although there is a flourishing literature on outsourcing and offshoring, there has not been as much attention paid to its relation with trade policies and tariffs. I argue that the link between tariffs and firms' organizational choices is indeed relevant. To sustain this claim, I develop a theoretical model in which tariffs affect offshoring and outsourcing and, consequently, affect the ratio of intra-firm imports to total imports. Moreover, I show that these predictions regarding the effects of tariffs on intra-firm trade are strongly supported by the data.

In recent years, a new trade literature has developed focusing on the organizational choices of individual firms.⁴ The model by Antràs and Helpman (2004) is of particular interest for this paper. They combine three elements: (1) the within-industry heterogeneity of Melitz (2003), the Helpman and Krugman (1985) general equilibrium setting of international trade, and (3) the Grossman-Hart-Moore theory of the firm.⁵ Antràs and Helpman develop a North-South

¹This is the widely-reported process of international specialization. See, for example, the evidence presented by Yi (2003) and Hummels, Ishii, and Yi (2001) on increased vertical specialization. Likewise, Feenstra and Hanson (1996) report evidence in favor of increased offshoring for the United States.

²See Bartel, Lach, and Sichernman (2005), Abraham and Taylor (1996), Baker and Hubbard (2003, 2004) and Autor (2001, 2002) for evidence in favor of increased outsourcing. For a "trade" (rather than IO) empirical paper on outsourcing see Feenstra and Hanson (2005).

³For instance, in recent years 24 countries have joined the WTO (including a big country like China) and currently there are 30 other countries with accessions in progress.

⁴See Helpman (2006) and Spencer (2005) for two excellent surveys of this new literature.

⁵Actually, the last two features are taken from Antràs (2003) who was the first to combine the Helpman-

model with incomplete contracts in which entrepreneurs make two independent decisions: to integrate or outsource and, from which country to acquire the intermediate goods. Entrepreneurs face two trade-offs. On the one hand, the North has lower fixed costs but the South has lower variable costs. On the other hand, outsourcing requires lower fixed costs than vertical integration but the entrepreneur's *ex-post* share of the surplus is lower. Given the corresponding fixed costs for each organizational form, firms optimally sort based on the headquarter-intensity of the industry and of firm-specific productivity.

This paper builds on the Antràs and Helpman (2004) framework with two major differences. First, I extend their framework by explicitly modeling tariffs. This allows me to address questions such as: (a) How do firms react to the imposition of tariffs? (b) What are the differences in firms' reactions to Northern and Southern tariffs? Second, and perhaps the most important deviation from the above framework, I model offshoring as the foreign sourcing of *assembly*, whereas in the Antràs and Helpman model offshoring corresponds to the foreign sourcing of intermediate inputs. More specifically, I assume that each entrepreneur is in possession of a critical input, such as a blueprint. The entrepreneur then contacts a manager to process the input into a final good. It follows that the hiring of a Southern manager (i.e., offshoring) implies that the production of final goods will move from North to South. Hence, in contrast to Antràs and Helpman, in my model final goods can be produced in either country.

The Antràs and Helpman (2004) model would be a natural setting to incorporate tariffs. In their model, offshoring firms import intermediate inputs from the South, but all final goods are produced in the North. If I were able to observe firm-level data, I could incorporate tariffs directly into this setting and test the resulting theoretical predictions. For example, I might observe an American firm importing an input from China into the U.S. and exporting the final good to China – this firm would be affected by both the American tariff on inputs and the Chinese tariff on final goods. In other words, I could observe the *asymmetric* effects that both tariffs have on the decisions of a particular firm.

However, offshoring of intermediate inputs is not the only type of offshoring. Indeed, I find evidence that for the United States, the growth in offshoring of final goods assembly is at least as important as the growth in offshoring of intermediate inputs. Using highly disaggregated data, I find that from 2000 to 2006, final-good imports grew by 36% while intermediate-good imports grew 34%. Likewise, among intra-firm imports, those of final goods increased 33% while those of inputs increased by 29%.^{6,7}

Moreover, each way of modeling offshoring has different data requirements.⁸ Offshoring

Krugman view of international trade with the theory of the firm developed by Grossman and Hart (1986) and Hart and Moore (1990).

⁶It is always hard to define whether a good is final or intermediate. I have data disaggregated at the 6-digit Harmonized System level, roughly 5,000 industries. I consider an import to be of an intermediate good if the definition of the industry includes the word 'part' or 'component'.

⁷See Yeats (2001) for evidence on increases offshoring of intermediate goods. He finds evidence that during the 1990's the share of intermediate inputs imports to total imports has increased for the OECD countries.

⁸The necessity to choose between the two types of offshoring stems from the theoretical setting of Antràs and Helpman (2004). To incorporate the ability of firms to choose the type of offshoring would complicate the

of components, as explained in the example above, requires the observation of firm-level data and requires as well that intermediate goods imports be matched to final goods exports. In contrast, offshoring of final goods is less stringent in terms of data requirements. Going back to the previous example, I only need to observe final-good trade flows between the U.S. and China at the industry-level (and this kind of data is far more readily available). Indeed, since I model *offshoring as the overseas assembly of final goods*, these goods flow in both directions.⁹ Hence, within any particular industry, some final goods flow from North to South while others go from South to North. Given that Northern and Southern tariffs are clearly defined for every industry, I can study the simultaneous and *asymmetric* effects of both tariffs on each industry.¹⁰

The main theoretical findings are three. First, a tariff imposed by the North on final goods increases the likelihood that an entrepreneur will work with a Northern manager and decreases the incentives to work with a Southern manager. Intuitively, the Northern tariff reduces the minimum productivity needed by a firm to organize production with a Northern manager but increases the productivity level needed to do so with a Southern manager. Second, a Northern tariff (i) decreases the market share of offshoring firms, and (ii) decreases the relative market share of outsourcing versus vertically integrated firms (in *both* countries). Intuitively, the tariff protects firms that assemble in the North and, critically, its impact is particularly important among firms that are marginally indifferent between integrating with a Northern manager and outsourcing in the South. When firms choose the latter option, it is because the variable costs are sufficiently lower in the South to justify the higher fixed costs and lower surplus shares. The tariff, however, increases the variable costs thus causing more firms to lean towards integration with a Northern manager. My third theoretical finding is that a tariff on final goods imposed by the Southern government has the opposite effects: it increases (decreases) the chances of working with a Southern (Northern) manager and increases the market shares of offshoring and outsourcing firms. The Southern tariff works in the opposite direction to the Northern one; it protects those firms assembling in the South, especially those that are marginally indifferent between integrating with a Northern manager and outsourcing in the South.

I derive two testable implications from the theory. If offshoring increases (i.e., if there are more Northern firms producing in the South) Northern imports will increase. Similarly, if there is relatively more vertical integration than outsourcing, the composition of imports will change, with relatively more intra-firm trade and more arms'-length trade. Consequently, the above theoretical predictions can be "mapped" to empirical predictions about the ratio of intra-firm imports to total imports. In particular, Northern (Southern) tariffs cause the ratio

model's tractability, although it would be an interesting extension.

⁹One can think of this as the overseas assembly activities reported by Swenson (2005) or the export-processing activities in China reported by Feenstra and Hanson (2005).

¹⁰Even with this alternative definition of offshoring there are intermediate inputs going from North to South. From a theoretical point of view, Southern tariffs on these inputs affect offshoring firms alone, so they are analogous to Northern tariffs on final goods. However, since I cannot attribute intermediate goods to a particular final good industry, my empirical work will neglect the effects of Southern tariffs on inputs.

of Northern intra-firm imports to total imports to increase (decrease). Intuitively, Northern (Southern) tariffs decrease (increase) total offshoring but, as explained above, imports due to offshore-vertical-integration decrease (increase) relatively less than imports due to offshore-outsourcing. I test these predictions using highly disaggregated data for the United States (the North) for years 2000 to 2006.

The empirical findings provide support for these implications of my theory. In particular, I find that: (i) higher U.S. tariffs increase the ratio of American intra-firm imports to total American imports; and (ii) higher foreign tariffs decrease this ratio. In the relevant subsample of the data, the mean of the ratio is 44% (29% if I include those observations where the ratio is zero). Using this subsample, I find that a one percentage point increase in the American tariff is associated with a one percentage point increase in the ratio, while a one percentage point increase in the foreign tariff implies a 0.3 percentage point decrease in the ratio.

These results hold across several econometric specifications. First, I consider a simple OLS regression of the share of intra-firm imports to total imports on U.S. tariffs, foreign tariffs, and country, industry and time fixed effects. Next, I show that relaxing the linearity assumption, with quadratic or cubic terms, I obtain similar results. In addition, I show that the results still hold when I control for other variables which the literature has identified as possibly affecting this ratio. These include country-specific variables like capital and human capital abundance, and industry-specific variables like capital- and skill-intensity and transport costs. Finally, to address possible complications deriving from the fact that in roughly one third of the observations, the ratio takes a value of zero, I run two robustness checks: (i) quantile estimation, and (ii) selection correction (parametrically and semi-parametrically).

The paper is related to several branches in the literature. First, it is related to many recent papers that focus on the international organization of firms. Helpman (2006) divides this literature into two groups. The first deals with intra-industry-firm heterogeneity. These papers explain important stylized facts such as why some firms are exporters while others are foreign direct investors.¹¹ Other papers within this group explain why some firms follow a “complex” integration strategy, and why the typical distinction between horizontal and vertical FDI is now less meaningful.¹² The second group deals with the internalization decision of firms. The most typical analyses follow the so-called “incomplete contract approach to the theory of the firm” – i.e., environments where production requires cooperation between agents (such as final good producers and input suppliers) but where *ex-ante* commitments are not possible, creating hold-up problems. My paper, along with Antràs and Helpman (2004), belongs to this

¹¹The most influential paper to mention here is Melitz (2003). Helpman, Melitz, and Yeaple (2004) find support in the data for some of the theoretical implications of these type of models.

¹²For prominent examples of this kind of model see Yeaple (2003), Grossman, Helpman, and Szeidl (2006) and Ekholm, Foslid, and Markusen (2004). Similarly, Carr, Markusen, and Maskus (2001) present (and test) their Knowledge-Capital model as the synthesis of the dichotomic theories of horizontal FDI (Markusen, 1984) and vertical FDI (Helpman, 1984).

second group.^{13,14}

Second, the paper is also related to a burgeoning empirical literature on the determinants of intra-firm trade (motivated by the theoretical frameworks mentioned above). For instance, Antràs (2003) tests some of his predictions and finds that the ratio of intra-firm imports to total imports depends positively on the industry's capital intensity and on the country's capital abundance. Yeaple (2006) finds that capital and R&D intensity as well as productivity dispersion have a positive effect on intra-firm imports. Nunn and Treffer (2007, 2008) confirm the findings of Antràs and of Yeaple, and find evidence that improved contracting may also increase the share of intra-firm imports.¹⁵ Finally, Bernard, Jensen, Redding, and Schott (2008) emphasize the role of the degree of product contractibility.

Finally, the paper is also related to a handful of recent papers explicitly exploring the link between trade liberalization and firms' organizational choices. First, Ornelas and Turner (2008a) develop a model with incomplete contracts where firms decide to outsource or to in-source, and whether to offshore or not. Their model shows that the welfare effects of tariffs depend on firms' organizational forms, specifically, on the different hold-up problems that arise with each organizational choice. Second, Ornelas and Turner (2008b) present a partial equilibrium model where tariffs on inputs aggravate the international hold-up problem. Trade liberalization encourages international trade through three different channels: it lowers import costs, it reduces the under-investment stemming from the hold-up problem, and it may induce the formation vertically-integrated multinational firms, thereby increasing trade even further. Thus, their model is able to generate non-linear responses of trade flows to lower trade costs, a feature found in the data. Third, Antràs and Staiger (2008) study the Nash equilibrium and internationally efficient trade policy choices of governments in an incomplete-contract environment, in order to understand the implications of offshoring for the design of international trade agreements. Among other differences with my paper, none of these papers performs an empirical study of the theoretical implications.¹⁶

The rest of the paper is organized as follows. Section 2 develops the theoretical model. First, I present a slightly modified version of the basic framework of Antràs and Helpman (2004). Next, I introduce tariffs (first, Northern; then, Southern) into that setting and explore their effects. Section 3 presents my empirical work. First, I describe the testable implications of the theory and the data set. Second, I present the estimates under several specifications. Finally, Section 4 concludes.

¹³Within this group I should also mention the work by Grossman and Helpman (2002, 2005) and by McLaren (2000). They emphasize the searching and matching problems faced by final good producers and input producers. In these papers outsourcing is more likely to occur the thicker the input market is.

¹⁴Some papers like Grossman and Helpman (2004) model imperfect monitoring and managerial incentive problems as the driving force behind the outsourcing decision.

¹⁵This last prediction is derived from Antràs and Helpman (2006), an extension to their paper that I commented above.

¹⁶Conconi, Legros, and Newman (2008) also study the effects of trade liberalization on organizational choices, although in a setting quite different from the present one.

2 Theory

2.1 Basic Model

In this subsection I review the basic features of the Antràs and Helpman (2004) model. This is done to facilitate the introduction of tariffs in the following subsections. At the same time, I provide a reinterpretation of the activities of the different agents such that offshoring is now of final goods (and no longer of intermediate inputs). Within this subsection, where there are no trade costs, this is just a relabeling of the Antràs and Helpman model. However, with the introduction of tariffs, this modification turns out to have an important effect on the theoretical predictions delivered by the model.

The world is composed of two countries, North and South. The world is populated by a unit measure of consumers; a fraction γ of them live in the North country while the remaining $(1 - \gamma)$ are located in the South.

There are two kinds of goods. A homogeneous good, labeled x_0 , is used as a numeraire. Additionally, there are J industries producing differentiated goods $x_j(i)$.

Consumers around the world share the same Dixit-Stiglitz preferences represented by the utility function

$$U = x_0 + \frac{1}{\mu} \sum_j X_j^\mu \quad (1)$$

where $\mu \in (0, 1)$ and $X_j \equiv \left[\int x_j(i)^\alpha di \right]^{\frac{1}{\alpha}}$ is the aggregate consumption index for sector j , with $\alpha \in (0, 1)$. As usual in the literature, it is assumed $\alpha > \mu$, which implies that varieties within a sector are more substitutable for each other than for x_0 or $x_k(i)$, $k \neq j$. It follows that a differentiated product has inverse demand given by

$$p_j(i) = x_j(i)^{\alpha-1} P_j^{\frac{\alpha-\mu}{1-\mu}} \quad (2)$$

where $p_j(i)$ is the price of good $x_j(i)$ and $P_j \equiv \left[\int p_j(i)^{\frac{\alpha}{\alpha-1}} di \right]^{\frac{\alpha-1}{\alpha}}$ is the aggregate price index of industry j .

Labor is the only factor of production. To get one unit of x_0 , the North requires one unit of labor while the South needs $1/w > 1$ units of labor. It is assumed that the labor supply is sufficiently large in both countries so that, in equilibrium, the homogeneous good is produced at both locations. It follows that the Northern wages will be higher than the Southern ones: $w^N > w^S = w$.

The production of a differentiated good requires the cooperation of two types of agents: an entrepreneur (E) and an assembly manager (A). Entrepreneurs are only located in the North while managers can be found in both countries. Antràs and Helpman (2004) assume that the manager provides an input needed by the entrepreneur, and that the entrepreneur then assembles the input into a final good. Therefore, in their model all final good production takes place in the North. By contrast, I assume that the entrepreneur provides headquarter

services $h_j(i)$ (blueprints, or design of the variety i) while the manager supplies assembly services $a_j(i)$. Thus, in my model, final goods assembly can occur in either North or South. Both entrepreneur and manager need one unit of labor to get one unit of $h_j(i)$ and $a_j(i)$, respectively.

In order to actually produce $x_j(i)$ an entrepreneur must follow the procedure described below.

First, he pays a fixed entry cost f_E of Northern labor units. Then, he draws a productivity level θ from a known distribution function $G(\theta)$. With this information he decides whether to remain or exit the market. If he decides to stay in the market, he will combine the specifically tailored inputs $h_j(i)$ and $a_j(i)$. In particular, production will be given by

$$x_j(i) = \theta_i \left(\frac{h_j(i)}{\nu_j} \right)^{\nu_j} \left(\frac{a_j(i)}{1 - \nu_j} \right)^{1 - \nu_j} \quad (3)$$

where $\nu_j \in (0, 1)$ measures the relative (industry) headquarter intensity or, using Helpman (2006) terminology, the contractual input intensity.

Next, the entrepreneur must make two simultaneous decisions: (1) to contact a type A agent in either North (N) or South (S); (2) to decide whether to insource (V) or outsource (O) the assembly of the final goods. Both decisions together determine each firm's *organizational form*.

There are different fixed costs associated with each organizational form and all are denominated in terms of Northern labor. Thus, $w^N f_k^l$ is the fixed cost associated with a firm that conducts assembly at location $l \in \{N, S\}$ and has ownership structure $k \in \{V, O\}$. Antràs and Helpman (2004) assume that

$$f_V^S > f_O^S > f_V^N > f_O^N. \quad (4)$$

This implies that offshoring and vertically integrating are associated with higher fixed costs than assembling in the North and outsourcing, respectively. In other words, establishing assembly activities abroad generates higher fixed costs than doing so domestically. Likewise, the additional managerial activities outweigh any potential economies of scope due to integration.

Each entrepreneur E offers a contract in order to attract a manager A. The contract specifies a fee (positive or negative) that must be paid by A – the goal of the fee is to satisfy A's participation constraint at the lowest possible cost. Since there is an infinitely elastic supply of A agents, the manager's profits (net of the fee) are equal, in equilibrium, to the outside option.

Contracts are incomplete: E and A cannot sign *ex-ante* any enforceable contract specifying $h(i)$ and $a(i)$, but rather they bargain over the relationship's *ex-post* surplus. Bargaining is Nash-type and the entrepreneur's bargaining weight is equal to $\beta \in (0, 1)$ of the resulting

revenue. The revenue of firm i is given by $R_j(i) = p_j(i) x_j(i)$ or¹⁷

$$R_j(i) = P_j^{\frac{\alpha-\mu}{1-\mu}} \theta^\alpha \left(\frac{h_i}{\nu_j} \right)^{\nu_j \alpha} \left(\frac{a_i}{1-\nu_j} \right)^{\alpha(1-\nu_j)}. \quad (5)$$

One must consider the outside options of each agent in order to determine the bargaining outcome. Each manager has an outside option of zero because his work $a(i)$ is specially customized for the product $x(i)$. Likewise, entrepreneurs have an outside option of zero if the organizational form chosen is one with outsourcing. In contrast, under vertical integration, each E has property rights over the work of the managers. Thus, the entrepreneur can fire the manager and seize the production. However, without A's cooperation, E will only get a fraction $\delta^l \in (0, 1)$ of the output – thus, his outside option is $(\delta^l)^\alpha R(i)$.¹⁸ It follows that the *ex-post* bargaining shares will be the following:

$$\beta_V^N = (\delta^N)^\alpha + \beta [1 - (\delta^N)^\alpha] \geq \beta_V^S = (\delta^S)^\alpha + \beta [1 - (\delta^S)^\alpha] > \beta_O^N = \beta_O^S = \beta \quad (6)$$

For any given organizational form (l, k) , the entrepreneur chooses $h(i)$ to maximize $\beta_k^l R(i) - w^N h(i)$ while the manager chooses $a(i)$ to maximize $(1 - \beta_k^l) R(i) - w^l a(i)$. Solving these two problems, one finds the operating profits of a firm whose manager is at location l and has ownership structure k .¹⁹

$$\pi_k^l(\theta, P, \nu) = \Psi_k^l(P) \frac{\alpha-\mu}{(1-\mu)(1-\alpha)} \theta^{\frac{\alpha}{1-\alpha}} - f_k^l w^N \quad (7)$$

where

$$\Psi_k^l(\nu) = \frac{1 - \alpha [\beta_k^l \nu + (1 - \beta_k^l)(1 - \nu)]}{\left[\frac{1}{\alpha} \left(\frac{w^N}{\beta_k^l} \right)^\nu \left(\frac{w^l}{1 - \beta_k^l} \right)^{1-\nu} \right]^{\frac{\alpha}{1-\alpha}}} \quad (8)$$

Each entrepreneur's problem is to choose the optimal organizational form. Analogously, his problem is to select one of the four triplets (β_k^l, w^l, f_k^l) for $l \in \{N, S\}$ and $k \in \{V, O\}$. It is clear from equation (7) that profits are decreasing in both w^l and f_k^l . However, it is unclear how profits depend on β . As explained by Antràs and Helpman (2004), there is a $\beta^*(\nu) \in [0, 1]$ that is the optimal surplus share that an entrepreneur would chose (*ceteris paribus*) if there were a continuum of possible organizational forms. This optimal share $\beta^*(\nu)$ is increasing in ν , reflecting the fact that *ex-ante* efficiency requires that a larger share of the revenue must be given to the party undertaking the relatively more important activity. However, since each entrepreneur chooses from among only four values of β , he will pick the pair $\{l, k\}$ that is closest to the ideal β^* . Given $\beta^*(0) = 0$ and $\beta^*(1) = 1$ we have that

¹⁷It is assumed that trade occurs costlessly.

¹⁸Additionally, Antràs and Helpman assume $\delta^N \geq \delta^S$, reflecting that the lack of agreement is more costly to the entrepreneur when the manager is located in the South.

¹⁹Hereafter, I drop the j subscripts.

$$\begin{aligned} \text{Low } \nu \text{ (close to 0): } & \beta^*(\nu) < \beta_O^N = \beta_O^S = \beta < \beta_V^S \leq \beta_V^N \Rightarrow \frac{\partial}{\partial \beta} \pi(\cdot) < 0, \\ \text{High } \nu \text{ (close to 1): } & \beta^*(\nu) > \beta_V^N \geq \beta_V^S > \beta_O^N = \beta_O^S = \beta \Rightarrow \frac{\partial}{\partial \beta} \pi(\cdot) > 0. \end{aligned}$$

In this paper, I am interested in those sectors with relatively high headquarters intensity. Thus, I make the following assumption.

Assumption 1. *Throughout the paper I assume that ν is “high”, so profits depend positively on E ’s bargaining share: $\frac{\partial}{\partial \beta} \pi(\cdot) > 0$.²⁰*

This means that in a relatively headquarter-intensive sector (with high ν), if there were no other cost/benefit differences among the four organizational forms, the entrepreneur would choose to integrate in the North. However, since there actually are other differences in costs and benefits among the different forms, the optimal choice of $\{l, k\}$ will depend on the firm specific productivity parameter θ .²¹

Equilibrium. Antràs and Helpman (2004) show that all four possible organizational forms may occur in equilibrium. The analysis follows from the alternative profits given by equation (7). First, note that profits are linear in $\theta^{\frac{\alpha}{1-\alpha}}$, with slope equal to $\Psi_k^l P^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}}$. Next, note that π_O^l is flatter than π_V^l for both N and S . In contrast, it is unclear whether π_V^N is steeper or flatter than π_O^S . The reason for this is two-fold. On the one hand, (N, V) gives the entrepreneur a larger surplus share, which makes π_V^N steeper. On the other hand, Southern wages are lower, making π_O^S steeper. To avoid this ambiguity, it is assumed that the wage differential is large relative to the difference between β and β_V^N . Specifically,

$$\left(\frac{w^N}{w}\right)^{1-\nu} > \phi(\beta_V^N, \nu) / \phi(\beta, \nu) \quad (9)$$

where $\phi(\gamma, \nu) \equiv \{1 - \alpha[\gamma\nu + (1 - \gamma)(1 - \nu)]\}^{(1-\alpha)/\alpha} \gamma^\nu (1 - \gamma)^{1-\nu}$. When this condition is satisfied, the following ordering holds:

$$\Psi_V^S(\nu) > \Psi_O^S(\nu) > \Psi_V^N(\nu) > \Psi_O^N(\nu) \quad (10)$$

Using this fact (see Table I and Figure I) it follows that the least productive firms – those with productivities below θ_1 – will exit immediately. Of the remaining firms, the more (less)

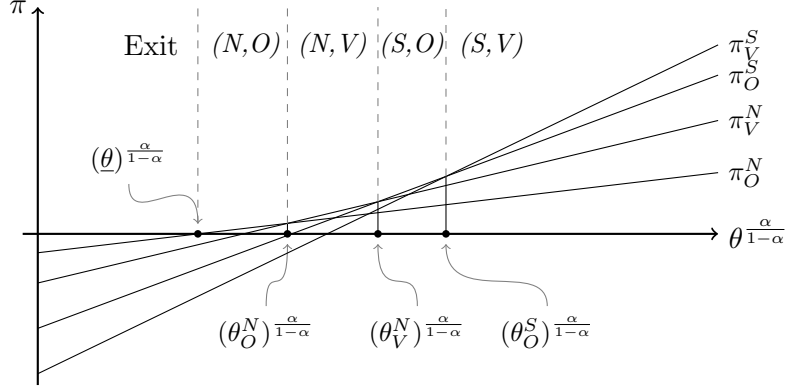
²⁰In the case where ν is “low” outsourcing always dominates vertical integration – the only types of firms that may exist in equilibrium are (N, O) and (S, O) . Hence, the ratio of intra-firm imports to total imports, the object I study on the empirical section, will always be zero. This means that, according to the theory for the low- ν case, *any* regressor, including tariffs, attempting to explain the share of intra-firm imports should be insignificant. Nunn and Trefler (2008), focusing on the effects of productivity dispersion on the share of intra-firm trade, find supportive evidence of this broader prediction: while for high- ν industries they obtain significant estimates, for low- ν industries their estimates are not statistically significant.

²¹A free-entry condition, equating the expected profits of a potential entrant to the fixed entry cost, closes the model. Specifically,

$$\int_{\theta_1(P)}^{\infty} \pi(\theta, P, \nu) dG(\theta) = w^N f_E$$

From this expression one can solve for P , and the other variables.

Figure I: Profit lines from Equation (7).



productive ones get their inputs in the South (North). Within each of these two groups, those with higher θ integrate, while the others outsource.^{22,23}

Table I: Organizational Form by Productivity.

$\theta_i \in$	Firm-type
$(0, \theta_1)$	<i>Exit</i>
(θ_1, θ_2)	(N, O)
(θ_2, θ_3)	(N, V)
(θ_3, θ_4)	(S, O)
(θ_4, ∞)	(S, V)

Intuitively, low productivity firms will have low levels of production and will try to reduce their fixed costs by doing their assembly in the North. In contrast, high productivity firms will have high levels of output (and so low average fixed costs) and will therefore be more concerned in reducing their variable costs. Thus, they source in the low wage South.²⁴

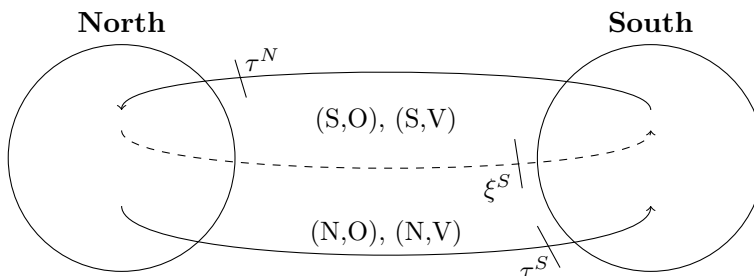
Consequently, the least productive firms (those not offshoring) export differentiated final

²²It is easy to check that any of the three types $\{(N, O), (N, V), (S, O)\}$ may not exist in equilibrium. In contrast, as long as there is no upper bound in the support of $G(\theta)$, there will always be firms choosing (S, V) . Moreover, if in any equilibrium there is more than one type, firms are going to sort in the way described above.

²³To guarantee that all four types will exist in equilibrium one needs $\theta_1 < \theta_2 < \theta_3 < \theta_4$. This requires $\frac{f_O^N}{\Psi_O^N} < \frac{f_O^N - f_V^N}{\Psi_O^N - \Psi_V^N} < \frac{f_V^N - f_O^S}{\Psi_V^N - \Psi_O^S} < \frac{f_O^S - f_V^S}{\Psi_O^S - \Psi_V^S}$.

²⁴Notice that, in equilibrium, all firms engage in international trade, a feature already found in Antràs and Helpman (2004). This is somewhat counterfactual, especially in the case of the least productive firms (see Bernard, Jensen, Redding, and Schott (2006)). The model delivers this prediction because there are no fixed export costs: when a firm chooses to produce, it faces two demands (Northern and Southern) but the fixed cost needs only to be incurred once to serve either or both markets. The inclusion of a fixed export cost would greatly affect the model's tractability. Moreover, within the "new" trade literature, some papers model features like 'only some firms are exporters' while others model the internalization decision. To the best of my knowledge, there is no paper dealing with both, although this is clearly an important direction for future research.

Figure II: Trade Flows.



goods from the North to the South. In contrast, the more productive ones (those offshoring) export differentiated final goods from the South to the North and blueprints (or, more generally, inputs) from the North to the South.²⁵ Figure II represents these international trade flows, where the solid lines represent final goods and the dashed line represents the flows in inputs. Additionally, one can see that different tariffs will affect the firms in any given industry in an asymmetric fashion. If the Northern government decides to impose a tariff t_N on the imports of differentiated goods it will (directly) affect only the offshoring firms, (S, V) and (S, O) . Similarly, if the Southern government imposes a tariff t_S on their imports of differentiated goods, the (N, V) and (N, O) firms will be the ones directly affected. In the following two sections I study precisely the effects of these policies.^{26,27}

2.2 Northern Tariffs

Suppose the Northern government imposes a tariff t_N ($\tau_N \equiv 1 + t_N$) on the imports of differentiated goods assembled in the South. For simplicity, assume that the Southern government follows a free trade policy: $t_S = 0$.²⁸

The tariff creates a *wedge* between both markets. Consequently, Northern and Southern aggregate prices (P_N and P_S , respectively) will differ.

As shown in the Appendix, the profit functions of those firms producing in the North will

²⁵The homogeneous good will keep trade balanced.

²⁶The South could also impose a tariff ξ_S on its imports of inputs $h(i)$, as depicted on Figure II. From a theoretical point of view, this tariff would only affect offshoring firms (S, V) and (S, O) : so, in this sense, the effects of ξ_S would be analogous to those of t_N . However, since I am not able to attribute intermediate goods to a particular final good, my empirical work cannot handle the effects of Southern tariffs on inputs. Therefore, I will not analyze the effects of ξ_S in this paper. See Díez (2006) for a theoretical analysis of the effects of tariffs on inputs.

²⁷Although transport costs would have a similar effect to tariffs, I focus on tariffs because they are naturally asymmetric across counties, while this might not be the case for transport costs. Additionally, Baier and Bergstrand (2001) find evidence for OECD countries that the impact of tariff decreases on the growth of trade has been three times the impact of lower transport costs.

²⁸All the results still hold if both tariffs are positive, although the algebra becomes more complicated.

be the following:

$$\begin{aligned}\pi_k^N(i) &= \left((1-\gamma) P_S^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}} + \gamma P_N^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}} \right) \Psi_k^l \theta_i^{\frac{\alpha}{1-\alpha}} - f_k^N w^N \\ &= \mathcal{A} \Psi_k^l \theta_i^{\frac{\alpha}{1-\alpha}} - f_k^N w^N\end{aligned}\quad (11)$$

where $\mathcal{A} \equiv \left((1-\gamma) P_S^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}} + \gamma P_N^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}} \right)$ and $k \in \{O, V\}$.

Likewise, offshoring firms will have the following profit functions:

$$\begin{aligned}\pi_k^S(i) &= \left((1-\gamma) P_S^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}} + \gamma P_N^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}} \tau_N^{\frac{1}{\alpha-1}} \right) \Psi_k^l \theta_i^{\frac{\alpha}{1-\alpha}} - f_k^S w^N \\ &= \mathcal{B} \Psi_k^l \theta_i^{\frac{\alpha}{1-\alpha}} - f_k^S w^N\end{aligned}\quad (12)$$

where $\mathcal{B} \equiv \left((1-\gamma) P_S^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}} + \gamma P_N^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}} \tau_N^{\frac{1}{\alpha-1}} \right)$ and $k \in \{O, V\}$.

From the above equations it is clear that profits are still linear in $\theta^{\frac{\alpha}{1-\alpha}}$. Firms performing assembly in the North will have profit functions with slope equal to $\mathcal{A} \Psi_k^N$, while offshoring firms will have profit functions with slope $\mathcal{B} \Psi_k^S$. Comparing \mathcal{A} and \mathcal{B} , it is clear that the tariff will affect the slope of the profit lines of offshoring firms relative to non-offshoring firms. Indeed, while profits of all firms will depend positively on both aggregate prices, those firms performing assembly in the South will get only a fraction $\tau_N^{\frac{1}{\alpha-1}} < 1$ of the profits that are attributable to Northern sales. In other words, while non-offshoring firms will receive the full price paid by Northern consumers, offshoring firms will keep only a fraction: the price net of the tariff t_N .

From these four profit functions, I obtain four expressions for the cutoffs as functions of the tariff and both aggregate prices.²⁹

$$\begin{aligned}\pi_O^N = 0 &\Rightarrow \theta_1(P_N, P_S, \tau_N) = \left[\frac{w^N f_O^N}{\Psi_O^N} \frac{1}{\mathcal{A}} \right]^{(1-\alpha)/\alpha} \\ \pi_O^N = \pi_V^N &\Rightarrow \theta_2(P_N, P_S, \tau_N) = \left[\frac{w^N (f_O^N - f_V^N)}{(\Psi_O^N - \Psi_V^N)} \frac{1}{\mathcal{A}} \right]^{(1-\alpha)/\alpha} \\ \pi_O^S = \pi_V^N &\Rightarrow \theta_3(P_N, P_S, \tau_N) = \left[\frac{w^N (f_V^N - f_O^S)}{(\Psi_V^N \mathcal{A} - \Psi_O^S \mathcal{B})} \right]^{(1-\alpha)/\alpha} \\ \pi_O^S = \pi_V^S &\Rightarrow \theta_4(P_N, P_S, \tau_N) = \left[\frac{w^N (f_O^S - f_V^S)}{(\Psi_O^S - \Psi_V^S)} \frac{1}{\mathcal{B}} \right]^{(1-\alpha)/\alpha}\end{aligned}\quad (13)$$

Additionally, both aggregate prices P_N and P_S are related. Specifically, as I show in the

²⁹To guarantee, at least initially, that all four types of firms exist in equilibrium, one needs

$$0 < \theta_1 < \theta_2 < \theta_3 < \theta_4$$

This requires the following conditions: $\frac{f_O^N}{\Psi_O^N \mathcal{A}} < \frac{f_O^N - f_V^N}{(\Psi_O^N - \Psi_V^N) \mathcal{A}} < \frac{f_V^N - f_O^S}{\Psi_V^N \mathcal{A} - \Psi_O^S \mathcal{B}} < \frac{f_O^S - f_V^S}{(\Psi_O^S - \Psi_V^S) \mathcal{B}}$.

Appendix, they can be expressed in the following way:

$$P_S^{\frac{\alpha}{\alpha-1}} = P_N^{\frac{\alpha}{\alpha-1}} + \left(1 - \tau_N^{\frac{\alpha}{\alpha-1}}\right) (\rho_O^S [V(\theta_4) - V(\theta_3)] + \rho_V^S [V(\infty) - V(\theta_4)]) \quad (14)$$

where $\rho_k^l = \left[\alpha \left(\frac{\beta_k^l}{w^N} \right)^\nu \left(\frac{1-\beta_k^l}{w^l} \right)^{1-\nu} \right]^{\frac{\alpha}{1-\alpha}}$ and $V(\theta) \equiv \int_0^\theta \theta'^{\frac{\alpha}{1-\alpha}} g(\theta') d\theta'$.

From equation (14) it is clear that when $\tau_N = 1$ (free trade) the two aggregate prices are equal. However, in the presence of a Northern tariff, these indices will differ because offshoring firms (those with productivities above θ_3) will face a tariff when selling in the Northern market: Southern prices will be lower than Northern prices. The second term of (14) captures this idea.

Finally, a free entry condition, stating that expected profits must be equal to the fixed entry cost, closes the model. It may be written as

$$w^N f_E = \int_{\theta_1}^{\theta_2} \pi_O^N g(\theta) d\theta + \int_{\theta_2}^{\theta_3} \pi_V^N g(\theta) d\theta + \int_{\theta_3}^{\theta_4} \pi_O^S g(\theta) d\theta + \int_{\theta_4}^{\infty} \pi_V^S g(\theta) d\theta. \quad (15)$$

2.2.1 Effects on Cutoffs

From the above discussion, it is apparent that I have a system of six equations (13-15) and six unknowns: $\theta_1, \theta_2, \theta_3, \theta_4, P_N$ and P_S . My interest is in how the tariff t_N affects the firms' decisions: that is, what is the effect of t_N on the productivity cutoffs.

Small Tariffs. For simplicity, I will first focus the analysis locally around free trade, that is, when the original trade policy is $t_N = 0$. In my data set, the relevant variation seems to be centered around free trade. Indeed, in the subset used for my estimations, the Northern tariff has a median of 0 and a mean of 0.8%; likewise, the Southern tariff has a median of 0 and a mean of 5.5%. Hence, the theoretical analysis around free trade seems especially relevant given these features of my data set. Nevertheless, I extend the analysis to consider the large-tariff case below.

Replacing the expressions for profits, cutoffs and prices in the free entry condition (15), I can evaluate the effects of t_N . I summarize these effects in the following proposition.

Proposition 1. *In the benchmark case, for any differentiable distribution function $G(\cdot)$, if the Northern government previously maintained a free trade policy ($t_N = 0$) and then imposes a small tariff $t_N > 0$ on the Northern imports of Southern differentiated goods, it will have the following effects:*

1. *Cutoffs θ_1 and θ_2 will decrease.*
2. *Cutoffs θ_3 and θ_4 will increase.*
3. *The Northern aggregate price P_N will increase.*

Proof. See Appendix. ■

Intuitively, this policy *protects* the firms producing domestically (in the North). Thus, there is a decrease in the minimum productivity required to be either a (N, O) or (N, V) firm. At the same, the tariff *hurts* offshoring firms by restricting their access to the Northern market. Consequently, the least productive firms within (S, O) and (S, V) will have to reorganize as (N, V) or (S, O) firms. Finally, as expected, the tariff also increases the aggregate prices paid by consumers in the North.

Figure III: Effects of t_N .

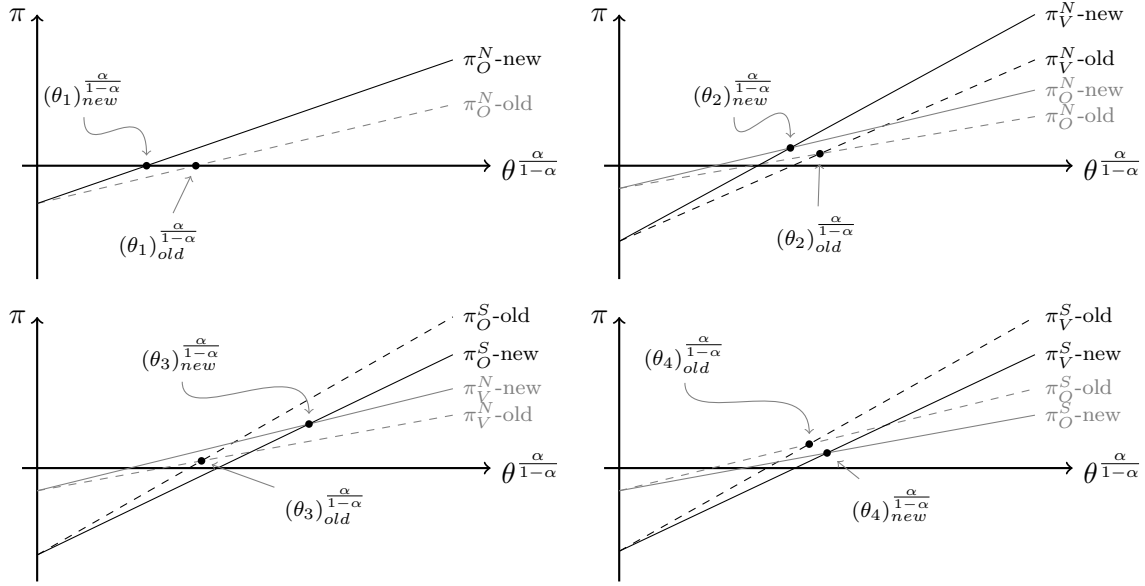


Figure III presents a graphical representation of Proposition 1. The tariff t_N protects those firms producing in the North, making their profit lines steeper and, therefore, reducing the cutoffs θ_1 and θ_2 . In contrast, the tariff t_N restricts the access of offshoring firms to the Northern market, reducing the slope of their profit functions, thus increasing the cutoffs θ_3 and θ_4 .

Large Tariffs. Higher values of the tariff t_N would reinforce this process: further increases of t_N will cause offshoring firms' profits to decrease and non-offshoring firms' profits to increase. Hence, the productivity cutoffs will react to the tariff t_N in the same way as in the locally around free trade case.

Proposition 2. *In the benchmark case, for any differentiable distribution function $G(\cdot)$, an increase of the tariff t_N imposed on the Northern imports of Southern differentiated goods will have the following effects:*

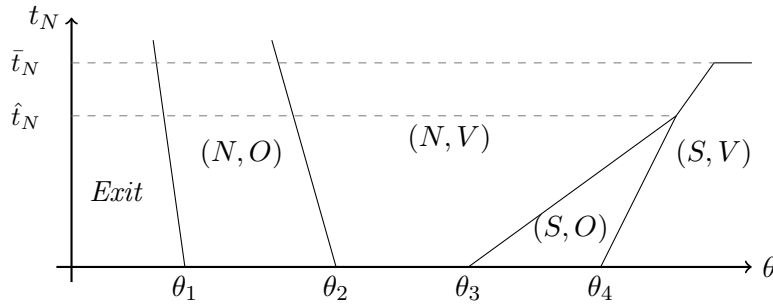
1. Cutoffs θ_1 and θ_2 will decrease.
2. Cutoffs θ_3 and θ_4 will increase.

Proof. See Appendix. ■

Recall that the benchmark-case equilibrium with four different kinds of firms requires $0 < \theta_1 < \theta_2 < \theta_3 < \theta_4$. It is straightforward to check that $0 < \theta_1 < \theta_2$ for any (finite) value of t_N . Thus, there will always be firms choosing to organize as (N, O) and (N, V) .

However, provided that the number of consumers in the North, γ , is large relative to the wage differential, there will be a prohibitive tariff level, \bar{t}_N , such that no firm will offshore whenever $t_N \geq \bar{t}_N$. Intuitively, if the tariff is very large and there are “enough” consumers in the North, no firm will find it profitable to exploit the wage differential offshoring because of the “lost” sales in the Northern market. Graphically, this means that the profit function π_V^N is now steeper than π_V^S : hence, (N, V) is always preferred to (S, V) .³⁰ Moreover, this implies that π_V^N is also steeper than π_V^S . Since π_V^S is steeper than π_O^S , there will also exist a tariff level $\hat{t}_N < \bar{t}_N$ such that for all tariffs $t_N > \hat{t}_N$, (N, V) is always preferred to (S, O) .³¹

Figure IV: Cutoffs as a function of t_N .



To sum up, the magnitude of the tariff t_N will determine the outcome of the industry equilibrium as shown in the example of Figure IV.³² Indeed, high values of t_N will allow for only two kinds of firms, (N, O) and (N, V) . Thus, for sufficiently high levels of the Northern tariff, there will be no offshoring and, hence, no Northern imports of differentiated goods. As t_N starts decreasing, however, the most productive firms will find offshoring profitable and some (S, V) firms will appear: for this relatively high range of t_N , Northern imports of differentiated goods will appear, and these will only involve intra-firm transactions. Finally, for even lower values of t_N , as more firms decide to offshore, an increasing fraction of these will

³⁰Formally, this requires $\frac{\Psi_V^N}{\Psi_V^S} > \frac{B}{A}$. The LHS of the inequality is fixed while its RHS is decreasing in t_N – in the appendix I show that $\frac{dA}{dt_N} > 0$ and $\frac{dB}{dt_N} < 0$. Thus, if the LHS of the inequality, which depends on w^S/w^N , is sufficiently high, there is a tariff level beyond which the inequality always holds.

³¹For tariffs $t_N \in (\hat{t}_N, \bar{t}_N)$, high-productivity firms will organize as (S, V) and less productive firms will organize as either (N, O) or (N, V) . Whenever this is the case, there will be a new cutoff θ'_3 originating from the intersection of π_V^N and π_V^S .

$$\theta'_3 = \left[\frac{w^N (f_V^N - f_V^S)}{(A\Psi_V^N - B\Psi_V^S)} \right]^{(1-\alpha)/\alpha}$$

From the previous analysis, this new cutoff θ'_3 will increase with t_N .

³²In general, the movements of the cutoffs with respect to t_N will not be linear.

organize as (S, O) , resulting in the benchmark case equilibrium. Here, the share of Northern imports of differentiated goods that is intra-firm will be strictly less than one.

2.2.2 Effects on Market Shares

If I specify a particular distribution function for the productivities, then I am able to measure the effects of the tariff on the market shares of each organizational form.

Following the literature (see Antràs and Helpman (2004), Helpman, Melitz, and Yeaple (2004)), suppose that θ is Pareto distributed:

$$G(\theta) = 1 - \left(\frac{b}{\theta}\right)^z$$

where z is the shape parameter of the function and assumed to be large enough so that the variance is finite. Then, the distribution of firm sales is also Pareto, with shape parameter $z - \frac{\alpha}{1-\alpha}$.

Define σ_k^l as the market share of firms that produce at location l and have ownership structure k . Making use of the expressions for the cutoffs, one can compute these shares as follows:

$$\begin{aligned}\sigma_O^N &= [V(\theta_2) - V(\theta_1)] \mathcal{A} \rho_O^N(v) / R(v) \\ \sigma_V^N &= [V(\theta_3) - V(\theta_2)] \mathcal{A} \rho_V^N(v) / R(v) \\ \sigma_O^S &= [V(\theta_4) - V(\theta_3)] \mathcal{B} \rho_O^S(v) / R(v) \\ \sigma_V^S &= [V(\infty) - V(\theta_4)] \mathcal{B} \rho_V^S(v) / R(v)\end{aligned}$$

where ρ_k^l , $V(\theta)$, \mathcal{A} and \mathcal{B} are defined as before, and

$$\begin{aligned}R(v) &= [V(\theta_O^N) - V(\theta)] \mathcal{A} \rho_O^N(v) + [V(\theta_V^N) - V(\theta_O^N)] \mathcal{A} \rho_V^N(v) \\ &\quad + [V(\theta_O^S) - V(\theta_V^S)] \mathcal{B} \rho_O^S(v) + [V(\infty) - V(\theta_O^S)] \mathcal{B} \rho_V^S(v).\end{aligned}$$

Proposition 3. *In the benchmark case, if $G(\cdot)$ is Pareto, the imposition of a tariff t_N on Northern imports of differentiated goods causes $\frac{\sigma_O^S}{\sigma_V^S}$, $\frac{\sigma_V^S}{\sigma_O^S}$, and $\frac{\sigma_O^N}{\sigma_V^N}$ to decrease. Hence,*

1. *total offshoring ($\sigma_O^S + \sigma_V^S$) decreases,*
2. *outsourcing decreases relative to integration in both countries.*

Moreover, an increase in t_N decreases the sales of firms organizing as (S, O) and (S, V) (especially in Northern markets). Hence, it also decreases total imports.

Proof. See Appendix. ■

As expected, the tariff t_N decreases the market shares of offshoring firms. The effect of the tariff is particularly important for firms with mid-range productivities (firms with productivities close to θ_3). These are the firms that are on the margin between (N, V) and (S, O) .

They weigh higher bargaining shares, higher variable costs and lower fixed costs in the North, against lower shares, lower variables costs and higher fixed costs in the South. A Northern tariff, from the firm's point of view, is equivalent to an increase in Southern variable costs, and makes (N, V) relatively more attractive than (S, O) . Thus, while overall offshoring decreases, the decrease is especially significant among firms organized as (S, O) ; likewise, although overall domestic assembly increases, the increase of firms organized as (N, V) is relatively greater.

With a tariff t_N , Northern imports decrease because of the lower sales of offshoring firms. However, this effect is relatively stronger in the case of outsourcing firms (see the second point of Proposition 3). Therefore, arms'-length imports decrease relatively more than intra-firm imports. I summarize this in the following corollary.

Corollary. *The ratio of Northern intra-firm imports to total imports increases with the Northern tariff.*

This positive relation between the tariff and the ratio of intra-firm imports to total imports is the first prediction I test in the empirical section.

2.3 Southern Tariffs

In this subsection I assume that the North follows a free trade policy ($t_N = 0$), while the South imposes a tariff t_S ($\tau_S \equiv 1 + t_S$) on their imports of Northern differentiated goods. The analysis is analogous to the previous case.

The profit functions of those firms producing in the North will now be:

$$\begin{aligned}\pi_k^N(i) &= \left((1 - \gamma) P_S^{\frac{\alpha - \mu}{(1 - \mu)(1 - \alpha)}} \tau_S^{\frac{1}{\alpha - 1}} + \gamma P_N^{\frac{\alpha - \mu}{(1 - \mu)(1 - \alpha)}} \right) \Psi_k^S \theta_i^{\frac{\alpha}{1 - \alpha}} - f_k^N w^N \\ &= \mathcal{C} \Psi_k^S \theta_i^{\frac{\alpha}{1 - \alpha}} - f_k^N w^N\end{aligned}\tag{16}$$

where $\mathcal{C} \equiv \left((1 - \gamma) P_S^{\frac{\alpha - \mu}{(1 - \mu)(1 - \alpha)}} \tau_S^{\frac{1}{\alpha - 1}} + \gamma P_N^{\frac{\alpha - \mu}{(1 - \mu)(1 - \alpha)}} \right)$ and $k \in \{O, V\}$.

Likewise, the new profit functions of offshoring firms will be:

$$\begin{aligned}\pi_k^S(i) &= \left((1 - \gamma) P_S^{\frac{\alpha - \mu}{(1 - \mu)(1 - \alpha)}} + \gamma P_N^{\frac{\alpha - \mu}{(1 - \mu)(1 - \alpha)}} \right) \Psi_k^S \theta_i^{\frac{\alpha}{1 - \alpha}} - f_k^S w^N \\ &= \mathcal{A} \Psi_k^S \theta_i^{\frac{\alpha}{1 - \alpha}} - f_k^S w^N\end{aligned}\tag{17}$$

where \mathcal{A} is defined as before and $k \in \{O, V\}$.

From these profit functions, I obtain the new expressions for the cutoffs.³³

³³Once again, to guarantee that all four types of firms exist in equilibrium one needs $0 < \theta_1 < \theta_2 < \theta_3 < \theta_4$. This requires the following conditions: $\frac{f_O^N}{\Psi_O^N \mathcal{C}} < \frac{f_O^N - f_V^N}{(\Psi_O^N - \Psi_V^N) \mathcal{C}} < \frac{f_V^N - f_O^S}{\Psi_V^N \mathcal{C} - \Psi_O^S \mathcal{A}} < \frac{f_O^S - f_V^S}{(\Psi_O^S - \Psi_V^S) \mathcal{A}}$.

$$\pi_O^N = 0 \Rightarrow \theta_1 (P_N, P_S, \tau_S) = \left[\frac{w^N f_O^N}{\Psi_O^N} \frac{1}{\mathcal{C}} \right]^{(1-\alpha)/\alpha} \quad (18)$$

$$\pi_O^N = \pi_V^N \Rightarrow \theta_2 (P_N, P_S, \tau_S) = \left[\frac{w^N (f_O^N - f_V^N)}{(\Psi_O^N - \Psi_V^N)} \frac{1}{\mathcal{C}} \right]^{(1-\alpha)/\alpha}$$

$$\pi_O^S = \pi_V^N \Rightarrow \theta_3 (P_N, P_S, \tau_S) = \left[\frac{w^N (f_V^N - f_O^S)}{(\Psi_V^N \mathcal{C} - \Psi_O^S \mathcal{A})} \right]^{(1-\alpha)/\alpha}$$

$$\pi_O^S = \pi_V^S \Rightarrow \theta_4 (P_N, P_S, \tau_S) = \left[\frac{w^N (f_O^S - f_V^S)}{(\Psi_O^S - \Psi_V^S)} \frac{1}{\mathcal{A}} \right]^{(1-\alpha)/\alpha}$$

Aggregate prices are related by an expression analogous to (14) (see the Appendix for the details):

$$P_N^{\frac{\alpha}{\alpha-1}} = P_S^{\frac{\alpha}{\alpha-1}} + \left(1 - \tau_S^{\frac{\alpha}{\alpha-1}}\right) \left[\rho_O^N [V(\theta_2) - V(\theta_1)] + \rho_V^N [V(\theta_3) - V(\theta_2)] \right] \quad (19)$$

where ρ_k^l and $V(\cdot)$ are defined as before.

In the absence of the tariff aggregate prices are equal. However, the second term of (19) shows that whenever $t_S > 0$ these prices will be different because the tariff only affects those firms producing in the North (those with productivities in the range $[\theta_1, \theta_3]$). In particular, Southern prices will be higher than Northern prices. Along the same lines, from the definition of \mathcal{C} , firms assembling in the North will get only a fraction $\tau_S^{\frac{1}{\alpha-1}} < 1$ of the profits that are attributable to Southern sales.

2.3.1 Effects on Cutoffs

Small Tariffs. Proceeding as in the previous subsection, I use the free entry condition (15) along with equations (16-19) to evaluate how the imposition of the tariff t_S affects the cutoffs.³⁴

I summarize these results in the following proposition (see the Appendix for the details).

Proposition 4. *In the benchmark case, for any differentiable distribution function $G(\cdot)$, if the Southern government previously maintained a free trade policy ($t_S = 0$), and then imposes a small tariff $t_S > 0$ on the Southern imports of Northern differentiated goods, it will have the following effects:*

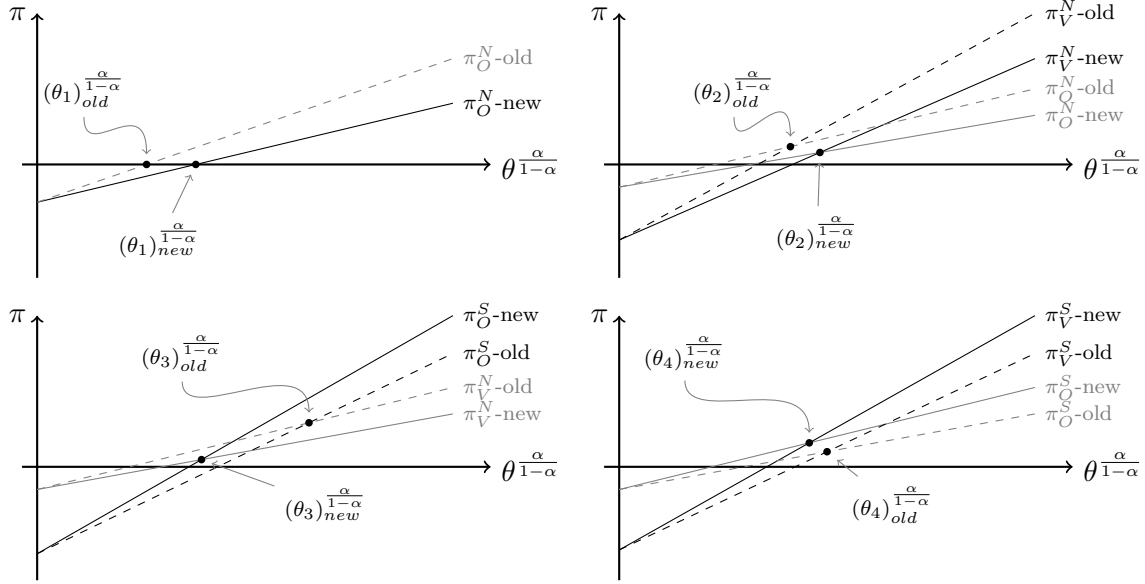
1. Cutoffs θ_1 and θ_2 will increase.
2. Cutoffs θ_3 and θ_4 will decrease.
3. The Southern aggregate price P_S will increase.

Proof. See Appendix. ■

³⁴Once more, I focus the analysis locally around free trade.

The tariff t_S , in contrast to t_N , *hurts* the firms producing in the North and *protects* those offshoring. Thus, after t_S is imposed, profits of (N, O) and (N, V) firms decrease so that a higher productivity level is required for assembly in the North to be profitable. In contrast, the tariff increases the profits of offshoring firms (through the higher aggregate prices P_S) so a lower productivity level is needed to organize as an (S, O) or (S, V) firm.

Figure V: Effects of t_S .



Graphically, as seen in Figure V, the tariff t_S reduces the slope of the profit lines of those firms producing in the North (increasing θ_1 and θ_2). Thus, some firms with productivity close to the original value of θ_1 will exit, while others that were (N, V) will reorganize as (N, O) . Conversely, the tariff makes offshoring profit lines steeper (reducing θ_3 and θ_4). Therefore, firms near the old value of θ_3 will reorganize as (S, O) , while those close to the original θ_4 will switch to (S, V) .

Large Tariffs. High values of the tariff t_S have analogous effects to those described for t_N . Recall that the benchmark case, where there are four types of firms in equilibrium, will hold as long as the tariff is moderate.

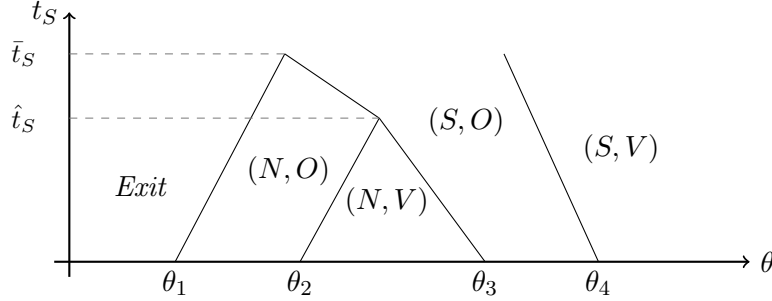
Proposition 5. *In the benchmark case, for any differentiable distribution function $G(\cdot)$, an increase of the tariff t_S imposed on the Southern imports of Northern differentiated goods will have the following effects:*

1. Cutoffs θ_1 and θ_2 will increase.
2. Cutoffs θ_3 and θ_4 will decrease.

Proof. See Appendix. ■

The benchmark case requires $0 < \theta_1 < \theta_2 < \theta_3 < \theta_4$. However, as t_S increases this ordering may not be satisfied since θ_1 and θ_2 will increase while θ_3 and θ_4 will decrease.³⁵ Thus, there may exist a value \hat{t}_S such that $\theta_3 < \theta_2$ for all $t_S \geq \hat{t}_S$ – in which case no firm will organize as (N, V) . Moreover, there may also exist some other value $\bar{t}_S > \hat{t}_S$ such that $\theta_3 < \theta_1$: if $t_S \geq \bar{t}_S$ then no firm will organize as (N, O) either.³⁶

Figure VI: Cutoffs as a function of t_S .



In summary, the magnitude of the tariff t_S will determine the outcome of the industry equilibrium as shown in the example of Figure VI.³⁷ High values of t_S will allow only two kinds of firms, (S, O) and (S, V) , and no Northern production of differentiated goods. As t_S starts decreasing some (N, O) firms will appear. Finally, for even lower values of t_S , some firms will organize as (N, V) , resulting in the benchmark case with four different kinds of firms in equilibrium.

2.3.2 Effects on Market Shares

Assuming again a Pareto distribution for the productivities, one can compute the market shares of each type of organizational form.

$$\begin{aligned}\sigma_O^N &= [V(\theta_2) - V(\theta_1)] \mathcal{C} \rho_O^N(v) / R(v) \\ \sigma_V^N &= [V(\theta_3) - V(\theta_2)] \mathcal{C} \rho_V^N(v) / R(v) \\ \sigma_O^S &= [V(\theta_4) - V(\theta_3)] \mathcal{A} \rho_O^S(v) / R(v) \\ \sigma_V^S &= [V(\infty) - V(\theta_4)] \mathcal{A} \rho_V^S(v) / R(v)\end{aligned}$$

where $V(\cdot)$, ρ_k^l , \mathcal{A} and \mathcal{C} are defined as before and

$$\begin{aligned}R(v) &= [V(\theta_O^N) - V(\underline{\theta})] \mathcal{C} \rho_O^N(v) + [V(\theta_V^N) - V(\theta_O^N)] \mathcal{C} \rho_V^N(v) \\ &\quad + [V(\theta_O^S) - V(\theta_V^N)] \mathcal{A} \rho_O^S(v) + [V(\infty) - V(\theta_O^S)] \mathcal{A} \rho_V^S(v).\end{aligned}$$

³⁵Graphically, with t_S the profit lines π_O^N and π_V^N become flatter while π_O^S and π_V^S become steeper.

³⁶Formally, $\theta_2 < \theta_3 \Leftrightarrow \frac{f_V^N - f_O^N}{f_O^S - f_V^S} < \frac{(\Psi_V^N - \Psi_O^N)c}{\Psi_O^S \mathcal{A} - \Psi_V^N c}$ and $\theta_1 < \theta_3 \Leftrightarrow \frac{f_O^N}{f_O^S - f_V^N} < \frac{\Psi_O^N c}{\Psi_O^S \mathcal{A} - \Psi_V^N c}$. Since $\frac{d\mathcal{A}}{dt_S} > 0$ and $\frac{d\mathcal{C}}{dt_S} < 0$ (see Appendix), as t_S increases it gets harder for both conditions to be satisfied.

³⁷The movements of the cutoffs with respect to t_S in general will not be linear.

Proposition 6. *In the benchmark case, if $G(\cdot)$ is Pareto, the imposition of a tariff t_S on Southern imports of differentiated goods causes $\frac{\sigma_O^S}{\sigma_V^S}$, $\frac{\sigma_V^S}{\sigma_O^S}$, and $\frac{\sigma_O^N}{\sigma_V^N}$ to increase. Hence,*

1. *total offshoring ($\sigma_O^S + \sigma_V^S$) increases,*
2. *outsourcing increases relative to integration in both countries.*

Moreover, an increase in t_S increases the sales from firms organized as (S, O) and (S, V) (especially in Northern markets). Hence, it increases total imports.

Proof. See Appendix. ■

This policy, by protecting the Southern market, encourages entrepreneurs to offshore (to look for Southern managers). Thus, not surprisingly, the imposition of the tariff t_S increases the market shares of offshoring firms. Again, the effect is particularly important among firms with mid-range productivities. With the tariff, these firms organize as (S, O) rather than as (N, V) , and therefore increasing outsourcing relative to vertical integration.

With a higher tariff t_S , Northern imports increase because of the higher sales of the offshoring firms. However, this effect is relatively stronger for outsourcing firms (see the second point of Proposition 6). Therefore, arms'-length imports increase relatively more than intra-firm imports. I summarize this in the following corollary.

Corollary. *The ratio of Northern intra-firm imports to total imports decreases with the Southern tariff.*

The negative relation between Southern tariffs and the ratio of Northern intra-firm imports to total imports is the second prediction that I test in the following section.

3 Empirical Evidence

3.1 Testable Implications

In this section I test the main theoretical predictions from the previous section. From Corollaries to Propositions 3 and 6, for any sector j , I expect Northern imports to behave in the following way:

$$\tilde{m} \equiv \frac{M_V}{M_V + M_O} = f(\underbrace{t^N}_{(+)}, \underbrace{t^S}_{(-)}) \quad (20)$$

where \tilde{m} is the ratio of intra-firm imports to total imports in sector j , M_V are the imports due to the activity of firms that vertically integrate in South and M_O are the imports from firms that outsource in South. From the theory section, the ratio \tilde{m} depends positively on Northern tariffs and negatively on Southern tariffs.

Therefore, for any particular industry, I can study how the ratio of intra-firm imports to total imports is affected by U.S. and foreign tariffs. Specifically, I will want to test whether for any final good industry with relatively *high headquarters intensity*:³⁸

³⁸Recall from Assumption 1 that I focus on sectors with high headquarters intensity.

- Higher U.S. tariffs increase the ratio of intra-firm imports to total imports.
- Higher foreign tariffs decrease the ratio of intra-firm imports to total imports.

Next, I describe the data set with which I will test the predictions embodied by equation (20).

3.2 Data

3.2.1 Sources

Trade data is from the Foreign Trade Division of the U.S. Census Bureau.³⁹ Importers must declare whether or not the transaction is with a related party. This makes it possible to distinguish between intra-firm (related party) and arm’s-length (non-related party) imports. The data are at the 6-digit level of the Harmonized System (HS), for the years 2000 through 2006.⁴⁰ The database includes imports from a group of selected countries: Canada, Mexico, China, Malaysia, Ireland and Brazil. These countries are the top-6 U.S. suppliers, conditional that at least 2/3 of the intra-firm imports involve a U.S. parent firm.⁴¹ This criterion stems from the theory: I want to analyze the behavior of offshoring firms based in the United States.

Tariff data comes from the United Nation’s TRAINS database. For each HS6 industry, for the period 2000-2006, I observe the tariffs “effectively applied” by the U.S. on American imports and by the foreign countries on their imports from the U.S. The effectively applied tariff is defined as the minimum of the MFN tariff and a preferential tariff, if the latter exists.

Finally, to measure headquarter’s intensity I use the NBER productivity database put together by Bartelsman, Becker and Gray (see Bartelsman and Gray, 1996). For each U.S. 4-digit SIC industry, the database contains information on total employment (l), non-production workers (s), and capital (k) for 1996. With this data I construct skill- (s/l) and capital-intensity (k/l) measures. I use the former as the default measure of HQ intensity since it is closer to the theoretical concept; nonetheless, I use the latter measure to check its robustness.

3.2.2 Description

Table II presents some information on intra-firm imports for 2006. Overall, American imports were \$1.8 trillion, of which \$863 billion (47%) were imported from a related party. Taken together, the countries in the sample account for (roughly) 45% of total imports and 48% of intra-firm imports.

³⁹I am grateful to Andy Bernard for pointing out the existence of this database to me.

⁴⁰The data is highly disaggregated: it involves roughly 5,000 industries. This allows me to exclude those sectors that are clearly input producers (recall from the theory that the Northern country only imports final goods from the South). To do this, I exclude from the sample any HS6 sector whose definition contains the word ‘part’ or ‘component.’ This is available from Peter Schott’s webpage and was used in Schott (2004). In the appendix I present some results for the predictions on intermediate inputs found in Diez (2006).

⁴¹The breakdown of related party imports into American or foreign parent is from Zeile (2003).

The last column of Table II presents my variable of interest: the ratio of intra-firm imports to total imports, hereafter labeled as m . The ratio shows huge variation across countries – it ranges from 24% for China up to 89% for Ireland. Note that there is no clear factor (i.e., income or geographical) determining this behavior. The two lowest ratios are from relatively poor countries (China and Brazil) but, at the same time, there are two other relatively poor countries (Mexico and Malaysia) with ratios above Canada. Likewise, although neighboring countries as Canada and Mexico have relatively high ratios, distant countries as Ireland and Malaysia present even higher values.⁴²

Table II: Total and Intra-Firm Imports, 2006.

Country	Intra-Firm Imports		Total Imports		Related / Total
	Value	Share	Value	Share	
Brazil	8.3	1%	26.2	1%	32%
Canada	139.5	16%	303.0	16%	46%
China	70.7	8%	287.1	16%	25%
Ireland	25.8	3%	28.9	2%	89%
Malaysia	26.3	3%	36.4	2%	72%
Mexico	114.5	13%	197.1	11%	58%
Sample	385.2	45%	878.7	48%	44%
World	862.7	100%	1,845.1	100%	47%

Note: Import values are expressed in billions of U.S. dollars.

The theoretical ratio \tilde{m} and the observed ratio m are not perfectly mapped. From the theory, the object of interest is the composition of imports due to offshoring American firms. However, the data also includes those imports due to the activities of foreign firms. For example, related party imports from China include the imports due to American firms offshoring and integrating in China along with those imports due to the exports from Chinese firms to their subsidiaries in the U.S. Hence, the observed M_{rel} related-party imports also are only a proxy for the theoretical M_V imports: $M_{rel} \geq M_V$. Likewise, the observed M_{non} non-related imports are just a proxy for the theoretical M_O imports: $M_{non} \geq M_O$.⁴³ More specifically, I only observe the left-hand-side of the following two expressions:

$$\begin{aligned}
 M_{non} &= M_{non}^{US} + M_{non}^F \\
 M_{rel} &= M_{rel}^{US} + M_{rel}^F
 \end{aligned}$$

⁴²Developed countries usually have medium to high ratios whereas developing countries show great variation. For example, among the tiniest exporters to the U.S., on the one hand, all imports from Burma and East Timor are intra-firm; and on the other hand, almost all imports from Eritrea or Sudan are arm’s-length imports. The website of the Foreign Trade Division of the U.S. Census, provides data by country and 6-digit NAICS industries.

⁴³By selecting the countries I was able to (partially at least) take care of this in regards of intra-firm imports. For the countries in the sample, in the case of intra-firm imports, at least 66% of them involve an American parent firm. Unfortunately, there is no way of doing something similar with the arm’s-length imports.

where M_k^{US} are those imports whose origin involves the offshoring decision of an American firm and M_k^F are those imports that do not include American offshoring, for $k \in \{non, rel\}$. Thus, the observed M_{non}^{US} corresponds to the theoretical M_O , while the observed M_{rel}^{US} corresponds to the theoretical M_V .

It is possible to show that the observed ratio m and the theoretical ratio \tilde{m} are equivalent when, for any industry and country, the following relation holds:

$$\frac{M_{rel}^{US}}{M_{non}^{US}} = \frac{M_{rel}^F}{M_{non}^F} \quad (21)$$

Going back to the example, I need to assume that when one considers the American imports from China, the ratio of related to non-related party imports is the same, whether the imports involve American or Chinese firms.⁴⁴

Tables III and IV summarize the basic statistics of the ratio m and the tariffs by-country and by-industry, respectively.⁴⁵ There are several features to point out.

First, there are many observations where the ratio m takes a value of zero (see the fifth column on either table). Overall, 35% of the observations have $m = 0$. This holds across countries (varying from 24% of the observations for Canada to 45% for Brazil) and across industries (from 28% for HS8 to 51% for HS5). Consequently, the mean and the median are always substantially different. This is one of the reasons why I check the robustness of the conditional mean estimates (OLS) with quantile regressions.

Second, U.S. tariffs are on average lower than foreign tariffs. In fact, there are many observations where the U.S. tariffs are zero. This is true both, by-country and by-industry, where the median is most times zero. Overall, the mean of American tariffs is 1.5% but the median is 0.

Third, the tariffs imposed by the *foreign* countries show greater variation across countries and across industries. Indeed, while Canada and Mexico usually impose zero tariffs on the U.S., the rest of the countries usually have much higher values, especially China and Brazil. Likewise, across industries one observes sectors such as HS1 where the median is zero and others like HS6 where the median is 10%. Overall, these tariffs have a mean of 7.2% and a median of 2.9%.

Consequently, as will become clear in the following subsections, the inclusion of those observations with $m = 0$ will be relevant. And, at the same time, the lack of variation in the tariffs will make it hard to obtain significant estimates, especially in the case of American tariffs.⁴⁶

⁴⁴If the difference between the theoretical ratio \tilde{m} and the observed ratio m is on average zero and is uncorrelated with the regressors, then the estimates will be unbiased. Additionally, all empirical papers based on the Antràs and Helpman (2004) framework face the same issue, so they implicitly make the same assumption.

⁴⁵The 6-digit industries are aggregated up to the 1-digit HS. See the Appendix for a description of them.

⁴⁶My original idea was to use primarily time-series variation to identify the effects. However, given the little variation of the tariff data, I rely mostly on the cross-sectional variation. Even if this were not so, the limited time range of my data would also be a restriction to time-series identification. Indeed, with data from 2000 through 2006, I would not be able to take properly into account the dynamic responses of firms to anticipated

Table III: Statistics by Country.

Country	Obs.	$m(\%)$			$t^{US}(\%)$			$t^F(\%)$		
		mean	median	$m = 0$	mean	median	sd	mean	median	sd
Brazil	10,217	0.28	0.01	0.45	1.8	0.0	6.4	14.8	15.5	5.3
Canada	21,935	0.24	0.08	0.24	0.0	0.0	0.2	0.0	0.0	0.0
China	15,074	0.11	0.01	0.38	3.7	2.9	4.3	12.1	10.0	8.0
Ireland	6,973	0.32	0.03	0.47	4.0	2.7	11.7	4.3	3.2	4.5
Malaysia	4,273	0.24	0.00	0.50	2.8	1.7	3.8	10.2	5.0	11.2
Mexico	17,050	0.38	0.19	0.30	0.2	0.0	2.8	8.0	0.0	11.0

Table IV: Statistics by Industry.

HS	Obs.	$m(\%)$			$t^{US}(\%)$			$t^F(\%)$		
		mean	median	$m = 0$	mean	median	sd	mean	median	sd
Pooled	75,522	0.26	0.05	0.35	1.5	0.0	5.2	7.2	2.9	9.1
0	1,480	0.13	0.00	0.48	1.1	0.0	3.4	6.7	0.0	13.0
1	1,926	0.20	0.01	0.46	1.3	0.0	2.8	7.3	0.0	11.8
2	8,416	0.25	0.02	0.44	1.6	0.0	12.4	4.9	2.0	7.7
3	8,899	0.33	0.14	0.29	1.3	0.0	2.2	7.0	5.0	8.0
4	6,388	0.20	0.03	0.35	0.8	0.0	2.3	7.4	3.0	8.7
5	8,065	0.15	0.00	0.51	3.4	0.0	5.1	7.9	5.0	8.9
6	7,172	0.17	0.02	0.32	3.9	0.0	5.8	11.0	10.0	11.4
7	10,493	0.26	0.06	0.31	1.0	0.0	2.2	6.7	3.0	8.1
8	17,557	0.33	0.14	0.28	0.7	0.0	1.7	6.7	1.8	8.6
9	5,126	0.29	0.09	0.29	0.9	0.0	1.9	7.4	2.0	9.2

3.3 Baseline Results

3.3.1 Simple Estimation

The theoretical predictions refer to industries with relatively high headquarters (HQ) intensity. The ratio of skilled workers measures how important are the the *white-collar* activities relative to the *blue-collar* activities in a given industry. Although I acknowledge this is not perfect, I use it as my default measure of HQ intensity.⁴⁷ Additionally, the theory does not pin down what level should be considered high. Consequently, I use the median as the default but I also check using the 25th and 75th percentiles as alternative cutoff values.

At the same time, from the theory we know that in sectors with high HQ intensity there should not be any observations with $m = 0$, while in sectors with low HQ intensity all observations should have $m = 0$. This provides me with a second criterion of what is a HQ intensive sector. However, given that the observed m includes not only the imports due to American

or unanticipated tariff changes. See Freund and McLaren (1999) for evidence of anticipatory sunk investments made to prepare for accession to a trading block.

⁴⁷Nunn and Trefer (2007) also use this same ratio as one of their measures of HQ intensity. In a different context, this measure has also been used by Domowitz, Hubbard, and Petersen (1988).

offshoring firms but also the “ordinary” imports (exports of foreign firms to the U.S.) this criterion is not entirely satisfactory either.

Therefore, I have two possible ways of identifying an industry as a HQ intensive sectors. Since neither of them is completely accurate, in this subsection I will take a relatively “conservative” approach and keep in the sample only those that satisfy both criteria.⁴⁸

Definition 1. *An industry i has High HQ intensity if:*

1. *the ratio of skilled workers is above the sample median,*
- and,*
2. *the observed $m_i > 0$.*

The basic estimation equation is the following:

$$m_{ict} = \beta_0 + \beta_1 \cdot t_{ict}^{US} + \beta_2 \cdot t_{ict}^F + \beta_3 \cdot X_{ict} + \varepsilon_{ict} \quad (22)$$

where for industry i , country c and year t , m_{ict} is the ratio of intra-firm imports to total imports, t_{ict}^{US} is the tariff applied by the U.S. on foreign country c , and t_{ict}^F is the tariff applied by the foreign country on the U.S and X_{ict} is a group of controls. From the theory, I expect to find β_1 to be positive and β_2 to be negative.

Table V presents the results for different specifications. All results on the table are OLS estimates, and the standard errors are heteroskedasticity-robust. The different columns vary through alternative choices of fixed effect controls as well as the inclusion (or not) of Chinese observations. There are several things to point out.^{49,50}

First and foremost, the results show strong support for the theory: the estimated β_1 's are positive and significant and likewise the estimated β_2 's are negative and significant. Just as the theory predicted, tariffs affect the imports of all offshoring firms but their effect is especially important among those that are outsourcing. Therefore, higher U.S. tariffs *hurt* all imports but especially non-related party imports. Thus, American tariffs have a positive effect on the ratio of intra-firm imports to total imports. Conversely, foreign tariffs have a negative effect on the ratio.

Second, the estimates of β_1 are quite sensitive to the inclusion of Chinese observations: their omission greatly increases the estimated values as well as their level of statistical significance. In contrast, the estimates for β_2 do not seem to be affected by the inclusion/omission of Chinese observations. Thus, with the full sample (including China), the absolute value of the estimates of β_1 and β_2 are similar. But when I drop these observations the magnitude of β_1 is greater than β_2 , suggesting that the effect on m of changes in American tariffs is “greater” than the effect of changes in foreign tariffs.

⁴⁸Conservative in the sense that it is *hard* to remain in the sample. Hence, I am quite confident that those that satisfy this criteria are indeed HQ intensive sectors. I relax this definition in the next subsection.

⁴⁹The software used for all the empirical work was R, version 2.6.0.

⁵⁰The sensitivity to Chinese observations is not entirely surprising given China’s particular regulations towards foreign investment (see OECD, 2006).

Table V: OLS Simple Regression.

	Linear					Quadratic	
	-1-	-2-	-3-	-4-	-5-	-6-	-7-
β_1	0.0024* (0.001)	0.013*** (0.002)	0.0020 (0.001)	0.0124*** (0.002)	0.0098*** (0.002)	0.0045* (0.003)	0.0216*** (0.004)
β_2	-0.0037*** (0.000)	-0.0039*** (0.001)	-0.0031*** (0.000)	-0.0032*** (0.000)	-0.0022*** (0.000)	-0.0040*** (0.001)	-0.0043*** (0.001)
Obs.	24,323	19,726	24,323	19,726	19,726	24,323	19,726
Ctry	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	No	No	Yes	Yes	Yes
Ind	No	No	No	No	Yes	No	No
China	Yes	No	Yes	No	No	Yes	No

Notes: ‘***’, ‘**’ and ‘*’ refers to statistical significance at the 1%, 5% and 10% levels, respectively. Standard errors are heteroskedasticity-robust. The reported estimates for the quadratic model actually are the marginal effects $\partial m / \partial t^{US}$ and $\partial m / \partial t^F$.

Finally, on the last two columns, I relax the linearity assumption, and present the estimates for the case of a quadratic model. Specifically, I estimate the following equation:

$$m_{ict} = \beta_0 + \beta_1 \cdot t_{ict}^{US} + \beta_2 \cdot (t_{ict}^{US})^2 + \beta_3 \cdot t_{ict}^F + \beta_4 \cdot (t_{ict}^F)^2 + \beta_5 \cdot t_{ict}^{US} \cdot t_{ict}^F + \beta_6 \cdot X_{ct} + \epsilon_{ict} \quad (23)$$

The reported estimates are the marginal effects and the standard errors were obtained computing the conditional variance. Both, estimates and standard errors, are evaluated at the sample mean of the covariates. The estimates look very similar to those of the linear model, although I should also point out that there is a big increase in the magnitude of β_1 .⁵¹

Overall, these results are supportive of the theory. Higher U.S. tariffs are associated with higher intra-firm import shares and higher foreign tariffs are associated to lower intra-firm import shares.

3.3.2 Estimation with industry- and country-controls

The literature has identified some other factors that might affect the behavior of the intra-firm import ratio m . Therefore, in this subsection I add to the basic equation (22) industry and country controls that have been highlighted by Antràs (2003), Yeaple (2006), Bernard, Jensen, Redding, and Schott (2008) and Nunn and Treffer (2007).

⁵¹I also tried other alternatives to the linear specification such as a cubic model. The results were very similar to those reported on Table V.

Thus, the new estimation equation is the following:

$$m_{ict} = \beta_0 + \beta_1 \cdot t_{ict}^{US} + \beta_2 \cdot t_{ict}^F + \beta_3 \left(\frac{k}{l}\right)_i + \beta_4 \left(\frac{s}{l}\right)_i + \beta_5 \cdot freight_i + \beta_6 \left(\frac{K}{L}\right)_c + \beta_7 \left(\frac{H}{L}\right)_c + \beta_8 X_t + \varepsilon_{ict} \quad (24)$$

where $\left(\frac{k}{l}\right)_i$ is industry i 's log of capital intensity, $\left(\frac{s}{l}\right)_i$ is industry i 's skill intensity, $freight_i$ is industry i 's transport cost, $\left(\frac{K}{L}\right)_c$ is country c 's log of capital abundance, $\left(\frac{H}{L}\right)_c$ is country c 's log of human capital abundance and X_t is a year fixed effect. Again, I expect to find $\beta_1 > 0$ and $\beta_2 < 0$.⁵²

Table VI: OLS Regressions with country- and industry-controls.

	Without $m = 0$		With $m = 0$	
	-1-	-2-	-3-	-4-
β_1	0.013*** (0.004)	0.029*** (0.005)	0.003 (0.003)	0.013*** (0.003)
β_2	-0.003*** (0.001)	-0.004*** (0.001)	-0.002*** (0.001)	-0.003*** (0.001)
Obs.	24,263	19,678	37,100	29,478
China	Yes	No	Yes	No

Notes: '***', '**' and '*' refers to statistical significance at the 1%, 5% and 10% levels, respectively. Standard errors clustered by (4-digit SIC Industry, Country) pairs.

The first two columns of Table VI present the results using Definition 1.^{53,54} Note that the estimates have the right sign and are statistically significant. Hence, once I take into account most of the factors previously identified by the literature, the tariffs continue affecting the ratio of intra-firm imports as predicted by the theory. Moreover, the estimates are similar to those found in the previous subsection, without the inclusion the country- and industry-controls. Thus, taking the first column as the baseline results, I find that a one percentage point increase in the U.S. tariff is associated with a 1.3 percentage point increase in the ratio m , while a one percentage point increase in the foreign tariff implies a 0.3 percentage point decrease in the ratio. In the last two columns of Table VI I relax the second criterion of Definition 1: I estimate equation (24) including those observations with $m = 0$. Note that when I include these observations, the magnitude of the estimates is reduced and the estimate for the U.S. tariff loses significance. Finally, Chinese observations still affect the magnitude

⁵²Data for the country variables is from Hall and Jones (1999). The data for the freight costs is from Bernard, Jensen, and Schott (2006). Some of these papers also mention productivity dispersion as an important factor affecting m – unfortunately, I could not gain access to such data.

⁵³Since the controls vary at the 4-digit SIC level or at the country level, and not at the HS6 level like the trade and tariff data, I report standard errors clustered by (4-digit SIC Industry, Country) pairs. See Nunn and Trefler (2007) for a similar treatment of the standard errors.

⁵⁴The estimates for the country- and industry-controls (not reported here) have the expected signs and most times are statistically significant.

and significance of the U.S. tariffs estimate.

Table VII: OLS Regressions with Controls by 1-digit Industries

HS	Obs.	β_1	β_2
Pool	24,263	0.013*** (0.004)	-0.003*** (0.001)
0	239	0.015* (0.008)	-0.004*** (0.001)
1	670	0.041* (0.024)	-0.003* (0.002)
2	4,298	0.027** (0.011)	-0.002 (0.001)
3	5,030	0.019*** (0.005)	-0.002 (0.002)
4	1,190	0.009* (0.005)	-0.004** (0.002)
6	603	0.019 (0.013)	0.0016 (0.002)
7	1,741	0.033** (0.016)	-0.004** (0.002)
8	7,397	0.024*** (0.008)	-0.004*** (0.001)
9	2,963	0.011 (0.008)	-0.0067*** (0.002)

Notes: '***', '**' and '*' refers to statistical significance at the 1%, 5% and 10% levels, respectively. Standard errors clustered by (4-digit SIC Industry, Country) pairs.

Table VII presents the results of estimating equation (24) breaking down the sample into 1-digit HS industries; I also include the results for the pooled sample for comparison purposes. Once more, the results are supportive of the theory. Most of the estimates have the right sign and are statistically significant. Indeed, this is the case in 7 (out of 9) industries for the American tariff estimate, and in 6 (out of 9) industries for the foreign tariff estimate.⁵⁵ The strongly significant results for industry HS-8 are particularly reassuring: this industry, which represents almost 1/3 of the pooled sample, is composed by industrial manufactured goods that best fit the concept of differentiated goods. These results, however, were obtained using Definition 1 – namely, dropping the observations with $m = 0$. In the same way as with the pooled sample, the inclusion of these observations does not affect the signs of the point estimates, but it reduces their statistical significance.

⁵⁵Industry HS-5 was dropped due to the small number of observations.

3.4 Alternative Specifications

In this subsection I explore alternatives to the baseline case. The main interest is on the sensitivity of the estimates to the inclusion/exclusion of those observations with $m = 0$. I analyze this in two different ways. First, I present some quantile-regression estimations. Second, I address the possible selection problem of the ratio m parametrically and semi-parametrically.^{56,57}

3.4.1 Quantile Estimation

In this subsection I depart from the linear regression model and estimate quantile regressions instead. I am interested in learning how the tariffs affect the ratio m at different parts of m 's distribution. This seems particularly relevant in my case: recall that roughly 1/3 of the observations have $m = 0$ – thus, I believe it is really important to extend the knowledge of m 's response beyond the conditional mean implied by OLS regressions (Koenker and Hallock, 2001).

The new estimating equation, analogous to equation (24), is the following:

$$Q(m_{ict}|Z_{ict}) = \lambda_0 + \lambda_1 \cdot t_{ict}^{US} + \lambda_2 \cdot t_{ict}^F + \lambda_3 \left(\frac{k}{l}\right)_i + \lambda_4 \left(\frac{s}{l}\right)_i + \lambda_5 \cdot freight_i + \lambda_6 \left(\frac{K}{L}\right)_c + \lambda_7 \left(\frac{H}{L}\right)_c \quad (25)$$

where $Q(m_{ict}|Z_{ict})$ is the conditional quantile function and I condition on the variables $Z_{ict} = \{t_{ict}^{US}, t_{ict}^F, (\frac{k}{l})_i, (\frac{s}{l})_i, freight_i, (\frac{K}{L})_c, (\frac{H}{L})_c\}$.

Table VIII shows the results of estimating equation (25) for four different quantiles of m . The algorithm used for fitting is the variant of the Barrodale and Roberts simplex algorithm described in Koenker and D'Orey (1987). Standard errors were computed through a bootstrap procedure, resampling over (SIC 4-digit Industry, country) pairs, with 500 replications. From the theory, I expect to find $\lambda_1 > 0$ and $\lambda_2 < 0$.⁵⁸

Given the significant censoring of the dependent variable m (recall that $m = 0$ for 1/3 of the observations), it is not surprising that high-quantile estimates work better than low-quantile estimate, as can be seen on Table VIII. The estimates for λ_2 are always negative and almost always significant. In the case of λ_1 , the estimate in the median regression is not significant and, in fact, has the opposite sign. However, for the upper quantiles, the estimated λ_1 becomes positive and significant.⁵⁹

Overall, these results suggest that the theory finds support in the data even when looking at functionals of m 's distribution. However, the median regression also indicates that the large

⁵⁶Given the large number of zeros (and to a much smaller degree, of ones), I also tried a Tobit estimation, taking 0 and 1 as censoring points. The results were almost exactly like the OLS estimates presented above.

⁵⁷I also performed a Difference-in-Differences estimation. I took industries with no tariff changes as the control group and I had different treatment groups for those industries where the American (Foreign) tariff increased (decreased). The point estimates had the right sign although they were not statistically significant.

⁵⁸Estimation was done using the package “quantreg” for R. The idea for the block bootstrap procedure is to take into account that the observations are not *iid* (i.e., clustering of standard errors).

⁵⁹Given the large number of observations with $m = 0$, I do not report estimates for lower quantiles because there would be no variation in m .

Table VIII: Quantile Regressions with country and industry controls.

	Quantile:			
	$Q = 0.5$	$Q = 0.7$	$Q = 0.8$	$Q = 0.9$
λ_1	-0.0005 (0.0015)	0.0035 (0.0045)	0.0080* (0.0047)	0.0101*** (0.0030)
λ_2	-0.0005 (0.0004)	-0.0017* (0.0009)	-0.0020** (0.0008)	-0.0010** (0.0005)

Notes: ‘***’, ‘**’ and ‘*’ refers to statistical significance at the 1%, 5% and 10% levels, respectively. Standard errors obtained through bootstrap. The total number of observations was 37,100.

amount of observations with $m = 0$ play a significant role.

3.4.2 Selection Model

In this subsection I address the selection problem that is likely to exist with the ratio m : intra-firm trade can only be observed if firms have established affiliates in the foreign country. I correct for selection in two ways, parametrically and semi-parametrically.

First, I estimate a 2-step Heckman model. An appropriate instrument should be correlated with the fixed cost of establishing a plant in a foreign country but uncorrelated with the variable cost of sourcing from that facility. Following Bernard, Jensen, Redding, and Schott (2008), I proxy the fixed costs of a facility in country c with (i) the number of airline departures from country c in 1998, and (ii) the average cost of a 3-minute phone call from country c to the U.S. in 1998.⁶⁰

On the first stage, the selection equation consists of a probit regression, whose dependent variable is a dummy variable that equals one if there is intra-firm trade and zero otherwise. The regressors used on the selection equation are those of equations (24) and (25), with the addition of the two instruments mentioned on the previous paragraph. On the second stage, I use the inverse Mills ratio from the probit estimation and the variables from equation (24) to run the outcome equation.⁶¹

The first column of Table IX shows the results of the Heckman estimation. As expected, the probability of positive intra-firm trade is positively related to the number of airline departures and negatively related to phone call fares. Moreover, the second-stage estimates for both tariffs strongly support my theoretical predictions: higher American tariffs increase the ratio of intra-firm imports to total imports, and higher foreign tariffs decrease this ratio. In fact,

⁶⁰I also tried alternative instruments like the number of days needed to start up a new business, the cost of setting up a new business, the rate of the population with HIV, and the number of phone land lines per 100 people. The results were qualitatively identical to those I present here. The data source for all these variables is the World Bank’s World Development Indicators.

⁶¹The estimation was done using the package “sampleSelection” for R. Standard errors were computed through a bootstrap procedure, resampling over (SIC 4-digit Industry, country) pairs, with 500 replications.

Table IX: Selection Corrections.

<i>First stage:</i>		
Air	0.0380**	
	(0.0172)	
Phone	-0.3118***	
	(0.0479)	
<i>Second stage:</i>		
	Heckit	Control Function
t^{US}	0.0117***	0.0064**
	(0.0043)	(0.0026)
t^F	-0.0024***	-0.0017***
	(0.0006)	(0.0005)
IMR	0.0548	
	(0.1508)	
p		-26.98***
		(7.70)
p^2		47.46***
		(12.83)
p^3		-26.98***
		(7.09)

Notes: '***', '**' and '*' refers to statistical significance at the 1%, 5% and 10% levels, respectively. Standard errors obtained through bootstrap with clustering. The total number of observations was 37,100. IMR stands for Inverse Mills ratio.

the tariff estimates are similar to the baseline OLS estimates. Notice that the coefficient of the inverse Mills ratio is not significant, suggesting that there is no selection.

Next, I follow a semi-parametric approach to correct for selection. I still estimate the first-stage probit, but I relax the normality assumption and use a control function method instead. Specifically, on the second stage I replace the inverse Mills ratio by a polynomial (cubic) approximation, using the probabilities estimated on the first stage; see Heckman and Robb (1985) and Heckman and Navarro-Lozano (2004).⁶²

The second column of Table IX presents the results. The estimates for both tariffs still have the expected sign and are statistically significant, although their magnitude is smaller than before. Additionally, the estimates of the probabilities coefficients (p , p^2 and p^3) are statistically significant, so it is not possible to reject the null hypothesis about the existence of selection of unobservables.

⁶²In a future version of the paper, I intend to relax even further the assumptions of the Heckit estimator. For example, along the lines of Helpman, Melitz, and Rubinstein (2008), that study the selection problem for the case of total trade flows under parametric, semi-parametric and non-parametric specifications.

4 Concluding Remarks

This paper aims to explain the effects of tariffs on the optimal organizational form chosen by firms. In particular, I attempt to develop a theoretical framework capable of matching some stylized facts such as increasing offshoring and outsourcing as well as a general trend towards trade liberalization.

I show that a increase in the tariff t_N imposed by the Northern government decreases the market shares of firms that choose to offshore their production as well as the shares of those that choose to outsource. In contrast, an increase in the tariff t_S imposed by the Southern government has the opposite effects.

Additionally, I find that U.S. data strongly supports my theoretical predictions. Under different specifications I find evidence in favor of the following two facts: (i) higher U.S. tariffs increase the ratio of American intra-firm imports to total imports, and (ii) higher foreign tariffs decrease the ratio.

There are several directions in which these findings may be extended. First, in light of these findings and those of Ornelas and Turner (2008a), it would be very interesting to study the welfare effects of tariffs. Indeed, on the one hand, I find that tariffs not only affect offshoring but also the insourcing/outsourcing decision. On the other hand, Ornelas and Turner find that the welfare effects of tariffs depend on whether trade is intra-firm or arms'-length. Thus, these results combined imply that the design of trade policies needs to take into account the firm-level effects of tariffs, in particular, the effects on the firms' internalization decisions. Proceeding along these lines, one could characterize governments' optimal tariff policies and explore the role (if any) for trade agreements. Second, I believe that a better understanding of the different kinds of offshoring is needed. Although this paper focuses on the offshoring of final goods, efforts must be made to incorporate the offshoring of inputs.⁶³ Third, it would also be very interesting to develop a (tractable) theoretical framework to deal with the outsourcing decision where only some firms are exporters, thereby matching a stylized fact found in the data. Finally, the theory has another testable implication to extend the empirical analysis. Indeed, while negotiated trade liberalization in the GATT/WTO has been conducted mainly by "Northern" countries, it now seems that "Southern" countries will play a bigger role. Thus, if in the near future, both Northern and Southern tariffs decrease, then, according to the theory, the share of intra-firm imports, m , should remain fairly constant (after controlling for market sizes). Alternatively, if just Southern tariffs decrease, then m should increase. This also seems an interesting prediction for future study.

⁶³See the Appendix for a brief analysis of input offshoring.

APPENDIX

A Theoretical Derivations

A.1 General Considerations

A.1.1 Consumers' problem

Preferences are given by

$$U = x_0 + \frac{1}{\mu} \sum_j X_j^\mu$$

where $X_j = (\int x_j(i)^\alpha di)^{1/\alpha}$ is the aggregate consumption index of industry j , $\alpha > \mu$ and $\alpha, \mu \in (0, 1)$. The Marshallian (individual) demands for the differentiated good $x_j(i)$ is given by

$$\begin{aligned} x(i) &= p(i)^{\frac{1}{\alpha-1}} P^{\frac{\mu-\alpha}{(\alpha-1)(1-\mu)}} \\ &\Leftrightarrow \\ p(i) &= x(i)^{\alpha-1} P^{\frac{\alpha-\mu}{1-\mu}} \end{aligned} \tag{A-1}$$

Alternatively, if there is a tariff τ on imported differentiated goods, the demand will be given by

$$\begin{aligned} x(i) &= (\tau p(i))^{\frac{1}{\alpha-1}} (P)^{\frac{\mu-\alpha}{(\alpha-1)(1-\mu)}} \\ &\Leftrightarrow \\ p(i) &= x(i)^{\alpha-1} P^{\frac{\alpha-\mu}{1-\mu}} \tau^{-1} \end{aligned} \tag{A-2}$$

A.1.2 Firms' problem

Firms producing in North

Sales in each market. In the presence of a Southern tariff τ_S , firms will face two different demands and therefore will have to make two decisions – the quantities to offer in the North and in the South.

$$p_N(i) = \gamma^{1-\alpha} x_N(i)^{\alpha-1} P_N^{\frac{\alpha-\mu}{1-\mu}}; \quad p_S(i) = (1-\gamma)^{1-\alpha} x_S(i)^{\alpha-1} P_S^{\frac{\alpha-\mu}{1-\mu}} \tau_S^{-1}$$

where $x_N(i) + x_S(i) = x(i)$. Assuming that there are γ consumers in the North and $(1-\gamma)$ consumers in the South, the revenue of a firm will be given by

$$R = \gamma^{1-\alpha} P_N^{\frac{\alpha-\mu}{1-\mu}} x_N(i)^\alpha + (1-\gamma)^{1-\alpha} P_S^{\frac{\alpha-\mu}{1-\mu}} \tau_S^{-1} x_S(i)^\alpha$$

In order to decide how to split a given production level $x(i)$ between the Northern and Southern markets the firm will solve

$$\max \gamma^{1-\alpha} P_N^{\frac{\alpha-\mu}{1-\mu}} x_N(i)^\alpha + (1-\gamma)^{1-\alpha} P_S^{\frac{\alpha-\mu}{1-\mu}} \tau_S^{-1} (x(i) - x_N(i))^\alpha$$

The resulting optimal quantities are:⁶⁴

$$x_N(i) = \frac{\gamma P_N^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}}}{(1-\gamma) P_S^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}} \tau_S^{\frac{1}{\alpha-1}} + \gamma P_N^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}}} x(i) \quad (\text{A-3})$$

$$x_S(i) = \frac{(1-\gamma) P_S^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}} \tau_S^{\frac{1}{\alpha-1}}}{(1-\gamma) P_S^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}} \tau_S^{\frac{1}{\alpha-1}} + \gamma P_N^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}}} x(i) \quad (\text{A-4})$$

Output and revenue. Next, I plug in these quantities into the revenue function. After some algebra, the resulting revenue function is:

$$R = \mathcal{C} x^\alpha$$

where \mathcal{C} is defined as in the main text.

The production of $x(i) = \theta_i \left(\frac{h}{\nu}\right)^\nu \left(\frac{m}{1-\nu}\right)^{1-\nu}$ requires cooperation among an entrepreneur and a manager. Since contracts are incomplete they will choose h and m non-cooperatively – each one will get a fraction (β_k^l or $(1 - \beta_k^l)$) of the ex-post surplus.

The entrepreneur chooses h , taking m as given, in order to maximize:

$$\begin{aligned} & \max_h \beta R - w^N h \\ & \max_h \beta_k^l \mathcal{C} \left(\theta \left(\frac{h}{\nu}\right)^\nu \left(\frac{m}{1-\nu}\right)^{1-\nu} \right)^\alpha - w^N h \end{aligned}$$

In the same way, the manager chooses m , taking h as given:

$$\begin{aligned} & \max_m (1 - \beta_k^l) R - w^l m \\ & \max_m (1 - \beta_k^l) \mathcal{C} \left(\theta \left(\frac{h}{\nu}\right)^\nu \left(\frac{m}{1-\nu}\right)^{1-\nu} \right)^\alpha - w^l m \end{aligned}$$

Thus, for a given R , the optimal decisions for the entrepreneur and the manager are the following:

$$\begin{aligned} h^* &= \frac{\beta \alpha \nu R}{w^N} \\ m^* &= \frac{(1 - \beta) \alpha (1 - \nu) R}{w^l} \end{aligned} \quad (\text{A-5})$$

Replacing h^* and m^* in the expression for R , I get the final expression for the revenue collected by the firm:

$$R = \mathcal{C} \theta^{\frac{\alpha}{1-\alpha}} \left[\alpha \left(\frac{\beta}{w^N}\right)^\nu \left(\frac{(1-\beta)}{w^l}\right)^{1-\nu} \right]^{\frac{\alpha}{1-\alpha}} \quad (\text{A-6})$$

Combining this last expression with $R = \mathcal{A} x^\alpha$ I can solve for $x(i)$:

$$x(i) = \mathcal{C} \theta^{\frac{1}{1-\alpha}} \left[\alpha \left(\frac{\beta}{w^N}\right)^\nu \left(\frac{(1-\beta)}{w^l}\right)^{1-\nu} \right]^{\frac{1}{1-\alpha}} \quad (\text{A-7})$$

Profits. From the revenue expression, I can compute the profits earned by a firm.⁶⁵

⁶⁴Given these quantities, note that although I allow firms to price discriminate, they choose to set the same “factory gate” prices for both markets.

⁶⁵As explained in the paper, under the current contract structure, the manager will have zero profits and hence the entrepreneur profits will be equal to the firm’s profits.

$$\pi_k^l = R - f_k^l w^N - w^N h^* - w^l m^*$$

Finally, I plug in the expressions for R , h^* , and m^* to get:

$$\pi_k^l = \mathcal{C}\Psi_k^l \theta_i^{\frac{\alpha}{1-\alpha}} - f_k^l w^N \quad (\text{A-8})$$

where Ψ_k^l is defined as in the main text.

Firms producing in South

Offshoring firms, those producing in the South, only have to pay the tariff τ_N for their exports to the Northern market. They face the following two demands:

$$\begin{aligned} p_S(i) &= \gamma^{1-\alpha} x_S(i)^{\alpha-1} P_S^{\frac{\alpha-\mu}{1-\mu}} \\ p_N(i) &= (1-\gamma)^{1-\alpha} x_N(i)^{\alpha-1} P_N^{\frac{\alpha-\mu}{1-\mu}} \tau_N^{-1} \end{aligned}$$

Therefore, their revenue is

$$R = \gamma^{1-\alpha} P_N^{\frac{\alpha-\mu}{1-\mu}} \tau_N^{-1} x_N(i)^\alpha + (1-\gamma)^{1-\alpha} P_S^{\frac{\alpha-\mu}{1-\mu}} x_S(i)^\alpha$$

Proceeding in an analogous way as before, given a total production level $x(i)$, the optimal quantities sold in each market are the following:

$$x_N(i) = \frac{\gamma P_N^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}} \tau_N^{\frac{1}{\alpha-1}}}{(1-\gamma) P_S^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}} + \gamma P_N^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}} \tau_N^{\frac{1}{\alpha-1}}} x(i) \quad (\text{A-9})$$

$$x_S(i) = \frac{(1-\gamma) P_S^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}}}{(1-\gamma) P_S^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}} + \gamma P_N^{\frac{\alpha-\mu}{(1-\mu)(1-\alpha)}} \tau_N^{\frac{1}{\alpha-1}}} x(i) \quad (\text{A-10})$$

Finally, after replacing these quantities and solving the game between the entrepreneur and the manager, the resulting expressions for output, revenue and profit functions are the following:

$$x(i) = \mathcal{B} \theta_i^{\frac{1}{1-\alpha}} \left[\alpha \left(\frac{\beta}{w^N} \right)^\nu \left(\frac{(1-\beta)}{w^l} \right)^{1-\nu} \right]^{\frac{1}{1-\alpha}} \quad (\text{A-11})$$

$$R(i) = \mathcal{B} \theta_i^{\frac{\alpha}{1-\alpha}} \left[\alpha \left(\frac{\beta}{w^N} \right)^\nu \left(\frac{(1-\beta)}{w^l} \right)^{1-\nu} \right]^{\frac{1}{1-\alpha}} \quad (\text{A-12})$$

$$\pi_k^l(i) = \mathcal{B} \Psi_k^l \theta_i^{\frac{\alpha}{1-\alpha}} - f_k^l w^N \quad (\text{A-13})$$

where \mathcal{B} is defined as in the main text.

A.1.3 Are P_N and P_S related?

So far I have found expressions for the total quantity $x(i)$, the quantities sold in each market ($x_N(i)$ and $x_S(i)$), the choices of the entrepreneur (h) and the manager (m), the revenue R and the profits π_k^l earned by a firm. All of them are functions of the aggregate prices in the North P_N and in the South P_S and of the tariffs τ_N and τ_S . In this section, I show that the two aggregate prices are related.

Let $p_N^1(i)$ and $p_S^1(i)$ be the demands faced by non-offshoring firms in Northern and Southern markets, respectively. As shown in the paper, the productivity range of these firms is $(\theta_1, \theta_3, \dots)$. Likewise, let $p_N^2(i)$ and $p_S^2(i)$ be the demands faced by offshoring firms in Northern and Southern markets, respectively. These firms have productivities in (θ_3, ∞) .

The aggregate prices are defined in the following way:

$$\begin{aligned}
P_S &= \left(\int p_S(i)^{\frac{\alpha}{\alpha-1}} di \right)^{\frac{\alpha-1}{\alpha}} \\
&= \left(\int_{\theta_1}^{\theta_3} (\tau_S \cdot p_S^1(\theta))^{\frac{\alpha}{\alpha-1}} g(\theta) d\theta + \int_{\theta_3}^{\infty} p_S^2(\theta)^{\frac{\alpha}{\alpha-1}} g(\theta) d\theta \right)^{\frac{\alpha-1}{\alpha}} \\
P_N &= \left(\int p_N(i)^{\frac{\alpha}{\alpha-1}} di \right)^{\frac{\alpha-1}{\alpha}} \\
&= \left(\int_{\theta_1}^{\theta_3} p_N^1(\theta)^{\frac{\alpha}{\alpha-1}} g(\theta) d\theta + \int_{\theta_3}^{\infty} (\tau_N \cdot p_N^2(\theta))^{\frac{\alpha}{\alpha-1}} g(\theta) d\theta \right)^{\frac{\alpha-1}{\alpha}}
\end{aligned}$$

Then, replacing the demands for their optimal values:

$$P_S^{\frac{\alpha}{\alpha-1}} = \tau_S^{\frac{\alpha}{\alpha-1}} \rho_O^N [V(\theta_2) - V(\theta_1)] + \tau_S^{\frac{\alpha}{\alpha-1}} \rho_V^N [V(\theta_3) - V(\theta_2)] + \rho_O^S [V(\theta_4) - V(\theta_3)] + \rho_V^S [V(\infty) - V(\theta_4)] \quad (\text{A-14})$$

$$P_N^{\frac{\alpha}{\alpha-1}} = \rho_O^N [V(\theta_2) - V(\theta_1)] + \rho_V^N [V(\theta_3) - V(\theta_2)] + \tau_N^{\frac{\alpha}{\alpha-1}} \rho_O^S [V(\theta_4) - V(\theta_3)] + \tau_N^{\frac{\alpha}{\alpha-1}} \rho_V^S [V(\infty) - V(\theta_4)] \quad (\text{A-15})$$

where ρ_k^l and $V(\theta)$ are defined as in the main text.

From equations (A-14) and (A-15) it is clear that the two aggregate prices are related. If there were no tariffs, they would be equal. In contrast, if there are tariffs, they will differ.

Suppose $\tau_S = 1$, then

$$P_S^{\frac{\alpha}{\alpha-1}} = P_N^{\frac{\alpha}{\alpha-1}} + \left(1 - \tau_N^{\frac{\alpha}{\alpha-1}}\right) [\rho_O^S [V(\theta_4) - V(\theta_3)] + \rho_V^S [V(\infty) - V(\theta_4)]]$$

Similarly, if $\tau_N = 1$:

$$P_N^{\frac{\alpha}{\alpha-1}} = P_S^{\frac{\alpha}{\alpha-1}} + \left(1 - \tau_S^{\frac{\alpha}{\alpha-1}}\right) [\rho_O^N [V(\theta_2) - V(\theta_1)] + \rho_V^N [V(\theta_3) - V(\theta_2)]]$$

A.2 Proofs of Subsection 2.2 (Northern Tariffs)

From the main text, I have six equations (four cutoff definitions, the free entry condition and the expression relating the aggregate prices) and six equations (the four cutoffs $\{\theta_1, \dots, \theta_4\}$, and the two aggregate prices P_N and P_S).

Differentiating the free entry condition with respect to P_N and τ_N , I can obtain $\frac{dP_N}{d\tau_N}$ in the following way:

$$\frac{dP_N}{d\tau_N} = - \frac{\frac{\partial RHS}{\partial \tau_N}}{\frac{\partial RHS}{\partial P_N}} \quad (\text{A-16})$$

Thus,

$$\frac{\partial RHS}{\partial \tau_N} = \frac{\partial \mathcal{A}}{\partial \tau_N} (\Psi_O^N [V(\theta_2) - V(\theta_1)] + \Psi_V^N [V(\theta_3) - V(\theta_2)]) + \frac{\partial \mathcal{B}}{\partial \tau_N} (\Psi_O^S [V(\theta_4) - V(\theta_3)] + \Psi_V^S [V(\infty) - V(\theta_4)]) \quad (\text{A-17})$$

$$\frac{\partial RHS}{\partial P_N} = \frac{\partial \mathcal{A}}{\partial P_N} (\Psi_O^N [V(\theta_2) - V(\theta_1)] + \Psi_V^N [V(\theta_3) - V(\theta_2)]) + \frac{\partial \mathcal{B}}{\partial P_N} (\Psi_O^S [V(\theta_4) - V(\theta_3)] + \Psi_V^S [V(\infty) - V(\theta_4)]) \quad (\text{A-18})$$

Let $\mathcal{I} \equiv \frac{\alpha - \mu}{(1 - \mu)(1 - \alpha)} > 0$. Also, recall from the main text that I evaluate the results around free trade (i.e., at $\tau_N = 1$), then

$$\begin{aligned} \left. \frac{\partial \mathcal{A}}{\partial P_N} \right|_{\tau_N=1} &= \mathcal{I} [(1 - \gamma) P_S^{\mathcal{I}-1} + \gamma P_N^{\mathcal{I}-1}] > 0, \\ \left. \frac{\partial \mathcal{B}}{\partial P_N} \right|_{\tau_N=1} &= \mathcal{I} [(1 - \gamma) P_S^{\mathcal{I}-1} + \gamma P_N^{\mathcal{I}-1}] > 0, \\ \left. \frac{\partial \mathcal{A}}{\partial \tau_N} \right|_{\tau_N=1} &= -\mathcal{I} (1 - \gamma) P_S^{\mathcal{I}-1} P_N^{\frac{1}{1-\alpha}} [\rho_O^S [V(\theta_4) - V(\theta_3)] + \rho_V^S [V(\infty) - V(\theta_4)]] < 0, \\ \left. \frac{\partial \mathcal{B}}{\partial \tau_N} \right|_{\tau_N=1} &= -\mathcal{I} (1 - \gamma) P_S^{\mathcal{I}-1} P_N^{\frac{1}{1-\alpha}} [\rho_O^S [V(\theta_4) - V(\theta_3)] + \rho_V^S [V(\infty) - V(\theta_4)]] - \gamma P_N^{\mathcal{I}} \frac{1}{1 - \alpha} < 0. \end{aligned}$$

After I plug these partial derivatives in (A-17) and (A-18), I am able to find the exact expression for (A-16).

$$\begin{aligned} \frac{dP_N}{d\tau_N} &= \frac{(1 - \gamma) P_S^{\mathcal{I}-1} P_N^{\frac{1}{1-\alpha}} [\rho_O^S [V(\theta_4) - V(\theta_3)] + \rho_V^S [V(\infty) - V(\theta_4)]]}{(1 - \gamma) P_S^{\mathcal{I}-1} + \gamma P_N^{\mathcal{I}-1}} \\ &+ \frac{\gamma P_N^{\mathcal{I}} \frac{1}{1-\alpha} \{\Psi_O^S [V(\theta_4) - V(\theta_3)] + \Psi_V^S [V(\infty) - V(\theta_4)]\}}{\mathcal{I} [(1 - \gamma) P_S^{\mathcal{I}-1} + \gamma P_N^{\mathcal{I}-1}] \{\Psi_O^N [V(\theta_2) - V(\theta_1)] + \Psi_V^N [V(\theta_3) - V(\theta_2)] + \Psi_O^S [V(\theta_4) - V(\theta_3)] + \Psi_V^S [V(\infty) - V(\theta_4)]\}} \end{aligned}$$

Therefore,

$$\left. \frac{dP_N}{d\tau_N} \right|_{\tau_N=1} > 0 \quad (\text{A-19})$$

Knowing $\frac{dP_N}{d\tau_N}$, I can find $\frac{dP_S}{d\tau_N}$

$$\begin{aligned} \left. \frac{dP_S}{d\tau_N} \right|_{\tau_N=1} &= \frac{\partial P_S}{\partial P_N} \frac{dP_N}{d\tau_N} + \frac{\partial P_S}{\partial \tau_N} d\tau_N \\ &= \frac{dP_N}{d\tau_N} - P_N^{\frac{1}{1-\alpha}} [\rho_O^S [V(\theta_4) - V(\theta_3)] + \rho_V^S [V(\infty) - V(\theta_4)]] \end{aligned}$$

Given the changes in the aggregate prices, the slopes of the profit lines will change in the following way:

$$\begin{aligned} \frac{d\mathcal{A}}{d\tau_N} &= \mathcal{I} \left[(1 - \gamma) P_S^{\mathcal{I}-1} \frac{dP_S}{d\tau_N} + \gamma P_N^{\mathcal{I}-1} \frac{dP_N}{d\tau_N} \right] \\ \frac{d\mathcal{A}}{d\tau_N} &= \frac{\gamma P_N^{\mathcal{I}} \frac{1}{1-\alpha} \{\Psi_O^S [V(\theta_4) - V(\theta_3)] + \Psi_V^S [V(\infty) - V(\theta_4)]\}}{\Psi_O^N [V(\theta_2) - V(\theta_1)] + \Psi_V^N [V(\theta_3) - V(\theta_2)] + \Psi_O^S [V(\theta_4) - V(\theta_3)] + \Psi_V^S [V(\infty) - V(\theta_4)]} > 0. \\ \frac{d\mathcal{B}}{d\tau_N} &= \mathcal{I} \left[(1 - \gamma) P_S^{\mathcal{I}-1} \frac{dP_S}{d\tau_N} + \gamma \tau^{\frac{1}{\alpha-1}} P_N^{\mathcal{I}-1} \frac{dP_N}{d\tau_N} \right] - \frac{1}{1-\alpha} \tau_N^{\frac{1}{\alpha-1}-1} \gamma P_N^{\mathcal{I}} \\ \frac{d\mathcal{B}}{d\tau_N} &= \frac{1}{1-\alpha} \gamma P_N^{\mathcal{I}} \left[\frac{\{\Psi_O^S [V(\theta_4) - V(\theta_3)] + \Psi_V^S [V(\infty) - V(\theta_4)]\}}{\Psi_O^N [V(\theta_2) - V(\theta_1)] + \Psi_V^N [V(\theta_3) - V(\theta_2)] + \Psi_O^S [V(\theta_4) - V(\theta_3)] + \Psi_V^S [V(\infty) - V(\theta_4)]} - 1 \right] < 0. \end{aligned}$$

A.2.1 Effects on Cutoffs

Given that $\frac{d\mathcal{A}}{d\tau_N} > 0$ and $\frac{d\mathcal{B}}{d\tau_N} < 0$, it is straightforward to check that

$$\left. \frac{d\theta_1}{d\tau_N} \right|_{\tau_N=1} = \left[\frac{w^N f_O^N}{\Psi_O^N} \frac{1}{\mathcal{A}} \right]^{\frac{1-\alpha}{\alpha}-1} \frac{w^N f_O^N}{\Psi_O^N} \frac{-1}{\mathcal{A}^2} \frac{d\mathcal{A}}{d\tau_N} < 0.$$

$$\begin{aligned}\frac{d\theta_2}{d\tau_N}\Big|_{\tau_N=1} &= \left[\frac{w^N(f_V^N - f_O^N)}{(\Psi_V^N - \Psi_O^N)} \frac{1}{\mathcal{A}} \right]^{\frac{1-\alpha}{\alpha}-1} \frac{w^N(f_V^N - f_O^N)}{(\Psi_V^N - \Psi_O^N)} \frac{-1}{\mathcal{A}^2} \frac{d\mathcal{A}}{d\tau_N} < 0. \\ \frac{d\theta_3}{d\tau_N}\Big|_{\tau_N=1} &= \left[\frac{w^N(f_O^S - f_V^N)}{(\Psi_O^S \mathcal{B} - \Psi_V^N \mathcal{A})} \right]^{\frac{1-\alpha}{\alpha}-1} \frac{-w^N(f_O^S - f_V^N)}{(\Psi_O^S \mathcal{B} - \Psi_V^N \mathcal{A})^2} \left(\Psi_O^S \frac{d\mathcal{B}}{d\tau_N} - \Psi_V^N \frac{d\mathcal{A}}{d\tau_N} \right) > 0. \\ \frac{d\theta_4}{d\tau_N}\Big|_{\tau_N=1} &= \left[\frac{w^N(f_V^S - f_O^S)}{(\Psi_V^S - \Psi_O^S)} \frac{1}{\mathcal{B}} \right]^{\frac{1-\alpha}{\alpha}-1} \frac{w^N(f_V^S - f_O^S)}{(\Psi_V^S - \Psi_O^S)} \frac{-1}{\mathcal{B}^2} \frac{d\mathcal{B}}{d\tau_N} > 0.\end{aligned}$$

A.2.2 Effects on Market Shares

First, I study how $\frac{\sigma_O^S}{\sigma_V^S}$, $\frac{\sigma_V^S}{\sigma_O^S}$ and $\frac{\sigma_O^N}{\sigma_V^N}$ are affected by the tariffs.

$$\bullet \frac{\sigma_O^S}{\sigma_V^S} = \frac{[V(\theta_4) - V(\theta_3)]\rho_O^S}{[V(\infty) - V(\theta_4)]\rho_V^S}$$

$$\frac{\sigma_O^S}{\sigma_V^S} = \frac{\rho_O^S}{\rho_V^S} \left(\left[\frac{f_V^S - f_O^S}{\Psi_V^S - \Psi_O^S} \frac{\Psi_O^S - \Psi_V^N \mathcal{A}}{f_O^S - f_V^N} \right]^{\frac{1-\alpha}{\alpha}z-1} - 1 \right)$$

Given that $\frac{d\mathcal{A}}{d\tau_N} > 0$, $\frac{d\mathcal{B}}{d\tau_N} < 0$ and $z > \frac{\alpha}{1-\alpha}$ it follows that $\left. \frac{d\left(\frac{\sigma_O^S}{\sigma_V^S}\right)}{d\tau_N} \right|_{\tau_N=1} < 0$.

$$\bullet \frac{\sigma_V^S}{\sigma_O^S} = \frac{[V(\infty) - V(\theta_4)]\mathcal{B}\rho_V^S}{[V(\theta_2) - V(\theta_1)]\mathcal{A}\rho_O^S}$$

$$\frac{\sigma_V^S}{\sigma_O^S} = \frac{\rho_V^S}{\rho_O^S} \frac{\left(\frac{\mathcal{B}}{\mathcal{A}}\right)^{\frac{1-\alpha}{\alpha}z} \left[\frac{f_V^S - f_O^S}{\Psi_V^S - \Psi_O^S} \right]^{1-\frac{1-\alpha}{\alpha}z}}{\left[\frac{f_O^N}{\Psi_O^N} \right]^{1-\frac{1-\alpha}{\alpha}z} - \left[\frac{f_V^N - f_O^N}{\Psi_V^N - \Psi_O^N} \right]^{1-\frac{1-\alpha}{\alpha}z}}$$

Given that $\frac{d\mathcal{A}}{d\tau_N} > 0$, $\frac{d\mathcal{B}}{d\tau_N} < 0$ it follows that $\left. \frac{d\left(\frac{\sigma_V^S}{\sigma_O^S}\right)}{d\tau_N} \right|_{\tau_N=1} < 0$.

$$\bullet \frac{\sigma_O^N}{\sigma_V^N} = \frac{[V(\theta_2) - V(\theta_1)]\rho_O^N}{[V(\theta_3) - V(\theta_2)]\rho_V^N}$$

$$= \frac{\rho_O^N}{\rho_V^N} \frac{\left[\frac{f_O^N}{\Psi_O^N} \right]^{1-\frac{1-\alpha}{\alpha}z} - \left[\frac{f_V^N - f_O^N}{\Psi_V^N - \Psi_O^N} \right]^{1-\frac{1-\alpha}{\alpha}z}}{\left[\frac{f_O^N - f_V^N}{\Psi_V^N - \Psi_O^N} \right]^{1-\frac{1-\alpha}{\alpha}z} - \left[\frac{f_O^S - f_V^S}{\Psi_O^S \mathcal{A} - \Psi_V^N} \right]^{1-\frac{1-\alpha}{\alpha}z}}$$

Given that $\frac{d\mathcal{A}}{d\tau_N} > 0$, $\frac{d\mathcal{B}}{d\tau_N} < 0$ and $1 < \frac{1-\alpha}{\alpha}z$ it follows that $\left. \frac{d\left(\frac{\sigma_O^N}{\sigma_V^N}\right)}{d\tau_N} \right|_{\tau_N=1} < 0$.

Next, I am interested on the effects of tariffs on the sales of offshoring firms.

$$\begin{aligned}\text{sales}_O^S &= \mathcal{B}\rho_O^S [V(\theta_4) - V(\theta_3)] \\ &= \mathcal{B}^{\frac{1-\alpha}{\alpha}} z \rho_O^S b^{z-\frac{1}{1-\alpha}} \left[\left[\frac{w^N(f_O^S - f_V^N)}{(\Psi_O^S - \Psi_V^N \mathcal{A})} \right]^{1-\frac{1-\alpha}{\alpha}z} - \left[\frac{w^N(f_V^S - f_O^S)}{(\Psi_V^S - \Psi_O^S)} \right]^{1-\frac{1-\alpha}{\alpha}z} \right] \\ \frac{d\text{sales}_O^S}{d\tau_N} &< 0. \text{ (given that } 1 - \frac{1-\alpha}{\alpha}z < 0\text{).}\end{aligned}$$

$$\begin{aligned}\text{sales}_V^S &= \mathcal{B}\rho_V^S [V(\infty) - V(\theta_4)] \\ \frac{d\text{sales}_V^S}{d\tau_N} &< 0.\end{aligned}$$

Finally, I check how sales of offshoring firms are splitted between both markets:

$$\frac{\text{revenue}^N}{\text{revenue}^S} = \frac{\gamma^{1-\alpha} \tau_N^{-1} x_N^\alpha}{(1-\gamma)^{1-\alpha} x_S^\alpha} = \frac{\gamma \tau_N^{\frac{1}{\alpha-1}}}{(1-\gamma)}$$

$$\frac{d(R^N/R^S)}{d\tau_N} < 0.$$

Therefore:

1. The imposition of t^N decreases $\frac{\sigma_O^S}{\sigma_V^S}$, $\frac{\sigma_V^S}{\sigma_O^S}$, and $\frac{\sigma_O^N}{\sigma_V^N}$.
2. The imposition of t^N , decreases the sales of both (S, O) and (S, V) (especially in Northern markets). Hence, it also decreases total imports.

A.2.3 Proof of Proposition 2

Recall that the cutoffs are defined in the following way:

$$\begin{aligned} \theta_1 &= \left[\frac{w^N f_O^N}{\Psi_O^N} \frac{1}{\mathcal{A}} \right]^{\frac{1-\alpha}{\alpha}} \\ \theta_2 &= \left[\frac{w^N (f_V^N - f_O^N)}{(\Psi_V^N - \Psi_O^N)} \frac{1}{\mathcal{A}} \right]^{\frac{1-\alpha}{\alpha}} \\ \theta_3 &= \left[\frac{w^N (f_O^S - f_V^S)}{(\Psi_O^S \mathcal{B} - \Psi_V^S \mathcal{A})} \right]^{\frac{1-\alpha}{\alpha}} \\ \theta_4 &= \left[\frac{w^N (f_V^S - f_O^S)}{(\Psi_V^S - \Psi_O^S)} \frac{1}{\mathcal{B}} \right]^{\frac{1-\alpha}{\alpha}} \end{aligned} \quad (\text{A-20})$$

where \mathcal{A} determines the slope of the profit functions of non-offshoring firms:

$$\mathcal{A} \equiv (1-\gamma) P_S^{\mathcal{I}} + \gamma P_N^{\mathcal{I}} \quad (\text{A-21})$$

and \mathcal{B} determines the slope of offshoring firms' profit functions:

$$\mathcal{B} \equiv (1-\gamma) P_S^{\mathcal{I}} + \gamma P_N^{\mathcal{I}} \tau_N^{\frac{1}{\alpha-1}} \quad (\text{A-22})$$

with $\mathcal{I} \equiv \frac{\alpha-\mu}{(1-\mu)(1-\alpha)} > 0$ and $\frac{1}{\alpha-1} < 0$.

Proposition 2. *In the benchmark case, for any differentiable distribution function $G(\cdot)$, a tariff τ_N imposed on the Northern imports of differentiated goods will have the following effects:*

1. Cutoffs θ_1 and θ_2 will decrease: $\frac{d\theta_1}{d\tau_N} < 0$, $\frac{d\theta_2}{d\tau_N} < 0$,
2. Cutoffs θ_3 and θ_4 will increase: $\frac{d\theta_3}{d\tau_N} > 0$, $\frac{d\theta_4}{d\tau_N} > 0$.

Proof. The result follows from simple differentiation of (A-20), given that $\frac{d\mathcal{A}}{d\tau_N} > 0$ and $\frac{d\mathcal{B}}{d\tau_N} < 0$ by Lemma A.4 (see below). ■

Thus, I now need to show that $\frac{d\mathcal{A}}{d\tau_N} > 0$ and $\frac{d\mathcal{B}}{d\tau_N} < 0$. I prove it using the free entry condition and some intermediate results that I describe next.

Recall the free entry condition:

$$\int_{\theta_1}^{\theta_2} \pi_O^N g(\theta) d\theta + \int_{\theta_2}^{\theta_3} \pi_V^N g(\theta) d\theta + \int_{\theta_3}^{\theta_4} \pi_O^S g(\theta) d\theta + \int_{\theta_4}^{\infty} \pi_V^S g(\theta) d\theta = w^N f_E \quad (\text{A-23})$$

Making use of the free entry condition I rule out that \mathcal{A} and \mathcal{B} (slopes of the profit functions) move in the same direction. Intuitively, the free entry condition states that the area below the four profit functions must integrate to $w^N f_E$. Since $w^N f_E$ is fixed, it follows that if some lines become steeper, others must become flatter to compensate. I summarize this in the following Lemma.

Lemma A.1. *If an increase of τ_N causes \mathcal{A} to increase ($\frac{d\mathcal{A}}{d\tau_N} > 0$), then \mathcal{B} will decrease ($\frac{d\mathcal{B}}{d\tau_N} < 0$). Conversely, if τ_N causes \mathcal{A} to decrease ($\frac{d\mathcal{A}}{d\tau_N} < 0$), then \mathcal{B} will increase ($\frac{d\mathcal{B}}{d\tau_N} > 0$).*

Proof. First, re-write the free entry condition:

$$\begin{aligned} w^N f_E &= \int_{\theta_1}^{\theta_2} (\mathcal{A}\Psi_O^N \theta^{1-\alpha} - w^N f_O^N) dG(\theta) + \int_{\theta_2}^{\theta_3} (\mathcal{A}\Psi_V^N \theta^{1-\alpha} - w^N f_V^N) dG(\theta) \\ &\quad + \int_{\theta_3}^{\theta_4} (\mathcal{B}\Psi_O^S \theta^{1-\alpha} - w^N f_O^S) dG(\theta) + \int_{\theta_4}^{\infty} (\mathcal{B}\Psi_V^S \theta^{1-\alpha} - w^N f_V^S) dG(\theta) \end{aligned}$$

Next, totally differentiate with respect to τ_N :

$$0 = \frac{d\mathcal{A}}{d\tau_N} (\Psi_O^N [V(\theta_2) - V(\theta_1)] + \Psi_V^N [V(\theta_3) - V(\theta_2)]) + \frac{d\mathcal{B}}{d\tau_N} (\Psi_O^S [V(\theta_4) - V(\theta_3)] + \Psi_V^S [V(\infty) - V(\theta_4)])$$

where, by the Envelope Theorem, the derivatives with respect to the cutoffs cancel each other out. Since both terms in brackets are positive, it follows that $\text{sign}\left(\frac{d\mathcal{A}}{d\tau_N}\right) = -\text{sign}\left(\frac{d\mathcal{B}}{d\tau_N}\right)$. \blacksquare

Lemma A.2. *Suppose that τ_N causes P_N to increase ($\frac{dP_N}{d\tau_N} > 0$). Then, \mathcal{A} must also increase ($\frac{d\mathcal{A}}{d\tau_N} > 0$).*

Proof. Given the assumption of $\frac{dP_N}{d\tau_N} > 0$, if P_S increases ($\frac{dP_S}{d\tau_N} > 0$), \mathcal{A} will increase by definition. Instead, suppose that they both decrease: $\frac{dP_S}{d\tau_N} < 0$ and $\frac{d\mathcal{A}}{d\tau_N} < 0$. Then, \mathcal{B} must also decrease since:

$$\frac{d\mathcal{B}}{d\tau_N} = \underbrace{\frac{d\mathcal{A}}{d\tau_N}}_{<0} + \underbrace{\gamma \mathcal{I} P_N^{\mathcal{I}-1}}_{>0} \underbrace{\frac{dP_N}{d\tau_N} \left(\tau_N^{\frac{1}{\alpha-1}} - 1 \right)}_{<0} + \underbrace{\gamma P_N^{\mathcal{I}} \left(\frac{1}{\alpha-1} \right)}_{<0} \tau_N^{\frac{1}{\alpha-1}} < 0$$

But, by Lemma A.1 it is not possible for both \mathcal{A} and \mathcal{B} to decrease. \blacksquare

Lemma A.3. *It is not possible for these four conditions to hold at the same time: (i) $\frac{dP_S}{d\tau_N} > 0$, (ii) $\frac{dP_N}{d\tau_N} < 0$, (iii) $\frac{d\mathcal{A}}{d\tau_N} < 0$, and (iv) $\frac{d\mathcal{B}}{d\tau_N} > 0$.*

Proof. First, note that if this is the case, then $\frac{d\theta_3}{d\tau_N} < 0$ and $\frac{d\theta_4}{d\tau_N} < 0$. Next, recall how the aggregate prices are related:

$$\begin{aligned} P_S^{\frac{\alpha}{\alpha-1}} &= P_N^{\frac{\alpha}{\alpha-1}} + \left(1 - \tau_N^{\frac{\alpha}{\alpha-1}}\right) \left\{ \rho_O^S [V(\theta_4) - V(\theta_3)] + \rho_V^S [V(\infty) - V(\theta_4)] \right\} \\ &\Rightarrow \\ P_S^{\frac{\alpha}{\alpha-1}} - P_N^{\frac{\alpha}{\alpha-1}} &= \left(1 - \tau_N^{\frac{\alpha}{\alpha-1}}\right) \left\{ \rho_O^S [V(\theta_4) - V(\theta_3)] + \rho_V^S [V(\infty) - V(\theta_4)] \right\} \end{aligned}$$

Finally, I differentiate the last expression:

$$\underbrace{\frac{\alpha}{\alpha-1}}_{<0} P_S^{\frac{\alpha}{\alpha-1}-1} \underbrace{\frac{dP_S}{d\tau_N}}_{>0} - \underbrace{\frac{\alpha}{\alpha-1}}_{<0} P_N^{\frac{\alpha}{\alpha-1}-1} \underbrace{\frac{dP_N}{d\tau_N}}_{<0} = -\underbrace{\frac{\alpha}{\alpha-1}}_{>0} \tau_N^{\frac{\alpha}{\alpha-1}-1} \left\{ \cdot \right\} + \underbrace{\left(1 - \tau_N^{\frac{\alpha}{\alpha-1}}\right)}_{>0} \underbrace{\left\{ -\rho_O^S \frac{dV(\theta_3)}{d\tau_N} - (\rho_V^S - \rho_O^S) \frac{dV(\theta_4)}{d\tau_N} \right\}}_{>0}$$

where $\text{sign}\left(\frac{d\theta}{d\tau_N}\right) = \text{sign}\left(\frac{dV(\theta)}{d\tau_N}\right) = \text{sign}\left(\theta^{1-\alpha} g(\theta) \frac{d\theta}{d\tau_N}\right)$. Since the LHS is negative and the RHS is positive, there is a contradiction: so I can rule out this case. ■

Corollary A.1. *If $\frac{dP_S}{d\tau_N} > 0$ and $\frac{dP_N}{d\tau_N} < 0$, then $\frac{dA}{d\tau_N} > 0$, and $\frac{dB}{d\tau_N} < 0$.*

Proof. If $\frac{dP_S}{d\tau_N} > 0$ and $\frac{dP_N}{d\tau_N} < 0$ then, by the free entry condition, either (i) $\frac{dA}{d\tau_N} > 0$ and $\frac{dB}{d\tau_N} < 0$, or (ii) $\frac{dA}{d\tau_N} < 0$ and $\frac{dB}{d\tau_N} > 0$. However, case (ii) is not possible by Lemma A.3. ■

Lemma A.4. *If τ_N increases, then A will increase and B will decrease: $\frac{dA}{d\tau_N} > 0$ and $\frac{dB}{d\tau_N} < 0$.*

Proof. There are four possible ways in which the aggregate prices may change in response to τ_N :

1. $P_S \uparrow, P_N \uparrow \Rightarrow A \uparrow$ (by definition of A) $\Rightarrow B \downarrow$ (by Lemma A.1).
2. $P_S \downarrow, P_N \uparrow \Rightarrow A \uparrow$ (by Lemma A.2) $\Rightarrow B \downarrow$ (by Lemma A.1).
3. $P_S \downarrow, P_N \downarrow \Rightarrow A \downarrow, B \downarrow$ (Impossible by Lemma A.1).
4. $P_S \uparrow, P_N \downarrow \Rightarrow A \uparrow, B \downarrow$ (by Lemma A.1 and Corollary A.1).

■

A.3 Proofs of Subsection 2.3 (Southern Tariffs)

The derivations are completely analogous to those above. Thus, differentiating the free entry condition with respect to P_S and τ_S allows me to obtain:

$$\frac{dP_S}{d\tau_S} = -\frac{\frac{\partial RHS}{\partial \tau_S}}{\frac{\partial RHS}{\partial P_S}} \quad (\text{A-24})$$

$$\frac{\partial RHS}{\partial \tau_S} = \frac{\partial C}{\partial \tau_S} (\Psi_O^N [V(\theta_2) - V(\theta_1)] + \Psi_V^N [V(\theta_3) - V(\theta_2)]) + \frac{\partial A}{\partial \tau_S} (\Psi_O^S [V(\theta_4) - V(\theta_3)] + \Psi_V^S [V(\infty) - V(\theta_4)]) \quad (\text{A-25})$$

$$\frac{\partial RHS}{\partial P_S} = \frac{\partial C}{\partial P_S} (\Psi_O^N [V(\theta_2) - V(\theta_1)] + \Psi_V^N [V(\theta_3) - V(\theta_2)]) + \frac{\partial A}{\partial P_S} (\Psi_O^S [V(\theta_4) - V(\theta_3)] + \Psi_V^S [V(\infty) - V(\theta_4)]) \quad (\text{A-26})$$

Once again, recall from the main text that I evaluate the results around free trade (i.e., at $\tau_S = 1$), then:

$$\begin{aligned} \left. \frac{\partial A}{\partial P_S} \right|_{\tau_S=1} &= \mathcal{I} [(1-\gamma)P_S^{\mathcal{I}-1} + \gamma P_N^{\mathcal{I}-1}] > 0, \\ \left. \frac{\partial C}{\partial P_S} \right|_{\tau_S=1} &= \mathcal{I} [(1-\gamma)P_S^{\mathcal{I}-1} + \gamma P_N^{\mathcal{I}-1}] > 0, \\ \left. \frac{\partial A}{\partial \tau_S} \right|_{\tau_S=1} &= -\mathcal{I} \gamma P_N^{\mathcal{I}-1} P_S^{\frac{-1}{\alpha-1}} [\rho_O^N [V(\theta_2) - V(\theta_1)] + \rho_V^N [V(\theta_3) - V(\theta_2)]] < 0, \\ \left. \frac{\partial C}{\partial \tau_S} \right|_{\tau_S=1} &= (1-\gamma)P_S^{\mathcal{I}} \frac{1}{\alpha-1} - \mathcal{I} \gamma P_N^{\mathcal{I}-1} P_S^{\frac{-1}{\alpha-1}} [\rho_O^N [V(\theta_2) - V(\theta_1)] + \rho_V^N [V(\theta_3) - V(\theta_2)]] < 0. \end{aligned}$$

After I plug these partial derivatives in (A-25) and (A-26), I am able to find the exact expression for (A-24):

$$\begin{aligned} \frac{dP_S}{d\tau_S} \Big|_{\tau_S=1} &= \frac{\gamma P_N^{\mathcal{I}-1} \left(P_S^{\frac{-1}{\alpha-1}} [\rho_O^N [V(\theta_2) - V(\theta_1)] + \rho_V^N [V(\theta_3) - V(\theta_2)]] \right)}{(1-\gamma) P_S^{\mathcal{I}-1} + \gamma P_N^{\mathcal{I}-1}} \\ &+ \frac{(1-\gamma) P_S^{\frac{1}{1-\alpha}} \{ \Psi_O^N [V(\theta_2) - V(\theta_1)] + \Psi_V^N [V(\theta_3) - V(\theta_2)] \}}{\mathcal{I} [(1-\gamma) P_S^{\mathcal{I}-1} + \gamma P_N^{\mathcal{I}-1}] \{ \Psi_O^N [V(\theta_2) - V(\theta_1)] + \Psi_V^N [V(\theta_3) - V(\theta_2)] + \Psi_O^S [V(\theta_4) - V(\theta_3)] + \Psi_V^S [V(\infty) - V(\theta_4)] \}} > 0. \end{aligned}$$

Therefore,

$$\frac{dP_S}{d\tau_S} \Big|_{\tau_S=1} > 0 \quad (\text{A-27})$$

Knowing $\frac{dP_S}{d\tau_S}$, I can find $\frac{dP_N}{d\tau_S}$

$$\begin{aligned} \frac{dP_N}{d\tau_S} \Big|_{\tau_S=1} &= \frac{\partial P_N}{\partial P_S} \frac{dP_S}{d\tau_S} + \frac{\partial P_N}{\partial \tau_S} d\tau_S \\ &= \frac{dP_S}{d\tau_S} - P_S^{\frac{1}{1-\alpha}} [\rho_O^N [V(\theta_2) - V(\theta_1)] + \rho_V^N [V(\theta_3) - V(\theta_2)]] \end{aligned}$$

Given the changes in the aggregate prices, the slopes of the profit lines will change in the following way:

$$\begin{aligned} \frac{dA}{d\tau_S} &= \mathcal{I} \left[(1-\gamma) P_S^{\mathcal{I}-1} \frac{dP_S}{d\tau_S} + \gamma P_N^{\mathcal{I}-1} \frac{dP_N}{d\tau_S} \right] \\ \frac{dA}{d\tau_S} &= \frac{(1-\gamma) P_S^{\frac{1}{1-\alpha}} \{ \Psi_O^N [V(\theta_2) - V(\theta_1)] + \Psi_V^N [V(\theta_3) - V(\theta_2)] \}}{\Psi_O^N [V(\theta_2) - V(\theta_1)] + \Psi_V^N [V(\theta_3) - V(\theta_2)] + \Psi_O^S [V(\theta_4) - V(\theta_3)] + \Psi_V^S [V(\infty) - V(\theta_4)]} > 0. \\ \frac{dC}{d\tau_S} &= \mathcal{I} \left[(1-\gamma) P_S^{\mathcal{I}-1} \frac{dP_S}{d\tau_S} + \gamma P_N^{\mathcal{I}-1} \frac{dP_N}{d\tau_S} \right] - \frac{1}{1-\alpha} \tau_S^{\frac{1}{\alpha-1}-1} (1-\gamma) P_S^{\mathcal{I}} \\ &= \frac{1}{1-\alpha} (1-\gamma) P_S^{\mathcal{I}} \left(\frac{\Psi_O^N [V(\theta_2) - V(\theta_1)] + \Psi_V^N [V(\theta_3) - V(\theta_2)]}{\Psi_O^N [V(\theta_2) - V(\theta_1)] + \Psi_V^N [V(\theta_3) - V(\theta_2)] + \Psi_O^S [V(\theta_4) - V(\theta_3)] + \Psi_V^S [V(\infty) - V(\theta_4)]} - 1 \right) < 0. \end{aligned}$$

A.3.1 Effects on Cutoffs

Given that $\frac{dA}{d\tau_S} > 0$ and $\frac{dC}{d\tau_S} < 0$, it is straightforward to check that

$$\begin{aligned} \frac{d\theta_1}{d\tau_S} \Big|_{\tau_S=1} &= \left[\frac{w^N f_O^N}{\Psi_O^N} \frac{1}{C} \right]^{\frac{1-\alpha}{\alpha}-1} \frac{w^N f_O^N}{\Psi_O^N} \frac{-1}{C^2} \frac{dC}{d\tau_S} > 0. \\ \frac{d\theta_2}{d\tau_S} \Big|_{\tau_S=1} &= \left[\frac{w^N (f_V^N - f_O^N)}{(\Psi_V^N - \Psi_O^N)} \frac{1}{C} \right]^{\frac{1-\alpha}{\alpha}-1} \frac{w^N (f_V^N - f_O^N)}{(\Psi_V^N - \Psi_O^N)} \frac{-1}{C^2} \frac{dC}{d\tau_S} > 0. \\ \frac{d\theta_3}{d\tau_S} \Big|_{\tau_S=1} &= \left[\frac{w^N (f_O^S - f_V^N)}{(\Psi_O^S \mathcal{A} - \Psi_V^N C)} \right]^{\frac{1-\alpha}{\alpha}-1} \frac{-w^N (f_O^S - f_V^N)}{(\Psi_O^S \mathcal{A} - \Psi_V^N C)^2} \left(\Psi_O^S \frac{dA}{d\tau_S} - \Psi_V^N \frac{dC}{d\tau_S} \right) < 0. \\ \frac{d\theta_4}{d\tau_S} \Big|_{\tau_S=1} &= \left[\frac{w^N (f_V^S - f_O^S)}{(\Psi_V^S - \Psi_O^S)} \frac{1}{\mathcal{A}} \right]^{\frac{1-\alpha}{\alpha}-1} \frac{w^N (f_V^S - f_O^S)}{(\Psi_V^S - \Psi_O^S)} \frac{-1}{\mathcal{A}^2} \frac{dA}{d\tau_S} < 0. \end{aligned}$$

A.3.2 Effects on Market Shares

First, I want to study how $\frac{\sigma_O^S}{\sigma_V^S}$, $\frac{\sigma_O^N}{\sigma_V^N}$ and $\frac{\sigma_O^N}{\sigma_V^N}$ are affected by the tariffs.

$$\begin{aligned} \bullet \quad \frac{\sigma_O^S}{\sigma_V^S} &= \frac{[V(\theta_4) - V(\theta_3)] \rho_O^S}{[V(\infty) - V(\theta_4)] \rho_V^S} \\ \frac{\sigma_O^S}{\sigma_V^S} &= \frac{\rho_O^S}{\rho_V^S} \left[\left[\frac{\frac{f_O^S - f_V^N}{\Psi_O^S - \Psi_V^N} \frac{C}{\mathcal{A}}}{\frac{f_V^S - f_O^S}{\Psi_V^S - \Psi_O^S}} \right]^{1 - \frac{1-\alpha}{\alpha} z} - 1 \right] \end{aligned}$$

Given that $\frac{dA}{d\tau_S} > 0$, $\frac{dC}{d\tau_S} < 0$ and $1 < \frac{z(1-\alpha)}{\alpha}$ it follows that $\left. \frac{d\left(\frac{\sigma_V^S}{\sigma_O^S}\right)}{d\tau_S} \right|_{\tau_S=1} > 0$.

- $\frac{\sigma_V^S}{\sigma_O^S} = \frac{[V(\infty)-V(\theta_4)]\mathcal{A}\rho_V^S}{[V(\theta_2)-V(\theta_1)]C\rho_O^S}$

$$\frac{\sigma_V^S}{\sigma_O^S} = \frac{\mathcal{A}^{\frac{1-\alpha}{\alpha}z} \rho_V^S}{C^{\frac{1-\alpha}{\alpha}z} \rho_O^S} \frac{\left[\frac{f_V^S - f_O^S}{\Psi_V^S - \Psi_O^S}\right]^{1-\frac{1-\alpha}{\alpha}z}}{\left[\frac{f_O^N}{\Psi_O^N}\right]^{1-\frac{1-\alpha}{\alpha}z} - \left[\frac{f_V^N - f_O^N}{\Psi_V^N - \Psi_O^N}\right]^{1-\frac{1-\alpha}{\alpha}z}}$$

Given that $\frac{dA}{d\tau_S} > 0$, $\frac{dC}{d\tau_S} < 0$ and $0 < \frac{z(1-\alpha)}{\alpha}$ it follows that $\left. \frac{d\left(\frac{\sigma_V^S}{\sigma_O^S}\right)}{d\tau_S} \right|_{\tau_S=1} > 0$.

- $\frac{\sigma_O^N}{\sigma_V^N} = \frac{[V(\theta_2)-V(\theta_1)]\rho_O^N}{[V(\theta_3)-V(\theta_2)]\rho_V^N}$

$$\frac{\sigma_O^N}{\sigma_V^N} = \frac{\rho_O^N}{\rho_V^N} \frac{\left[\frac{f_O^N}{\Psi_O^N}\right]^{1-\frac{1-\alpha}{\alpha}z} - \left[\frac{f_V^N - f_O^N}{\Psi_V^N - \Psi_O^N}\right]^{1-\frac{1-\alpha}{\alpha}z}}{\left[\frac{f_V^N - f_O^N}{\Psi_V^N - \Psi_O^N}\right]^{1-\frac{1-\alpha}{\alpha}z} - \left[\frac{f_O^S - f_V^S}{\Psi_O^S - \Psi_V^S}\right]^{1-\frac{1-\alpha}{\alpha}z}}$$

Given that $\frac{dA}{d\tau_S} > 0$, $\frac{dC}{d\tau_S} < 0$ and $1 < \frac{z(1-\alpha)}{\alpha}$ it follows that $\left. \frac{d\left(\frac{\sigma_O^N}{\sigma_V^N}\right)}{d\tau_S} \right|_{\tau_S=1} > 0$.

Next, I am interested on the effects of tariffs on the sales of offshoring firms.

$$\begin{aligned} sales_O^S &= \mathcal{A}\rho_O^S [V(\theta_4) - V(\theta_3)] \\ &= \mathcal{A}^{\frac{1-\alpha}{\alpha}z} \rho_O^S b^{z-\frac{\alpha}{1-\alpha}} \left[\left[\frac{w^N(f_O^S - f_V^N)}{\Psi_O^S - \Psi_V^N} \right]^{1-\frac{1-\alpha}{\alpha}z} - \left[\frac{w^N(f_V^S - f_O^S)}{\Psi_V^S - \Psi_O^S} \right]^{1-\frac{1-\alpha}{\alpha}z} \right] \\ \frac{dsales_O^S}{d\tau_S} &> 0. \text{ (given that } 1 - \frac{1-\alpha}{\alpha}z < 0\text{).} \end{aligned}$$

$$\begin{aligned} sales_V^S &= \mathcal{A}\rho_V^S [V(\infty) - V(\theta_4)] \\ &= \mathcal{A}^{\frac{1-\alpha}{\alpha}z} \rho_V^S b^{z-\frac{\alpha}{1-\alpha}} \left[\frac{w^N(f_V^S - f_O^S)}{\Psi_V^S - \Psi_O^S} \right]^{1-\frac{1-\alpha}{\alpha}z} \\ \frac{dsales_V^S}{d\tau_S} &> 0. \end{aligned}$$

Finally, I check how sales of offshoring firms are splitted between both markets:

$$\begin{aligned} \frac{revenue^N}{revenue^S} &= \frac{\gamma^{1-\alpha} x_N^\alpha}{(1-\gamma)^{1-\alpha} \tau_S^{-1} x_S^\alpha} = \frac{\gamma}{(1-\gamma)\tau_S^{\frac{1}{\alpha-1}}} \\ \frac{d(R^N/R^S)}{d\tau_S} &> 0. \end{aligned}$$

Therefore:

1. The imposition of t^S increases $\frac{\sigma_O^S}{\sigma_V^S}$, $\frac{\sigma_V^S}{\sigma_O^S}$, and $\frac{\sigma_O^N}{\sigma_V^N}$.
2. The imposition of t^S , increases the sales of both (S, O) and (S, V) (especially in Northern markets). Hence, it also increases total imports.

A.3.3 Proof of Proposition 5

Recall that the cutoffs are defined in the following way:

$$\begin{aligned}
\theta_1 &= \left[\frac{w^N f_O^N}{\Psi_O^N} \frac{1}{\mathcal{C}} \right]^{\frac{1-\alpha}{\alpha}} \\
\theta_2 &= \left[\frac{w^N (f_V^N - f_O^N)}{(\Psi_V^N - \Psi_O^N)} \frac{1}{\mathcal{C}} \right]^{\frac{1-\alpha}{\alpha}} \\
\theta_3 &= \left[\frac{w^N (f_O^S - f_V^N)}{(\Psi_O^S \mathcal{A} - \Psi_V^N \mathcal{C})} \right]^{\frac{1-\alpha}{\alpha}} \\
\theta_4 &= \left[\frac{w^N (f_V^S - f_O^S)}{(\Psi_V^S - \Psi_O^S)} \frac{1}{\mathcal{A}} \right]^{\frac{1-\alpha}{\alpha}}
\end{aligned} \tag{A-28}$$

where \mathcal{A} determines the slope of the profit functions of offshoring firms:

$$\mathcal{A} \equiv (1 - \gamma) P_S^{\mathcal{I}} + \gamma P_N^{\mathcal{I}} \tag{A-29}$$

and \mathcal{C} determines the slope of non-offshoring firms' profit functions:

$$\mathcal{C} \equiv (1 - \gamma) P_S^{\mathcal{I}} \tau_S^{\frac{1}{\alpha-1}} + \gamma P_N^{\mathcal{I}} \tag{A-30}$$

with $\mathcal{I} \equiv \frac{\alpha-\mu}{(1-\mu)(1-\alpha)} > 0$ and $\frac{1}{\alpha-1} < 0$.

Proposition 5. *In the benchmark case, for any differentiable distribution function $G(\cdot)$, a tariff τ_S imposed on the Southern imports of differentiated goods will have the following effects:*

1. Cutoffs θ_1 and θ_2 will increase: $\frac{d\theta_1}{d\tau_S} > 0$, $\frac{d\theta_2}{d\tau_S} > 0$,
2. Cutoffs θ_3 and θ_4 will decrease: $\frac{d\theta_3}{d\tau_S} < 0$, $\frac{d\theta_4}{d\tau_S} < 0$.

Proof. The result follows from simple differentiation of (A-28), given that $\frac{d\mathcal{A}}{d\tau_S} > 0$ and $\frac{d\mathcal{C}}{d\tau_S} < 0$ by Lemma A.8 (see below). ■

Lemma A.5. *If an increase of τ_S causes \mathcal{A} to increase ($\frac{d\mathcal{A}}{d\tau_S} > 0$), then \mathcal{C} will decrease ($\frac{d\mathcal{C}}{d\tau_S} < 0$). Conversely, if τ_S causes \mathcal{A} to decrease ($\frac{d\mathcal{A}}{d\tau_S} < 0$), then \mathcal{C} will increase ($\frac{d\mathcal{C}}{d\tau_S} > 0$).*

Proof. First, re-write the free entry condition:

$$\begin{aligned}
w^N f_E &= \int_{\theta_1}^{\theta_2} (\mathcal{C} \Psi_O^N \theta^{\frac{\alpha}{1-\alpha}} - w^N f_O^N) dG(\theta) + \int_{\theta_2}^{\theta_3} (\mathcal{C} \Psi_V^N \theta^{\frac{\alpha}{1-\alpha}} - w^N f_V^N) dG(\theta) \\
&\quad + \int_{\theta_3}^{\theta_4} (\mathcal{A} \Psi_O^S \theta^{\frac{\alpha}{1-\alpha}} - w^N f_O^S) dG(\theta) + \int_{\theta_4}^{\infty} (\mathcal{A} \Psi_V^S \theta^{\frac{\alpha}{1-\alpha}} - w^N f_V^S) dG(\theta)
\end{aligned}$$

Next, totally differentiate with respect to τ_S :

$$0 = \frac{d\mathcal{C}}{d\tau_S} (\Psi_O^N [V(\theta_2) - V(\theta_1)] + \Psi_V^N [V(\theta_3) - V(\theta_2)]) + \frac{d\mathcal{A}}{d\tau_S} (\Psi_O^S [V(\theta_4) - V(\theta_3)] + \Psi_V^S [V(\infty) - V(\theta_4)])$$

where, by the Envelope Theorem, the derivatives with respect to the cutoffs cancel each other out. Since both terms in brackets are positive, it follows that $\text{sign}\left(\frac{d\mathcal{A}}{d\tau_S}\right) = -\text{sign}\left(\frac{d\mathcal{C}}{d\tau_S}\right)$. ■

Lemma A.6. Suppose that τ_S causes P_S to increase ($\frac{dP_S}{d\tau_S} > 0$). Then, \mathcal{A} must also increase ($\frac{d\mathcal{A}}{d\tau_S} > 0$).

Proof. Given the assumption of $\frac{dP_S}{d\tau_S} > 0$, if P_N increases ($\frac{dP_N}{d\tau_S} > 0$), \mathcal{A} will increase by definition. Instead, suppose that they both decrease: $\frac{dP_N}{d\tau_S} < 0$ and $\frac{d\mathcal{A}}{d\tau_S} < 0$. Then, \mathcal{C} must also decrease since:

$$\frac{d\mathcal{C}}{d\tau_S} = \underbrace{\frac{d\mathcal{A}}{d\tau_S}}_{<0} + (1-\gamma)\mathcal{I}P_S^{\mathcal{I}-1}\underbrace{\frac{dP_S}{d\tau_S}}_{>0}\underbrace{\left(\tau_S^{\frac{1}{\alpha-1}}-1\right)}_{<0} + (1-\gamma)\underbrace{P_S^{\mathcal{I}}\left(\frac{1}{\alpha-1}\right)}_{<0}\tau_S^{\frac{1}{\alpha-1}} < 0$$

But, by Lemma A.5 it is not possible for both \mathcal{A} and \mathcal{C} to decrease. ■

Lemma A.7. It is not possible for these four conditions to hold at the same time: (i) $\frac{dP_N}{d\tau_S} > 0$, (ii) $\frac{dP_S}{d\tau_S} < 0$, (iii) $\frac{d\mathcal{A}}{d\tau_S} < 0$, and (iv) $\frac{d\mathcal{C}}{d\tau_S} > 0$.

Proof. First, note that if this is the case, then $\frac{d\theta_1}{d\tau_S} < 0$, and $\frac{d\theta_2}{d\tau_S} < 0$ and $\frac{d\theta_3}{d\tau_S} > 0$. Next, recall how the aggregate prices are related:

$$\begin{aligned} P_N^{\frac{\alpha}{\alpha-1}} &= P_S^{\frac{\alpha}{\alpha-1}} + \left(1 - \tau_S^{\frac{\alpha}{\alpha-1}}\right) \left\{ \rho_O^N [V(\theta_2) - V(\theta_1)] + \rho_V^N [V(\theta_3) - V(\theta_2)] \right\} \\ &\Rightarrow \\ P_N^{\frac{\alpha}{\alpha-1}} - P_S^{\frac{\alpha}{\alpha-1}} &= \left(1 - \tau_S^{\frac{\alpha}{\alpha-1}}\right) \left\{ \rho_O^N [V(\theta_2) - V(\theta_1)] + \rho_V^N [V(\theta_3) - V(\theta_2)] \right\} \end{aligned}$$

Finally, I differentiate the last expression:

$$\underbrace{\frac{\alpha}{\alpha-1} P_N^{\frac{1}{\alpha-1}}}_{<0} \underbrace{\frac{dP_N}{d\tau_S}}_{>0} - \underbrace{\frac{\alpha}{\alpha-1} P_S^{\frac{1}{\alpha-1}}}_{<0} \underbrace{\frac{dP_S}{d\tau_S}}_{<0} = \underbrace{\frac{-\alpha}{\alpha-1} \tau_S^{\frac{1}{\alpha-1}}}_{>0} \{ \cdot \} + \underbrace{\left(1 - \tau_S^{\frac{\alpha}{\alpha-1}}\right)}_{>0} \underbrace{\left\{ \rho_V^N \frac{dV(\theta_3)}{d\tau_S} - \rho_O^N \frac{dV(\theta_1)}{d\tau_S} - (\rho_V^N - \rho_O^N) \frac{dV(\theta_2)}{d\tau_S} \right\}}_{>0}$$

where $\text{sign}\left(\frac{d\theta}{d\tau_S}\right) = \text{sign}\left(\frac{dV(\theta)}{d\tau_S}\right) = \text{sign}\left(\theta^{\frac{\alpha}{1-\alpha}} g(\theta) \frac{d\theta}{d\tau_S}\right)$. Since the LHS is negative and the RHS is positive, there is a contradiction: so I can rule out this case. ■

Corollary A.2. If $\frac{dP_N}{d\tau_S} > 0$ and $\frac{dP_S}{d\tau_S} < 0$, then $\frac{d\mathcal{A}}{d\tau_S} > 0$, and $\frac{d\mathcal{C}}{d\tau_S} < 0$.

Proof. If $\frac{dP_N}{d\tau_S} > 0$ and $\frac{dP_S}{d\tau_S} < 0$ then, by the free entry condition, either (i) $\frac{d\mathcal{A}}{d\tau_S} > 0$ and $\frac{d\mathcal{C}}{d\tau_S} < 0$, or (ii) $\frac{d\mathcal{A}}{d\tau_S} < 0$ and $\frac{d\mathcal{C}}{d\tau_S} > 0$. However, case (ii) is not possible by Lemma A.7. ■

Lemma A.8. If τ_S increases, then \mathcal{A} will increase and \mathcal{C} will decrease: $\frac{d\mathcal{A}}{d\tau_S} > 0$ and $\frac{d\mathcal{C}}{d\tau_S} < 0$.

Proof. There are four possible ways in which the aggregate prices may change in response to τ_S :

1. $P_S \uparrow, P_N \uparrow \Rightarrow \mathcal{A} \uparrow$ (by definition of \mathcal{A}) $\Rightarrow \mathcal{C} \downarrow$ (by Lemma A.5).
 2. $P_S \uparrow, P_N \downarrow \Rightarrow \mathcal{A} \uparrow$ (by Lemma A.6) $\Rightarrow \mathcal{C} \downarrow$ (by Lemma A.5).
 3. $P_S \downarrow, P_N \downarrow \Rightarrow \mathcal{A} \downarrow, \mathcal{C} \downarrow$ (Impossible by Lemma A.5).
 4. $P_S \downarrow, P_N \uparrow \Rightarrow \mathcal{A} \uparrow, \mathcal{C} \downarrow$ (by Lemma A.5 and Corollary A.2).
-

B Industry Description by 1-digit HS

HS	Description
0	Live Animals; Meat; Fish; Dairy Produce.
1	Cereals; Products of the Milling Industry; Fats and Oils.
2	Beverages; Tobacco; Mineral Fuels.
3	Pharmaceutical Products; Fertilizers; Paints; Cosmetics; Explosives; Plastics.
4	Rubber and Articles Thereof; Wood and Articles Thereof; Paper.
5	Silk; Wool; Cotton; Ropes and Cables; Carpets.
6	Apparel; Footwear; Ceramic Products.
7	Glass and Glassware; Precious Metals; Iron and Steel; Aluminum and Articles Thereof.
8	Tools; Machinery and Mechanical Appliances; Electrical Machinery; Sound Recorders and Reproducers, Television; Railway or Tramway Locomotives; Vehicles; Aircrafts, Spacecrafts; Ships.
9	Optical, Photographic, Precision, Medical Instruments; Clocks and Watches; Musical Instruments; Arms and ammunition; Furniture; Prefabricated Buildings; Toys; Works of Art.

C Simple OLS Estimates by Industry and Country

In this appendix I present the estimates of equation (22) for each 1-digit HS aggregate industry (pooling over countries) and for each country in our sample (pooling over industries).⁶⁶ There are several features to point out. First, overall the estimates have the right sign, although they are not always significant. Industries 8 and 9, which are mostly industrial differentiated goods, have significant estimates. Third, as highlighted on the main text, Chinese observations seem to behave against the theoretical predictions. Fourth, to handle the lack of significance, I ran a weaker test with the null hypothesis: “the estimate of β_1 (β_2) has the right sign.” The results are shown on the columns labeled $\beta_1 \geq 0$ and $\beta_2 \leq 0$. As can be seen on the tables, in almost all cases, I cannot reject the null.

⁶⁶In the case of Canada, there is very little tariff variation, and therefore Canada is dropped out when performing the by-country estimations.

Table X: Baseline Results by Industry.

HS	Obs.	β_1	$\beta_1 \geq 0$	β_2	$\beta_2 \leq 0$
Pool	19,726	0.013*** (0.002)	Y	-0.0039*** (0.001)	Y
0	190	0.0184** (0.01)	Y	-0.0031* (0.002)	Y
1	625	0.0613** (0.026)	Y	-0.0027*** (0.001)	Y
2	3,296	0.0359*** (0.006)	Y	-0.0025*** (0.001)	Y
3	4,240	0.0148*** (0.004)	Y	-0.0047*** (0.001)	Y
4	975	-0.0081 (0.005)	N*	-0.0024 (0.002)	Y
5	103	0.074*** (0.02)	Y	-0.0012 (0.009)	Y
6	453	0.0101 (0.020)	Y	-0.0030 (0.003)	Y
7	1,438	-0.0049 (0.013)	Y	-0.0028 (0.002)	Y
8	6,091	0.0126*** (0.004)	Y	-0.0017* (0.001)	Y
9	2,315	0.0327*** (0.008)	Y	-0.0067*** (0.001)	Y

Notes: '***', '**' and '*' refers to statistical significance at the 1%, 5% and 10% levels, respectively. Country and year fixed effects included. Chinese observations were excluded.

Table XI: Baseline Results by Country.

Country	Obs.	β_1		β_2	
		Estimate	≥ 0	Estimate	≤ 0
Brazil	2,825	0.0119*** (0.005)	Y	-0.0068*** (0.001)	Y
China	4,597	-0.0081*** (0.001)	N***	-0.003*** (0.001)	Y
Ireland	2,098	0.005 (0.004)	Y	0.0157*** (0.004)	N***
Malaysia	1,177	0.0002 (0.005)	Y	-0.0099*** (0.001)	Y
Mexico	5,444	0.0151*** (0.003)	Y	-0.0019*** (0.001)	Y

Notes: '***', '**' and '*' refers to statistical significance at the 1%, 5% and 10% levels, respectively. Regressions include year fixed effects.

D Offshoring of Intermediate Inputs

In Díez (2006) I studied the effects of tariffs on the ratio of intra-firm to total imports when trade flows occur just like in Antràs and Helpman (2004). In that setting, all final goods are produced in the Northern country and when a firm offshores is to obtain an intermediate good overseas.⁶⁷

One of the theoretical predictions from Díez (2006) is that, in the case of intermediate goods, the ratio of intra-firm imports to total imports m_{ict} depends positively on American tariffs.

Accordingly, I ran the following regression for those industries whose definition contains the word ‘component’ or ‘part.’

$$m_{ict} = \alpha_0 + \alpha_1 \cdot t_{ict}^{US} + \alpha_3 \left(\frac{k}{l}\right)_i + \alpha_4 \left(\frac{s}{l}\right)_i + \alpha_5 \cdot freight_i + \alpha_6 \left(\frac{K}{L}\right)_c + \alpha_7 \left(\frac{H}{L}\right)_c + X_t + \varepsilon_{ict} \quad (\text{D-31})$$

I expect to find $\alpha_1 > 0$.⁶⁸

Table XII shows that this theoretical result finds very weak support on the data. Indeed, the only case when the estimate has the right sign and is statistically significant is when Chinese and $m_i = 0$ observations are dropped.

Table XII: OLS Regressions

	-1-	-2-	-3-	-4-
α_1	-0.007 (0.005)	-0.001 (0.009)	0.004 (0.006)	0.0226* (0.012)
Obs.	5,510	4,531	4,251	3,407
$m_i = 0$	Yes	Yes	No	No
China	Yes	No	Yes	No

Notes: ‘***’, ‘**’ and ‘*’ refers to statistical significance at the 1%, 5% and 10% levels, respectively. Standard errors clustered by (4-digit SIC industry, Country) pairs.

To sum up, the data does not seem to support the theoretical predictions regarding the effects of tariffs on the ratio of intra-firm imports to total imports when offshoring is defined as procuring intermediate inputs overseas. Of course, for reasons discussed in the Introduction (i.e., the need to observe firm-level data, and to match input imports to final-good exports) the results of this appendix are not conclusive. Further and deeper research on this phenomena is needed but this goes beyond the scope of the present paper.

⁶⁷Since all final goods are produced in North, a Southern tariff on final goods will have no effect on the ratio of intra-firm imports because it will affect all types of firms in exactly the same way.

⁶⁸In this setting, the Southern countries do not import any intermediate goods. Therefore, the estimating equation does not include t_{ict}^F as a covariate.

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