All-Around Trade Liberalization and Firm-Level Employment: Theory and Evidence from China*

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Abstract

Chinese firms faced an all-around trade liberalization process during the early 2000s: lower barriers from other countries on Chinese goods, and lower Chinese barriers on other countries' goods and inputs. This paper disentangles the effects of each type of trade liberalization on Chinese firm-level employment. We find that reductions in Chinese and foreign final-good tariffs are associated with job destruction in low and mid-low productivity firms and job creation in high-productivity firms. Chinese final-good trade liberalization produces the largest firm-level employment responses, whereas the employment effects of Chinese input-trade liberalization are limited to job destruction in the least productive firms.

JEL Classification: F12, F14, F16

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1 Introduction

China's profound trade liberalization has been associated with large employment changes throughout the world. In particular, the rise of China as the world's largest trader has been related to substantial net job destruction in developed countries (see, for example, Autor, Dorn and Hanson, 2013, Acemoglu *et al.*, 2016, Pierce and Schott, 2016, Feenstra and Sasahara, 2017, and Feenstra, Ma and Xu, 2017 for the impact of Chinese competition on U.S. labor markets, and Mion and Zhu, 2013 for its impact on employment in Belgium). However, the study of Chinese labor market responses to trade liberalization is a relatively unexplored topic.[1] Using unique firm-level tariff data for trading Chinese manufacturing firms, the goal of this paper is to contribute to fill this gap by estimating the effects of trade liberalization on Chinese firm-level employment, taking into account differences across firms' types and productivities.

Since China's accession to the WTO in December 2001, Chinese firms have been subject to a process of trade liberalization encompassing several dimensions. On the one hand, trade barriers imposed by other countries on Chinese goods declined, which made it easier for Chinese firms to export. On the other hand, China also lowered trade barriers imposed on other countries' final goods — which increased competition for Chinese firms — and on other countries' inputs, which helped Chinese input-importing firms become more productive. Hence, the trade-induced reallocation of labor inside and between Chinese firms is the result of three liberalization forces that are related, but may act through different mechanisms. Crucially, this paper is able to disentangle the firm-level employment effects of these three liberalization forces.

To empirically disentangle the impact of each type of liberalization on Chinese firm-level employment, we use firm-level and customs data for Chinese trading firms from 2000 to 2006. A key feature of our empirical approach is that the richness of our data allows us to calculate *firm-level* tariff measures a la Lileeva and Trefler (2010) and Yu (2015). Hence, for each Chinese firm in each year we compute *(i)* its foreign tariff, which captures the degree of foreign protection the firm's goods face in all its export destinations, *(ii)* its final-good Chinese tariff, which captures the effective rate of protection received by the firm based on the tariff China imposes on products that are similar to the goods the firm produces, and *(iii)* its Chinese input tariff, which captures the firm's cost of importing inputs based on Chinese tariffs on the inputs the firm imports.

Abstracting from firm type, the first part of our empirical analysis focuses on the importance of firm heterogeneity in productivity for the responses of firm-level employment to changes in each type of tariff. We find that foreign and Chinese trade liberalization in final goods are associated with job

[1] An exception is Ma, Qiao and Xu (2015), who provide a picture of the evolution of Chinese job flows from 1998 to 2007.

destruction in the least productive firms, and job creation in the most productive firms. In general, final-good Chinese liberalization causes the stronger effects for both low- and high-productivity firms. These results highlight significant Melitz-type effects by which trade liberalization causes reallocation of market shares from low-productivity firms to high-productivity firms, with direct consequences on firm-level employment.

We then take a step further and separate all manufacturing trading firms into four types of firms: processing firms, non-importing exporters, importing exporters, and importing non-exporters. We find that firm heterogeneity in productivity is also relevant for comparisons across firms of the same type, with both types of liberalization in final goods having similar effects across all types of firms: job destruction in the least productive firms and job creation in the most productive firms. In contrast, Chinese input-trade liberalization effects on firm-level employment are limited to job destruction in the least productive firms.

The current paper contributes to the literature in at least three important ways. First, we are able to examine the effects of all-around trade liberalization on China's employment. The studies mentioned above look at the effects of import competition from China on the U.S. and other labor markets, and they all find that growing imports from China reduce employment. But it is also important to understand the other side of the coin: the extent to which China's global booming exports, after its WTO accession, affect China's manufacturing employment. Second, by distinguishing firms according to their type, this paper enriches our understanding of the consequences of China's export structure — heavily based on processing exports (see, Feenstra and Hanson, 2005, Yu, 2015, and Brandt and Morrow, 2017) — on firm-level employment. And third, to motivate the empirical exercise, this paper develops a theoretical model that highlights the different channels through which all-around trade liberalization affects China's firm-level employment.

Our theoretical model includes trade in both final goods and tasks, combining features of the heterogenous-firm model with monopolistic competition of Melitz (2003) and the trade-in-tasks (or inputs) models of Feenstra and Hanson (1996, 1997) and Grossman and Rossi-Hansberg (2008). Notably, the model carefully considers the different types of Chinese firms, which can be classified as either pure processing firms (which import inputs duty free but cannot sell domestically) or ordinary firms (which can import inputs and can access both the domestic and export markets). The model then characterizes how each type of trade liberalization — a reduction in the foreign tariff on final goods, a reduction in the Chinese tariff on final goods, or a reduction in the Chinese tariff on inputs — affects employment in each type of firm.

Within the model, firm-level employment responses are the result of the interaction of three main mechanisms: changes in the competitive environment in China and abroad (competition effects), changes in the fraction of tasks performed inside the firms (task relocation effects), and changes in marginal costs — efficiency gains or losses — due to task relocation effects (productivity effects). In general, trade liberalization is associated with tougher competition in both markets, which is a source of job destruction. On the other hand, the task relocation and productivity effects always drive opposite responses in firm-level employment. For example, after input trade liberalization, ordinary importing firms reduce the number of tasks performed inside the firm (a source of job destruction) but they become more productive, which allows them to charge lower prices and capture larger market shares (a source of job creation).[2] This structure provides a guide for the interpretation of the results from our empirical exercise.

In our model, Chinese liberalization in final goods exposes Chinese firms to tougher competition from foreign firms, which is a source of job destruction that can explain the predicted employment losses for all types of low-productivity firms. Meanwhile, Chinese liberalization in input trade reduces employment in low-productivity firms, and the impact is small and statistically insignificant for high-productivity ordinary firms. The negative effects are likely a consequence of competition and task relocation effects, while the small effects for high productivity firms reveal countervailing forces due to market share reallocations toward more productive firms, as well as market share expansions driven by efficiency gains. Lastly, destruction in low-productivity firms after foreign trade liberalization can be explained by competition effects, with slight job creation for high-productivity firms due to countervailing forces such as an easier domestic environment, the direct expansive effect on exporters, and possible efficiency gains.

The rest of the paper is organized as follows. Section 2 presents the model that help us understand the several channels through which different types of trade liberalization affect the different types of Chinese firms. Section 3 describes our firm-level and trade data, with particular emphasis in our firm-level tariff measures. In sections 4 and 5 we present our empirical results. Lastly, section 6 concludes.

2 Theoretical Motivation

This section presents the model that motivates our empirical exercise. In a setting with heterogeneous firms a la Melitz, we show how changes in the trinity of trade costs (external final-good trade costs, internal final-good trade costs, and input trade costs) affect Chinese firm-level employment.

There are two countries, China, which we call Home, and the rest of the world, which we call

[2] In the same vein, Groizard, Ranjan and Rodriguez-Lopez (2014) construct a heterogeneous-firm model of offshoring that describes the effects of input trade liberalization on firm-level employment. They derive similar effects to those described in this paper, but do not consider final-good trade costs, nor the existence of processing firms, which are very important in the Chinese manufacturing industry.

Foreign. Home has a mass of households of size $\mathbb{L}$, while Foreign's size is $\mathbb{L}^*$ — Foreign variables are denoted with a star ($*$). Each household in each country provides one unit of labor per unit of time to either a homogeneous-good sector or a heterogeneous-good sector. The homogeneous good is produced under perfect competition and is costlessly traded; on the other hand, differentiated goods are produced under monopolistic competition and each variety is potentially tradable.

The homogeneous good is the numeraire and its production requires only labor. One unit of Home labor produces exactly one unit of the homogeneous good; hence, the wage at Home is 1. At Foreign, however, one unit of labor produces $w^* > 1$ of the homogeneous good, and hence, the wage at Foreign is w^*.

2.1 Preferences and Demand

The utility function of the representative Home household is given by

$$U = H^{1-\eta} Z^{\eta}, \tag{1}$$

where H denotes the consumption of the homogeneous good, $Z = \left[\int_{\omega\in\Omega} z^c(\omega)^{\frac{\sigma-1}{\sigma}} d\omega\right]^{\frac{\sigma}{\sigma-1}}$ is the constant elasticity of substitution (CES) consumption aggregator of differentiated goods, and $\eta \in (0,1)$. In Z, $z^c(\omega)$ denotes the consumption of variety ω, Ω is the set of differentiated goods available for purchase, and $\sigma > 1$ is the elasticity of substitution between varieties. It follows that the representative household spends a fraction η of its income on differentiated goods and the rest on the homogeneous good.

The representative Home household's demand for variety ω is then given by $z^c(\omega) = \frac{p(\omega)^{-\sigma}}{P^{1-\sigma}}\eta$, where $p(\omega)$ is the price of variety ω, and $P = \left[\int_{\omega\in\Omega} p(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}$ is the price of the CES aggregator Z. Total Home labor income is $\mathbb{L}$ (there are $\mathbb{L}$ households, and the labor income of each household is 1), and thus, the total expenditure on differentiated goods is $\eta\mathbb{L}$. Hence, the market demand for variety ω is given by

$$z^D(\omega) = \frac{p(\omega)^{-\sigma}}{P^{1-\sigma}}\eta\mathbb{L}. \tag{2}$$

With similar preferences for Foreign households, their total expenditure on differentiated goods is $\eta w^*\mathbb{L}^*$, and hence Foreign's market demand for variety ω is $z^{*D}(\omega) = \frac{P^{*\sigma-1}}{p^*(\omega)^{\sigma}}\eta w^*\mathbb{L}^*$, where $p^*(\omega)$ is the Foreign price of variety ω, and $P^* = \left[\int_{\omega\in\Omega^*} p^*(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}$.

2.2 Production of Differentiated Goods

Differentiated-good firms in both countries are heterogeneous in productivity. As in the Chaney (2008) version of the Melitz (2003) model, there is a constant pool of potential producers in each

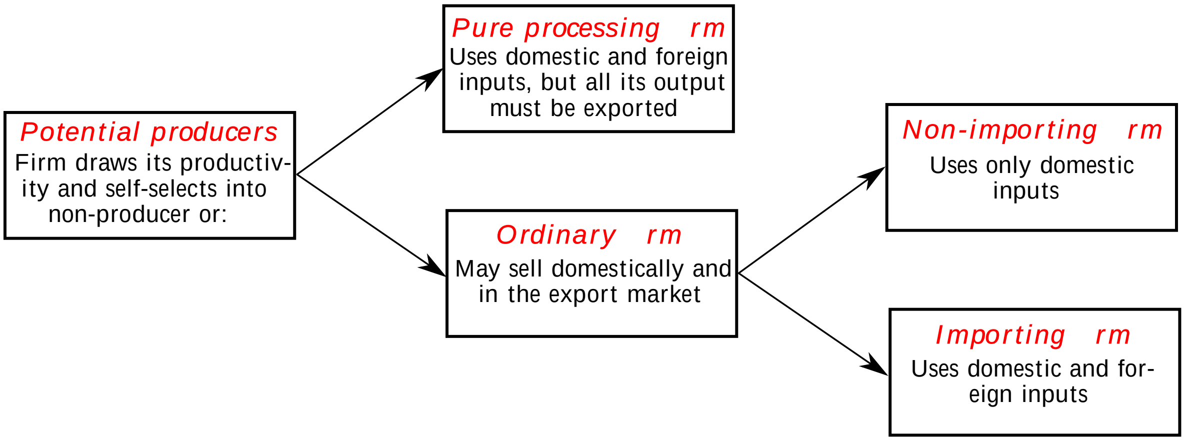


Figure 1: The Types of Home Firms

country, with each of them drawing its productivity φ from a cumulative distribution function $G(\varphi)$. The probability density function is denoted by $g(\varphi)$.

Each differentiated good is produced using a continuum of tasks in the interval $[0, 1]$. A fraction of these tasks is produced inside the firm using domestic labor, while the rest are obtained outside the firm from domestic or foreign input suppliers. Home firms are classified into the following three categories:

1. *Pure processing firms (P):* They import inputs duty-free, but in exchange they must export all their output.

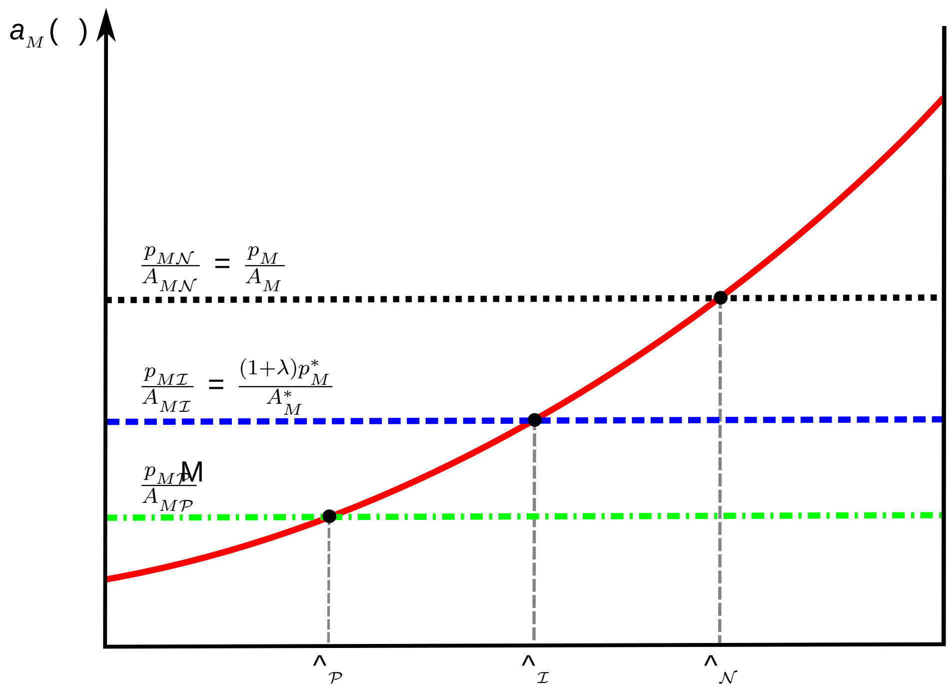
2. *Non-importing firms (N):* They obtain all their inputs domestically, sell for the domestic market, and may also export.

3. *Importing firms (I):* They import inputs (paying input trade costs), and sell for both the domestic and export markets.

This classification, summarized in Figure 1, captures very well the full range of Chinese firms. The assumptions that not all exporters import inputs, but that all importers export fit well our Chinese data, which yields that for ordinary firms, 39% of exporters are also importers, but that 85% of importers are also exporters. This is broadly consistent with the stylized facts described in Feng, Li and Swenson (2016).

The production function of a Home firm with productivity φ and status $s \in \{P, N, I\}$ is $z_s(\varphi) = \varphi Y_s$, where $Y_s = \left[\int_0^1 y_s(\omega)^{\frac{\theta-1}{\theta}} d\omega\right]^{\frac{\theta}{\theta-1}}$ is a CES tasks aggregator. In Y_s, $\theta \in [0, \infty)$ is the elasticity of complementarity/substitution between tasks: when $\theta \in [0, 1)$ tasks are complementary, when $\theta = 1$ we obtain the Cobb-Douglas aggregator and tasks are neither substitutes nor complements, and when $\theta > 1$ there is substitutability between tasks.

The production function for task for a rm with status



$a_M(\ )$
$\frac{p_{M\mathcal{N}}}{A_{M\mathcal{N}}} = \frac{p_M}{A_M}$
$\frac{p_{M\mathcal{I}}}{A_{M\mathcal{I}}} = \frac{(1+\lambda)p^*_M}{A^*_M}$
$\frac{p_{M\mathcal{P}}}{A_{M\mathcal{P}}}$ M
$\hat{}_{\mathcal{P}}$
$\hat{}_{\mathcal{I}}$
$\hat{}_{\mathcal{N}}$

$\frac{\sigma}{\sigma-1}\frac{c(\hat{\alpha}_s)}{\varphi}$ and $p_{Xs}(\varphi) = \frac{\sigma}{\sigma-1}\frac{(1+\tau)c(\hat{\alpha}_s)}{\varphi}$, respectively. Using these pricing equations and the market demand functions, we obtain that the firm's gross profit functions — before deducting fixed costs — from selling in each market are

$$\pi_{Ds}(\varphi) = \frac{1}{\sigma}\left(\frac{P}{p_{Ds}(\varphi)}\right)^{\sigma-1}\mathbb{L} \quad \text{and} \quad \pi_{Xs}(\varphi) = \frac{1}{\sigma}\left(\frac{P^*}{p_{Xs}(\varphi)}\right)^{\sigma-1} w^*\mathbb{L}^*. \tag{8}$$

As usual, for $r \in \{D, X\}$ and $s \in \{P, N, I\}$, $p'_{rs}(\varphi) < 0$ and $\pi'_{rs}(\varphi) > 0$ so that more productive firms charge lower prices and obtain larger profits.

Foreign differentiated-good firms do not have incentives to purchase materials from Home; thus, the production function of a Foreign firm with productivity φ is $z^*(\varphi) = A^*\varphi Y^*$, where A^* is an aggregate productivity factor for Foreign firms (normalized to 1 for Home firms) and $Y^* = \left[\int_0^1 y^*(\alpha)^{\frac{\theta-1}{\theta}} d\alpha\right]^{\frac{\theta}{\theta-1}}$ is the CES task aggregator. The Foreign firms' task production function is analogous to (3), their cost of producing one unit of task α with Foreign labor is w^*, and their cost of producing it with materials is $\frac{p^*_M}{A^*_M a^*_M(\alpha)}$. It follows that the fraction of tasks produced inside a Foreign firm with Foreign labor, $\hat{\alpha}^*$, is the solution to

$$a^*_M(\hat{\alpha}^*) = \frac{p^*_M}{A^*_M w^*}. \tag{9}$$

Analogously to Lemma 1, the unit cost of Y^* is $c^*(\hat{\alpha}^*)w^*$, where $c^*(\hat{\alpha}^*)$ is similar to (7) but with $\hat{\alpha}^*$ and $a^*_M(\alpha)$ instead of $\hat{\alpha}_s$ and $a_M(\alpha)$. The marginal cost for a Foreign firm with productivity φ is then $\frac{c^*(\hat{\alpha}^*)w^*}{A^*\varphi}$ from selling domestically, and $\frac{(1+\tau^*)c^*(\hat{\alpha}^*)w^*}{A^*\varphi}$ from selling in the Home market, with $\tau^* > 0$ denoting the tariff imposed by Home on differentiated-good imports from Foreign. Hence, the prices set by a Foreign firm with productivity φ are $p^*_D(\varphi) = \frac{\sigma}{\sigma-1}\frac{c^*(\hat{\alpha}^*)w^*}{A^*\varphi}$ in the domestic market, and $p^*_X(\varphi) = \frac{\sigma}{\sigma-1}\frac{(1+\tau^*)c^*(\hat{\alpha}^*)w^*}{A^*\varphi}$ in the export market. The firm's gross profit functions from selling in each market are

$$\pi^*_D(\varphi) = \frac{1}{\sigma}\left(\frac{P^*}{p^*_D(\varphi)}\right)^{\sigma-1} w^*\mathbb{L}^* \quad \text{and} \quad \pi^*_X(\varphi) = \frac{1}{\sigma}\left(\frac{P}{p^*_X(\varphi)}\right)^{\sigma-1}\mathbb{L}. \tag{10}$$

2.4 Cutoff Productivity Levels and the Masses of Firms

By Lemma 1 and $\hat{\alpha}_{\mathcal{P}} < \hat{\alpha}_{\mathcal{I}} < \hat{\alpha}_{\mathcal{N}}$, it is the case that $c(\hat{\alpha}_{\mathcal{P}}) < c(\hat{\alpha}_{\mathcal{I}}) < c(\hat{\alpha}_{\mathcal{N}})$. Although pure processing firms face the lowest cost of the task aggregator, the trade-off is that they are not allowed to access the domestic market (and they are not exempt of Foreign tariffs). There are fixed costs of importing inputs for both processing and ordinary firms, and there are fixed costs of selling in each market. These fixed costs along with the CES demand system imply the existence of cutoff productivity levels that determine firm status s (for Home firms) and the tradability of each differentiated good in each market.

There are four cutoff productivity levels for Home firms: one for pure processing firms, $\hat{}_{\mathcal{P}}$, one for non-importing firms selling only in the domestic market, $\hat{}_{D}$, one for non-importing firms selling to both the domestic and export markets, $\hat{}_{X}$, and one for importing-exporting firms, $\hat{}_{\mathcal{I}}$. In our Chinese data, Dai, Maitra and Yu (2016) show that processing firms are on average the least productive of all types of firms, and importing firms (of which the vast majority, 85 percent, are also exporters) are on average the most productive. Accordingly, we assume parameters such that $\hat{}_{\mathcal{P}} < \hat{}_{D} < \hat{}_{X} < \hat{}_{\mathcal{I}}$ always holds. Then, for example, a Home firm with productivity below $\hat{}_{\mathcal{P}}$ does not produce, while a firm with productivity between $\hat{}_{X}$ and $\hat{}_{\mathcal{I}}$ is an ordinary non-importing firm that sells to both markets. For Foreign firms there are only two cutoff productivity levels, $\hat{}^{*}_{D}$ and $\hat{}^{*}_{X}$, and we assume fixed costs and trade costs such that $\hat{}^{*}_{D} < \hat{}^{*}_{X}$ always holds.

Fixed costs are in terms of the homogeneous good. For $r \in \{D; X\}$, let f

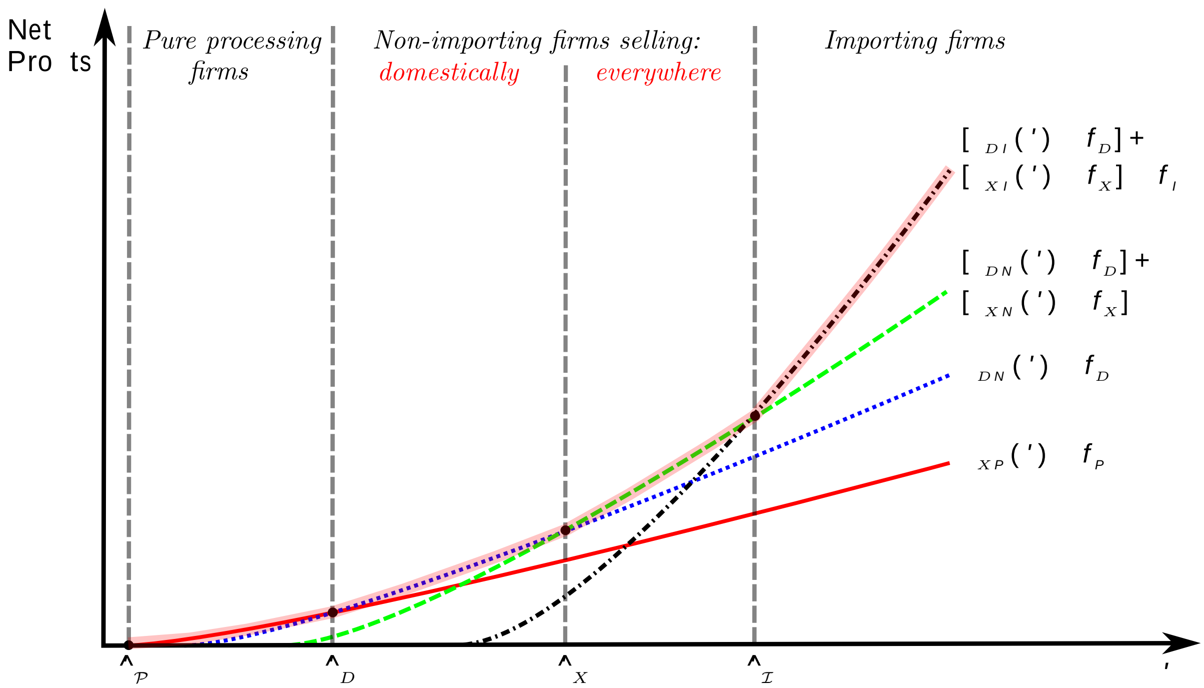


Figure 3: Cutoff Productivity Levels and the Partition of Firms

cutoff productivity levels in Figure 3, the masses of each type of Home producers are

$$N_{\mathcal{P}} = [G(\hat{\varphi}_{D}) - G(\hat{\varphi}_{\mathcal{P}})]N \tag{17}$$

$$N_{D\mathcal{N}} = [G(\hat{\varphi}_{\mathcal{I}}) - G(\hat{\varphi}_{D})]N; \tag{18}$$

$$N_{X\mathcal{N}} = [G(\hat{\varphi}_{\mathcal{I}}) - G(\hat{\varphi}_{X})]N; \tag{19}$$

$$N_{\mathcal{I}} = [1 - G(\hat{\varphi}_{\mathcal{I}})]N. \tag{20}$$

Foreign potential producers have the same productivity distribution as Home potential producers, and thus the mass of Foreign producers selling in their domestic market, N_D^*, and the mass of Foreign exporters, N_X^*, are given by

$$N_D^* = [1 - G(\hat{\varphi}_D^*)]N^*; \tag{21}$$

$$N_X^* = [1 - G(\hat{\varphi}_X^*)]N^*. \tag{22}$$

With N denoting the mass of differentiated-good varieties available for purchase at Home, and N^* denoting the mass of varieties available at Foreign, it follows that

$$N = N_{D\mathcal{N}} + N_{\mathcal{I}} + N_X^*; \tag{23}$$

$$N^* = N_D^* + N_{\mathcal{P}} + N_{X\mathcal{N}} + N_{\mathcal{I}}. \tag{24}$$

2.5 Equilibrium and Trade Liberalization

To close the model we rely on the expressions for the CES prices indexes P and P^*:

$$P = \left[N_{D\mathcal{N}} p_{D\mathcal{N}}^{1-\sigma} + N_{\mathcal{I}} p_{D\mathcal{I}}^{1-\sigma} + N_X^* p_X^{*1-\sigma} \right]^{\frac{1}{1-\sigma}}; \tag{25}$$

$$P^* = \left[N_D^* p_D^{*1-\sigma} + N_{\mathcal{P}} p_{X\mathcal{P}}^{1-\sigma} + N_{X\mathcal{N}} p_{X\mathcal{N}}^{1-\sigma} + N_{\mathcal{I}} p_{X\mathcal{I}}^{1-\sigma} \right]^{\frac{1}{1-\sigma}}; \tag{26}$$

where the masses of firms are given by (17)-(22), $p_{rs} \equiv p_{rs}(\varphi_{rs})$ is the average price of Home firms with status s selling in market r, $p_r^* \equiv p_r^*(\varphi_r^*)$ is the average price of Foreign firms selling in market r, $\varphi_{rs} = \left[\int_{\varphi \in \Phi_{rs}} \varphi^{\sigma-1} g(\varphi \mid \varphi \in \Phi_{rs}) d\varphi\right]^{\frac{1}{\sigma-1}}$ is the average productivity for status-s firms that sell in market r (with Φ_{rs} denoting the set of productivity values they take), and $\varphi_r^* = \left[\int_{\hat{\varphi}_r^*}^{\infty} \varphi^{\sigma-1} g(\varphi \mid \varphi \in [\hat{\varphi}_r^*, \infty)) d\varphi\right]^{\frac{1}{\sigma-1}}$ is the average productivity of Foreign firms selling in market r. We can now describe the equilibrium.

Definition 1. *An equilibrium in this model obtains* $\hat{\ }_s$ *for every* s *from* (4), $\hat{\ }^*$ *from* (9), $c(\hat{\ }_s)$ *for every* s *and* $c^*(\hat{\ }^*)$ *from Lemma 1, and then uses the indifference conditions* (11)-(16) *along with* (25) *and* (26) *to solve for* P, P^*, $\hat{\varphi}_{\mathcal{P}}$, $\hat{\varphi}_D$, $\hat{\varphi}_X$, $\hat{\varphi}_{\mathcal{I}}$, $\hat{\varphi}_D^*$, *and* $\hat{\varphi}_X^*$.

Our trade liberalization parameters are $\;$, $\;^*$, and $\;$ — recall that $\;$ is the Foreign tariff on final goods from Home, $\;^*$ is the Home tariff on final goods from Foreign, and $\;$ is the Home tariff on inputs from Foreign. Therefore, in this paper we refer to a decline in $\;$ as "Foreign trade liberalization", to a decline in $\;^*$ as "Home trade liberalization in final goods", and to a decline in $\;$ as "Home trade liberalization in inputs".

To understand the model's implications for the impact of each type of trade liberalization on firm-level employment, first we need to look at how equilibrium aggregate prices, cutoff productivity levels, and task cutoffs respond. We solve the model numerically using as benchmark the following parameter values: $\; = 3$, $A^* = 1.2$, $w^* = 1.1$, $\; = 0.5$, $\mathbb{L} = \mathbb{L}^* = N = N^* = 1$, $f_{\mathcal{P}} = 0.01$, $f_D = f_X = f_D^* = f_X^* = 0.02$, $f_{\mathcal{I}} = 0.06$, $p_M = 1$, $p_M^* = 0.7$, $A_{M\mathcal{P}} = A_{M\mathcal{I}} = A_M^* = 0.5$, $A_{M\mathcal{N}} = A_M = 0.3$, $\; = 1$, $a_M(\;) = 2a_M^*(\;) = 1 + 5\,\;^2$, $\; = \;^* = 2$, and $\; = 1.6$. Based on Combes *et al.* (2012), who find that the distribution of firm productivity for French firms is better approximated by a lognormal distribution, we assume that $g(\varphi) = \frac{1}{\varphi\sqrt{2\pi\rho}} \exp\left[-\frac{(\ln\varphi-\mu)^2}{2\rho}\right]$ with $\; = 0.02$ and $\; = 0.35$.[5] These parameters yield an interior solution with $\hat{\ }_{\mathcal{P}} < \hat{\ }_{\mathcal{I}} < \hat{\ }_{\mathcal{N}}$ and $\hat{\varphi}_{\mathcal{P}} < \hat{\varphi}_D < \hat{\varphi}_X < \hat{\varphi}_{\mathcal{I}}$. For our numerical comparative statics, we assume that $\;$ and $\;^*$ decline to 1.6 and that $\;$ declines to 1.4. Table B.1 in the Appendix shows the equilibrium values of our endogenous variables in the benchmark case along with their changes after a reduction in each type of tariff. Table 1 summarizes these numerical comparative static results.[6]

[5] Combes *et al.* (2012) estimate that firm-level productivity of French firms is a mix 95% lognormal and 5% Pareto,

Table 1: Responses of Prices and Cuto Levels to Tari Reductions

	^$_{\mathcal{I}}$	P	P^*	^$_{\mathcal{P}}$	^$_D$	^$_X$	^$_{\mathcal{I}}$	^$^*_D$	^$^*_X$
#	{	"	#	#	"	#	#	"	#
# *	{	#	#	"	"	"	"	"	#
#	#	#	#	"	"	"	#	"	"

For the cuto task levels, it is evident from Figure 2 that changes in and * do not a ect ^$_s$ for every s 2 $f P; N; I g$. Note also that the input tari , , does not a ect ^$_{\mathcal{P}}$ and ^$_{\mathcal{N}}$, but it does a ect ^$_{\mathcal{I}}$. In particular, Home trade liberalization in inputs (#) makes materials' imports cheaper and reduces the fraction of tasks performed with Home labor in ordinary importing Home rms ($i.e.$, $\frac{d\hat{\alpha}_{\mathcal{I}}}{d\lambda} > 0$); this can be seen in Figure 2 with a decline in the $\frac{(1+\lambda)p^*_M}{A^*_M}$ horizontal line. As trade liberalization (no matter the type) does not a ect ^$_{\mathcal{P}}$ and ^$_{\mathcal{N}}$, Table 1 only includes ^$_{\mathcal{I}}$.

The responses of aggregate prices summarize the changes in the competitive environment in each market. For example, a decline in P indicates a tougher competitive environment at Home | from (2), note that a decline in P implies that the demand for each di erentiated-good variety shifts to the left. Therefore, the second and third columns of Table 1 show that Home trade liberalization in either nal goods or inputs | a decline in * or | causes tougher competitive environments in both countries (P and P^* decline), while Foreign trade liberalization | a decline in | toughens the competitive environment at Foreign but softens it at Home (P^* declines but P increases).P cessing firms. Home trade liberalization in final goods ($\downarrow$ *) exposes all Home firms to tougher competition from Foreign firms in both markets, which leads to an increase in all the cutoff levels for Home firms. Lastly, Home trade liberalization in inputs ($\downarrow$) drives a decline in $\hat{\ }_{\mathcal{I}}$, as profit opportunities for ordinary importing firms increase; given that the marginal costs of new importing firms decline, it becomes harder for other types of Home firms to compete and $\hat{\ }_{\mathcal{P}}$, $\hat{\ }_{D}$, and $\hat{\ }_{X}$ rise.

2.6 Trade Liberalization and Firm-Level Employment

We can now obtain the amount of labor employed by each type of Home firm. As described above, a Home firm with status s uses domestic labor to produce the tasks in the interval $[0, \hat{\ }_s)$, while tasks in the interval $[\hat{\ }_s, 1]$ are procured using material inputs from outside the firm. The following lemma shows the firm-level demand for Home labor from selling in each market.

Lemma 2. *For a producing Home firm whose productivity φ sorts it into status $s \in \{P, N, I\}$, its demands for domestic labor to produce for each market are given by*

$$L_{Ds}(\varphi) = \frac{\varphi^{\sigma-1}\hat{\ }_s P^{\sigma-1}\mathbb{L}}{c(\hat{\ }_s)^{\sigma-\theta}}, \tag{27}$$

$$L_{Xs}(\varphi) = \frac{\varphi^{\sigma-1}\hat{\ }_s P^{*\sigma-1} w^{*}\mathbb{L}^{*}}{c(\hat{\ }_s)^{\sigma-\theta}(1+\ )^{\sigma-1}}, \tag{28}$$

where $\ \frac{\sigma-1}{\sigma}\ ^{\sigma}$ is a constant. The two exceptions to (27)-(28) are (1) $L_{D\mathcal{P}}(\varphi) = 0$ because pure processing firms are not allowed to sell domestically, and (2) $L_{X\mathcal{N}}(\varphi) = 0$ if $\varphi \in [\hat{\ }_D, \hat{\ }_X)$ because these non-importing firms do not export.

Given the results in Table 1, equations (27) and (28) indicate that trade liberalization affects firm-level employment at Home through the following channels: *(i)* by affecting each country's competitive environment (as reflected by changes in P and P^*), *(ii)* in the case of foreign trade liberalization ($\downarrow$), by directly expanding employment in exporting firms, which become instantly more competitive in the Foreign market, *(iii)* in the case of input trade liberalization ($\downarrow$), by reducing the fraction of tasks performed inside the firm by ordinary importing firms ($\downarrow \hat{\ }_{\mathcal{I}}$), with the consequent reduction on these firms' unit cost of the task aggregator ($\downarrow c(\hat{\ }_{\mathcal{I}})$).

In addition, Table 1 shows that all types of trade liberalization affect the cutoff productivity levels, and hence, some firms change their status $s \in \{P, N, I\}$ and market destinations $r \in \{D, X\}$, which also alters their employment (*e.g.*, an initially ordinary non-importing and non-exporting firm that becomes a pure processing firm after trade liberalization — due to the increase in $\hat{\ }_D$ — changes its employment from $L_{D\mathcal{N}}(\varphi)$ to $L_{X\mathcal{P}}(\varphi)$). In the following sections we describe the model's implications regarding the employment effects of each type of trade liberalization for each type of firm. In the end of this section, Table 2 summarizes the results.

2.6.1 Pure Processing Firms (P)

The employment of a pure processing firm with productivity φ is $L_{X\mathcal{P}}(\varphi) = \frac{\Upsilon \varphi^{\sigma-1} \hat{\alpha}_{\mathcal{P}} P^{*\sigma-1} w^* \mathbb{L}^*}{c(\hat{\alpha}_{\mathcal{P}})^{\sigma-\theta}(1+\tau)^{\sigma-1}}$. We describe first the case of firms that have status P before and after a trade cost shock, and then we study the case of firms that switch their status to P after the shock.

For firms that keep status P, note first from Table 1 that all types of trade liberalization cause a decline in P^* (the competitive environment becomes tougher at Foreign). This is a source of job destruction in $L_{X\mathcal{P}}(\varphi)$, and the only active channel in these firms after Home trade liberalization in final goods (# *) or in inputs (#). With Foreign trade liberalization (#), however, there is a direct countervailing force of job creation in $L_{X\mathcal{P}}(\varphi)$ as Home exporters become more competitive abroad.

Table 1 shows that all types of trade liberalization increase the cutoff productivity level that separates pure processing firms and ordinary non-importing firms, $\hat{\varphi}_D$, so that some firms switch from status N to status P. Let $\hat{\varphi}'_D$ denote the post-liberalization cutoff. Hence, for a Home firm with productivity $\varphi \in [\hat{\varphi}_D; \hat{\varphi}'_D)$, its domestic employment switches from $L_{D\mathcal{N}}(\varphi)$ to $L_{X\mathcal{P}}(\varphi)$. From (27) and (28), the ratio between the firm's post-liberalization and pre-liberalization employment is given by

$$\frac{L_{X\mathcal{P}}(\varphi)}{L_{D\mathcal{N}}(\varphi)} = \left(\frac{\hat{\alpha}_{\mathcal{P}}}{\hat{\alpha}_{\mathcal{N}}}\right)\left(\frac{c(\hat{\alpha}_{\mathcal{N}})}{c(\hat{\alpha}_{\mathcal{P}})}\right)^{\sigma-\theta}\left(\frac{P^{*\sigma-1} w^* \mathbb{L}^*}{(1+\tau)^{\sigma-1} P^{\sigma-1} \mathbb{L}}\right).$$

This firm's increase or decrease in employment depends on three channels. First, there is a reduction in the fraction of tasks performed inside the firm (recall that $\hat{\alpha}_{\mathcal{P}} < \hat{\alpha}_{\mathcal{N}}$), which is a source of job destruction. Second, there is a reduction in the firm's cost of the task aggregator, $c(\hat{\alpha}_{\mathcal{P}}) < c(\hat{\alpha}_{\mathcal{N}})$, which yields efficiency gains and is a source of job creation as long as $\sigma > \theta$ ($i.e.$, as long as the substitutability across varieties is higher than the substitutability across tasks). And third, as the firm switches between markets, the effect of trade liberalization on the firm's employment also depends on the size of the Foreign market (adjusted by the export cost) relative to the size of the Home market.

In the case of Foreign trade liberalization (#) there is also a decline in $\hat{\varphi}_{\mathcal{P}}$. Thus, some previously inactive firms become pure processing producers. For these firms their employment jumps from 0 to $L_{X\mathcal{P}}(\varphi)$.

2.6.2 Ordinary Non-Importing Firms (N)

Ordinary non-importing firms may sell only domestically or also export. We describe first the employment changes in non-exporting firms, and then we discuss the impact on exporting firms.

Home trade liberalization in final goods (# *) or in inputs (#) cause a tougher competitive environment at Home (P declines), while the opposite happens for Foreign trade liberalization (a decline in   increases P). Therefore, from (27) it follows that each continuing non-exporting rm reduces its employment after Home trade liberalization (in nal goods or in inputs), but expands its employment after Foreign trade liberalization. Either type of Home trade liberalization also makes exporting harder for ordinary non-importing rms, and thus, some previously exporting rms become non-exporters ($\hat{}_X$ rises), which also causes these rms' to reduce their employment.

The total demand for domestic labor of an ordinary non-importing rm that also exports is given by $L_{D\mathcal{N}}(') + L_{X\mathcal{N}}(')$. Such a rm faces tougher competitive environments in both markets after either type of Home trade liberalization (P and P^* fall after a decline in either * or), which implies job destruction. On the other hand, this type of rm is more likely to create jobs after Foreign trade liberalization (#). In that case, there is an increase in $L_{D\mathcal{N}}(')$ because the competitive environment becomes easier at Home (P rises), and in spite of a tougher competitive environment at Foreign (P^* falls), an expansion in $L_{X\mathcal{N}}(')$ is also possible due to the direct countervailing impact of a lower . In addition, Foreign trade liberalization causes a decline in $\hat{}_X$, which drives an expansion in employment in the new exporting rms.

Home trade liberalization in nal goods causes a reduction in pro ts for all Home rms, as they become subject to stronger competition from Foreign rms. As a consequence, some ordinary importing rms are no longer able to cover the xed cost of importing inputs and switch their status to non-importing (N) | note from Table 1 that $\hat{}_{\mathcal{I}}$ rises after a decline in *. Hence, those rms with productivities between the old and new $\hat{}_{\mathcal{I}}$ change their employment from $L_{D\mathcal{I}}(') + L_{X\mathcal{I}}(')$ to $L_{D\mathcal{N}}(') + L_{X\mathcal{N}}(')$, so that

$$\frac{L_{D\mathcal{N}}(') + L_{X\mathcal{N}}(')}{L_{D\mathcal{I}}(') + L_{X\mathcal{I}}(')} = \frac{\hat{}_{\mathcal{N}}}{\hat{}_{\mathcal{I}}} \left(\frac{c(\hat{}_{\mathcal{I}})}{c(\hat{}_{\mathcal{N}})}\right)^{\sigma-\theta} \left[\frac{(1+\ )^{\sigma-1}P'^{\sigma-1}\mathbb{L} + P^{*\prime\sigma-1}w^*\mathbb{L}^*}{(1+\ )^{\sigma-1}P^{\sigma-1}\mathbb{L} + P^{*\sigma-1}w^*\mathbb{L}^*}\right];$$

where P' and $P^{*\prime}$ are the post-liberalization aggregate prices. This expression shows one source of job creation and three sources of job destruction for these rms. First, the share of tasks performed inside these rms rises from $\hat{}_{\mathcal{I}}$ to $\hat{}_{\mathcal{N}}$, which is a source of job creation. Second, these rms' cost of the task aggregator rises from $c(\hat{}_{\mathcal{I}})$ to $c(\hat{}_{\mathcal{N}})$, which increases their marginal costs and prices, and thus makes them less competitive with respect to the other types of rms; this is a source of job destruction as long as   > . Lastly, tougher competitive environments at Home and Foreign ($P' < P$ and $P^{*\prime} < P^*$) are sources of job destruction.

2.6.3 Ordinary Importing Firms (I)

In this model, ordinary importing rms are the most productive of the three types and they sell in both markets. After trade liberalization in nal goods (#   or # *), the response of rm-level employment in a continuing ordinary importer is similar to the response of a continuing non-importing exporters: job destruction after a decline in * due to tougher competition in both markets, but possible job creation after a decline in due to Home firms become instantly more competitive at Foreign and a weaker competitive environment at Home (a job destruction force is also present when declines, however, as the increase in Home exporters cause a tougher competitive environment at Foreign).

Table 1 shows that trade liberalization in inputs (#) causes a decline in $\hat{}_{\mathcal{I}}$ (so that the fraction of imported inputs rises) and hence $c(\hat{}_{\mathcal{I}})$ falls. From (27) and (28), note that these changes generate two opposing effects on importing firms' employment: job destruction due to the lower fraction of tasks performed inside these firms (# $\hat{}_{\mathcal{I}}$), and job creation due to the fall in these firms' marginal costs | driven by the decline in the unit cost of the task aggregator, $c(\hat{}_{\mathcal{I}})$ | which allows them to charge lower prices and capture larger market shares. In turn, the increase in importing firms' efficiency toughens the competitive environment in both countries (P and P^* fall after a decline in), which causes further job destruction. In the end, these firms will create jobs after a decline in only if efficiency gains are sufficiently strong.

From Table 1, note that $\hat{}_{\mathcal{I}}$ falls after a decline in or . Therefore, after Foreign trade liberalization or Home input trade liberalization some firms switch status from non-importing to importing, changing their employment from $L_{D\mathcal{N}}(') + L_{X\mathcal{N}}(')$ to $L_{D\mathcal{I}}(') + L_{X\mathcal{I}}(')$. These firms reduce the number of tasks performed inside the firm ($\hat{}_{\mathcal{I}} < \hat{}_{\mathcal{N}}$), which destroys jobs, but they also have efficiency gains that lead to job creation (as long as $>$) because their cost of the task aggregator falls, $c(\hat{}_{\mathcal{I}}) < c(\hat{}_{\mathcal{N}})$. Home input trade liberalization toughens competition in both countries, causing further job destruction in these firms. Foreign trade liberalization also toughens competition in the Foreign market, but also promotes job creation in these firms through its direct positive impact on all Home exporters and the softening of competition at Home.

2.6.4 Summary

As a guide for the interpretation of the results of the empirical exercise below, Table 2 presents a summary of the model's implications for the employment responses of trading firms to each type of trade liberalization. The table excludes ordinary non-importing firms that do not export because our data only includes trading firms.

3 Data and Measures

This section describes the data and the construction of our tariff measures. The key advantage of our empirical approach is that we are able to exploit firm-level differences in exposure to each type of trade liberalization by constructing firm-level tariffs.

Table 2: Trading Firms' Employment Responses to Trade Liberalization

	Foreign trade liberalization ($\downarrow \tau$)	Home trade liberalization: in final goods ($\downarrow \tau^*$)	Home trade liberalization: in inputs ($\downarrow \lambda$)
Pure processing firms (P)	Same as next column, plus creation from direct effect on exporters, and creation from new P firms.	Destruction from tougher competition at Foreign. For $N \to P$ switchers, destruction from task relocation, creation from efficiency gains, and destruction or creation from market size effect.	
Ordinary non-importing firms (N) that export	Destruction from tougher competition at Foreign, creation from easier competition at Home, creation from direct effect, and creation from new exporters.	Destruction from tougher competition in both markets. Other channels for $I \to N$ switchers: creation from task relocation, destruction from efficiency losses.	Destruction from tougher competition in both markets.
Ordinary importing firms (I)	Destruction from tougher competition at Foreign, creation from easier competition at Home, creation from direct effect. Other channels for $N \to I$ switchers: destruction from task relocation, creation from efficiency gains.	Destruction from tougher competition in both markets.	Destruction from tougher competition in both markets, destruction from task relocation, creation from efficiency gains. Same channels for $N \to I$ switchers.

3.1 Data

We study the effects of each type of trade liberalization on Chinese firm-level employment from 2000 to 2006 — a period that includes the pinnacle of the so-called “China shock” on international labor markets — using three highly disaggregated yearly panel data sets: firm-level production data, tariff data, and product-level trade data. These datasets will allow us to compute firm productivity, firm-level tariffs, as well as other important firm-level control variables.

The firm-level production data comes from China's National Bureau of Statistics (NBS) annual survey on manufacturing firms, which includes all state-owned enterprises (SOEs) and non-SOEs whose annual sales exceed RMB 5 million (or equivalently $725,000). On average, the sample accounts for more than 95 percent of China's total annual output in the manufacturing sector.[7] As seen from Figure B.1 in the Appendix, the output of firms in the manufacturing sector accounts for around 40.4 percent of China's GDP in 2000 and around 43.4 percent of China's GDP in

[7] In 2006, the total value added of all the firms included in the survey was RMB 9,107 billion, which accounted for 99 percent of the value added of all firms in the manufacturing sector (RMB 9,131 billion), as reported by the 2007 China's Statistics Yearbook.

2006. Besides firm-level employment, this dataset covers more than 100 accounting variables and contains all of the information from the main accounting sheets, which includes balance sheets, loss and profit sheets, and cash flow statements.

However, as documented by Brandt, Van Biesebroeck and Zhang (2012) and other studies, the firm-level production dataset has obvious errors and omissions. Therefore, we clean the dataset following the procedures of Cai and Liu (2009) and Feenstra, Li and Yu (2014). In particular, manufacturing firms are kept in our sample only if they meet the requirements of the Generally Accepted Accounting Principles (GAAP).[8] After this rigorous filter is applied, approximately one-third of the total number of firms and one-quarter of firm sales are dropped.

Data on both China's exports and imports are accessed from China's General Administration of Customs. The trade data is compiled at the HS eight-digit product level and includes information of each product's quantity, value (in U.S. dollars), type of trade (*i.e.*, processing or non-processing), and even export destination (or import source). The tariff data comes from the World Integrated Trade Solution (WITS) database of the World Bank, and consists of *ad valorem* duties imposed by China and its trading partners at the six-digit level Harmonized System (HS).

The construction of firm-level tariffs requires matching firm-level production data and product-level trade data. Following Yu (2015), we use the firms' zip code, telephone numbers, and Chinese names, which in the end allow us to match 76,823 common trading firms, including both exporters and importers. Admittedly, the merged dataset loses many observations due to the well-known shortcoming of missing common matching identifiers in the two datasets. As discussed in Yu (2015), the merged sample is skewed towards large firms — as reflected by the higher averages in firm-level employment and exports — and therefore, the results in this paper are valid for large Chinese trading firms. The merged dataset accounts for around 40% of the manufacturing firms reported in the NBS manufacturing survey and contains about half of the export value reported in the customs dataset.[9]

3.2 Firm-Level Tariff Measures

Even if a firm belongs to a narrowly-defined industry, it could produce multiple products and, thus, its employment could be affected by multiple tariff lines. Inspired by Lileeva and Trefler (2010), who highlight the potential aggregation bias from using industry-level tariffs, we construct firm-

[8] We keep observations if all of the following hold: (1) total fixed assets cannot exceed total assets; (2) liquid assets cannot exceed total assets; (3) the net value of fixed assets is less than that of total assets; (4) number of employees cannot be less than eight; (5) the firm's identification number exists and is unique, and (6) the established time is valid.

[9] See Yu (2015) for a detailed description. Also, some of the firms in the data are pure trade intermediaries that do not have production activities. To ensure the precision of our estimates, we exclude these firms from the sample. Trade intermediaries are identified according to the procedures of Ahn, Khandelwal and Wei (2011).

speci c tari s to better capture the impact of each type of trade liberalization on Chinese rm-level employment. For each Chinese rm (indexed by *i*) at time *t*, we calculate the foreign tari against its nal goods ($_{it}$), the Chinese tari against competing nal goods ($^{*}_{it}$), and the Chinese tari on inputs the rm imports ($_{it}$).

Firms not only export multiple products, but also export them to multiple countries, with di erent subsets of products for di erent countries. The foreign tari for Chinese rm *i* at time *t*, $_{it}$, captures the degree of foreign protection faced by the rm's products. Based on tari s on the rm's goods in all its export destinations, $_{it}$ is given by

$$_{it} = \sum_{j \in J_i} \left[\frac{X_0^{ij}}{\sum_{j \in J_i} X_0^{ij}} \left(\sum_{k \in K_i} \frac{X_0^{ijk}}{X_0^{ij}} \right) T_t^{jk} \right]; \tag{29}$$

where T_t^{jk} is good *j*'s *ad valorem* tari imposed by country *k* in year *t*, X_0^{ijk} is the value of rm *i*'s exports of good *j* to country *k* in the rst year the product appears in the sample, $X_0^{ij} = \sum_{k \in K_{it}} X_0^{ijk}$, K_i is the set of export destinations of rm *i*, and J_i is the set of goods produced by rm *i*. Following Topalova and Khandelwal (2011), we x exports for each good at the initial period to avoid possible reverse causality in rm's exports with respect to foreign tari s. The ratio $X_0^{ijk} = X_0^{ij}$ governs the share of rm *i*'s good *j* exported to country *k* in the rst year the rm appears in the sample; thus, it captures the relative importance of T_t^{jk} in a ecting rm *i*'s exports of good *j*.

Chinese tari s on nal goods shield Chinese rms from foreign competition in the domestic market. Our measure for the Chinese tari on nal goods for rm *i* at time *t*, $^{*}_{it}$, captures the e ective rate of protection received by the rm based on the tari s China imposes on products that are similar to the goods the rm produces (see Qiu and Yu, 2020). A tari line has a more pronounced impact if the rm has a larger share of the corresponding good in its total domestic sales. Hence, $^{*}_{it}$ should be calculated as the average of all relevant tari s weighted by the share of each good's domestic sales. Our rm-level production dataset, however, reports information on a rm's total domestic sales but not on each product's domestic sales. Following Yu (2015), we adopt a less satisfactory measure for $^{*}_{it}$ that approximates the share of a good on a rm's domestic sales with the good's share on the rm's exports so that

$$^{*}_{it} = \sum_{j \in J_i} \left(\frac{X_0^{ij}}{\sum_{j \in J_i} X_0^{ij}} \right) T_t^{*j}; \tag{30}$$

where T_t^{*j} is China's *ad valorem* tari on product *j* in year *t*.

Our measure for the input tari faced by an ordinary Chinese rm *i* at time *t*, $_{it}$, captures the rm's cost of importing inputs as a result of Chinese tari s on the products imported by the rm.

As discussed here and in other works (see, *e.g.*, Feenstra and Hanson, 2005), processing imports are duty-free in China and that is the reason why pure processing firms face no input tariffs. An ordinary Chinese firm, however, may engage in both processing imports and non-processing imports. Therefore, λ_{it} is constructed as

$$\lambda_{it} = \sum_{j \in J_i^O} \left(\frac{M_0^{ij}}{\sum_{j \in J_i^M} M_0^{ij}} \right) T_t^{*j}, \tag{31}$$

where M_0^{ij} is firm i's imports of product j in the first year the firm appears in the sample, J_i^M is the set of firm i's imported products, and $J_i^O \subseteq J_i^M$ is the set of firm i's ordinary (non-processing) imported products. Note that (31) takes into account the zero tariff on the firm's processing imports. As with τ_{it} and τ^*_{it}, we use time-invariant weights to avoid an endogeneity problem due to the negative relationship between imports and tariffs.

Table B.2 in the Appendix shows the mean and standard deviation per year of our firm-level tariffs in (29), (30), and (31). Average Chinese tariffs on final goods fall the most during the period (from 15.47 percent to 7.46 percent), while the reductions in average foreign tariffs and Chinese input tariffs are rather small. Nevertheless, the standard deviations indicate large cross-sectional variation throughout the period. Note that firm-level input tariffs are small (about 2 percent on average for the entire period), which is a consequence of the large share of (duty-free) processing imports in ordinary firms (see Yu, 2015). Important for the precise estimation of the impact of each type of tariff reduction on firm-level employment, the pairwise simple correlations among foreign tariffs, Chinese final-good tariffs, and Chinese input tariffs are extremely low: the correlation is 0.01 between foreign tariffs and both Chinese final-good and input tariffs, and is 0.012 between Chinese final-good tariffs and input tariffs.

4 Liberalization and Chinese Firm-Level Employment

This section presents our empirical analysis for the effects of foreign tariffs (τ), Chinese final-good tariffs (τ^*), and Chinese input tariffs (λ) on firm-level employment. We start with specifications that ignore firm type to focus on the importance of firm heterogeneity in productivity, and later we consider specifications that capture differences across the different types of firms.

4.1 The Relevance of Heterogeneity in Productivity

Let $\mathbb{E}_{it}$ denote the employment of firm i at time t. Ignoring firm type, the econometric specification for the linearized firm-level labor demand is

$$E_{it} = \beta_\tau \tau_{it} + \gamma_\tau \tau_{it} \varphi_{it} + \beta_{\tau^*} \tau^*_{it} + \gamma_{\tau^*} \varphi_{it} \tau^*_{it} + \beta_\lambda \lambda_{it} + \gamma_\lambda \lambda_{it} \varphi_{it} + \alpha_i + \alpha_t + \delta \varphi_{it} + \varepsilon_{it}, \tag{32}$$

Table 3: Firm-Level Tariffs and Net Employment Responses with Different TFP Measures

	Log employment						
	Labor Productivity	*OLS*	*Augmented Olley-Pakes*	*Levinsohn-Petrin*	*ACF*	*System GMM*	*Relative SGMM*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Foreign tariff ($_{it}$)	0.16***	2.42***	1.11***	0.81***	0.74***	2.58***	1.18***
	(4.11)	(10.22)	(8.70)	(5.39)	(10.17)	(10.47)	(10.47)
Productivity	-1.92***	-0.75***	-0.22***	-0.12***	-0.24***	-0.99***	-4.13***
	(-4.51)	(-10.07)	(-8.52)	(-5.18)	(-9.96)	(-10.25)	(-10.20)
Chinese tariff ($^*_{it}$)	0.09	4.45***	1.82***	0.90***	1.34***	4.32***	2.26***
	(1.34)	(10.24)	(9.47)	(3.58)	(10.54)	(9.68)	(8.61)
Productivity	-2.12***	-1.45***	-0.42***	-0.16***	-0.52***	-1.75***	-8.28***
	(-4.47)	(-10.32)	(-11.01)	(-4.26)	(-13.60)	(-9.75)	(-8.58)
Input tariff ($_{it}$)	0.07	1.66*	1.33***	1.03**	0.79***	1.87*	0.94**
	(0.68)	(1.76)	(3.13)	(2.00)	(3.25)	(1.72)	(2.34)
Productivity	0.12	-0.48	-0.24***	-0.13*	-0.21***	-0.67	-2.94**
	(0.13)	(-1.63)	(-2.89)	(-1.74)	(-2.94)	(-1.60)	(-2.21)
Observations	56,549	56,549	39,355	38,829	39,355	56,549	56,549
R-squared	0.41	0.43	0.44	0.43	0.45	0.45	0.43

Notes: All regressions include firm fixed effects, year fixed effects, and state-owned status, foreign-owned status, export status, log capital per worker, and log sales as controls. Robust t-statistics (in parentheses) clustered at the firm level. Firm productivity is measured by value-added labor productivity in column 1, by standard OLS TFP in column 2, by augmented Olley-Pakes TFP in column 3, by the Levinsohn-Petrin TFP in column 4, by the Ackerberg-Caves-Frazer TFP in column 5, by system-GMM TFP in column 6, and by normalized system-GMM TFP in column 7. The coefficients are statistically significant at the *10%, **5%, or ***1% level.

where $E_{it} = \ln \mathbb{E}_{it}$, $_{it}$, $^*_{it}$ and $_{it}$ are the firm-level tariffs described above, $_i$ is a firm fixed effect, $_t$ denotes a time fixed effect, $_{it}$ is a vector of firm-level characteristics, and ε_{it} is the error term. The variable $_{it}$ is a measure of the productivity of firm i at time t, which interacted with firm-level tariffs allows us to capture heterogeneous impacts on firm-level employment. The coefficients of interest are $\{ _{\tau}, _{\tau}\}$, $\{ _{\tau^*}, _{\tau^*}\}$, $\{ _{\lambda}, _{\lambda}\}$, with each pair characterizing the response of firm-level employment to a change in each type of tariff. For example, the semi-elasticity of employment with respect to foreign tariffs for firm i at time t is given by $_{\tau} + _{\tau} \, _{it}$, so that for a one percentage point increase in the firm's foreign tariff ($e.g.$, from 6% to 7%), the firm's employment changes by $_{\tau} + _{\tau} \, _{it}$ percent.

Firm productivity is typically measured by total factor productivity (TFP). The most popular methods to compute TFP are the semi-parametric approaches of Olley and Pakes (1996), Levinsohn and Petrin (2003), and Ackerberg, Caves and Frazer (2015). Table 3 reports the estimation of (32) under different productivity measures. Column 1 starts with the value-added labor productivity and column 2 uses the standard OLS TFP measure. We then use the augmented Olley and Pakes (1996) TFP in column 3, the Levinsohn and Petrin (2003) TFP in column 4, and the Ackerberg, Caves and

Frazer (2015) TFP in column 5. Gandhi, Navarro and Rivers (2020) point out that labor | as one

A drawback of using raw TFP measures is that firm-level TFP is not directly comparable across industries (see Arkolakis, 2010). To solve this problem, column 7 in Table 3 shows the estimation of (32) under a *relative* system-GMM TFP measure that normalizes the raw system-GMM TFP by two-digit industry. Specifically, we construct $\phi_{it} \in (0,1)$ based on the firm's TFP rank relative to its industry peers at time t: the least productive firm in the industry takes a value close to zero, the firm at the median takes a value of 0.5, and the most productive firm takes a value close to 1. This also greatly simplifies the interpretation of the results: for a given tariff, the estimated semi-elasticity of employment for the least productive firm is $\hat{\beta}$, and for the most productive firm is $\hat{\beta} + \hat{\gamma}$. Column 7 shows that each type of trade liberalization is associated with job destruction in the least productive firms ($\hat{\beta} > 0$) and with job creation in the most productive firms ($\hat{\beta} + \hat{\gamma} < 0$). The magnitude of the semi-elasticities indicate that firm-level employment responds the most to Chinese liberalization in final-good trade, and the least to Chinese liberalization in input trade.[11]

To better gauge the effects of each type of trade liberalization along the productivity distribution of firms, we now sort firms into productivity quartiles using our relative system-GMM TFP measure. Thus, our econometric specification becomes

$$E_{it} = \sum_{\ell=1}^{4} \left[\beta^{\ell}_{\tau} \tau_{it} + \beta^{\ell}_{\tau^*} \tau^*_{it} + \beta^{\ell}_{\lambda} \lambda_{it} \right] \mathbb{1}\{Q^{\ell}_{t}\} + \alpha_i + \alpha_t + \gamma X_{it} + \varepsilon_{it}, \tag{33}$$

where $\ell \in \{1, 2, 3, 4\}$ indicates the quartile (low, medium-low, medium-high, and high), and $\mathbb{1}\{Q^{\ell}_{t}\}$ is a dummy variable taking the value of 1 if firm i belongs to quartile ℓ at time t. Hence, for each productivity quartile, the coefficients of interest are β^{ℓ}_{τ}, $\beta^{\ell}_{\tau^*}$, and β^{ℓ}_{λ}, which directly indicate the firm-level employment semi-elasticities of firms in quartile ℓ to each type of trade cost. This is our preferred specification, and thus, all of the following results in this paper show semi-elasticities by productivity quartile.

Table 4 presents the estimation of our specification in (33). Pure processing firms face zero input tariffs and enjoy preferential treatment from their international partners (see Ludema *et al.*, 2021). To account for this, and as a preview of our analysis by type of firm, column 1 presents the estimation using all firms, whereas columns 2 and 3 show the estimation after splitting the sample into ordinary firms and pure processing firms. All regressions include firm fixed effects, year fixed effects, and the same controls discussed above.

[11] Relatedly, Groizard, Ranjan and Rodriguez-Lopez (2015) use establishment level data from California from 1992 to 2004 to estimate the effects input and final-good trade costs on firm-level employment. Similar to our results, they find evidence of trade-induced job destruction in low-productivity firms and job creation in high-productivity firms. They also report that in the California data, the employment effects of input trade liberalization are more important than the effects of final-good trade liberalization. In contrast to our empirical analysis, they cannot distinguish between domestic and foreign final-good tariffs, and they have limited information on each establishment, which prevents them from identifying each firm's type and from obtaining firm-level tariffs.

Table 4: Firm-Level Tariffs and Net Employment Responses by Productivity Quartile

	Log employment		
	(1)	(2)	(3)
Foreign tariff ($_{it}$)			
First quartile	0.65***	0.62***	0.84***
	(7.61)	(6.18)	(3.47)
Second quartile	0.31***	0.32***	0.09
	(7.42)	(6.55)	(0.78)
Third quartile	-0.04	-0.02	-0.17
	(-1.08)	(-0.46)	(-1.35)
Fourth quartile	-0.31***	-0.28***	-0.56***
	(-7.44)	(-6.23)	(-3.24)
Chinese tariff ($^{*}_{it}$)			
First quartile	1.28***	1.41***	0.56*
	(11.62)	(10.45)	(1.95)
Second quartile	0.47***	0.48***	0.52***
	(7.87)	(6.64)	(3.10)
Third quartile	-0.12**	-0.02	-0.24
	(-2.22)	(-0.27)	(-1.54)
Fourth quartile	-0.68***	-0.54***	-1.15***
	(-11.01)	(-7.70)	(-5.40)
Input tariff ($_{it}$)			
First quartile	1.06***	1.11***	
	(4.34)	(4.36)	
Second quartile	0.14	0.34***	
	(1.17)	(2.62)	
Third quartile	0.13	0.14	
	(1.15)	(1.15)	
Fourth quartile	-0.14	-0.21*	
	(-1.29)	(-1.91)	
Pure processing firms	Yes	No	Only
Observations	56,549	46,443	10,106
R-squared	0.43	0.45	0.37

Notes: All regressions include firm fixed effects, year fixed effects, and state-owned status, foreign-owned status, export status, log capital per worker, and log sales as controls. Robust t-statistics (in parentheses) clustered at the firm level. Firms are classified into quartiles from low- to high-productivity according to their relative system-GMM TFP. The coefficients are statistically significant at the *10%, **5%, or ***1% level.

The three columns show that for each type of trade cost, employment semi-elasticities monotonically decrease as we move from the first to the fourth quartile, being positive and always statistically significant for low-productivity firms (first quartile) and negative and mostly statistically significant for high-productivity firms (fourth quartile). Thus, a reduction in either type of tariff reduces employment in low-productivity firms and increases employment in high-productivity firms, though the evidence is weak for high-productivity firms after a reduction in input tariffs.

Firms in the second quartile also have mostly statistically significant semi-elasticities (they also destroy employment after any type of liberalization), while firms in the third quartile are not significantly affected (the exception is the third-quartile coefficient for τ^*_{it} in column 1). In terms of coefficients' magnitudes, Chinese final-good trade liberalization has the largest effects for both job destruction in low and medium-low productivity firms, and job creation in high productivity firms.

Comparing columns 2 and 3, the most important difference between the employment responses of ordinary and pure processing firms is in the fourth-quartile coefficients for both Foreign and Chinese tariffs. Note that these are about two times larger for pure processing firms, and therefore, a decline in either type of tariff benefits employment in high-productivity pure processing firms the most.

The exercise in this section highlights the relevance of firm-level productivity for the employment effects of each type of trade liberalization. The results indicate standard Melitz's type effects, with changes in firm-level employment likely driven by trade-induced market share reallocations from low-productivity firms to high-productivity firms. Also, here we showed that the size of such employment effects depends on liberalization type and on the distinction between ordinary and pure processing firms.

4.2 Expansions and Contractions

It may be argued that employment or tariffs are non-stationary variables, so that the results from the estimation in levels of specifications (32) and (33) are not reliable. To account for this potential problem, in this section we use instead yearly first differences of our variables of interest. Our first-difference econometric specification is

$$\Delta E_{it} = \sum_{\ell=1} \left[\beta_{\tau}^{\ell} \Delta\tau_{it} + \beta_{\tau^*}^{\ell} \Delta\tau^*_{it} + \beta_{\lambda}^{\ell} \Delta\lambda_{it} \right] \mathbb{1}\{Q_t^{\ell}\} + \Delta\delta_t + \Delta\mu_{it} + \Delta\varepsilon_{it}, \tag{34}$$

where Δ represents the first difference of a variable so that, for example, ΔE_{it} is the log change in firm i's employment from $t-1$ to t.

The estimated responses of firm-level employment to tariff changes are the result of firms' expansion and contraction decisions. For example, if firms are expected to face net job destruction after a tariff reduction, the mechanism of destruction can be through a decline in the rate of job expansion, or an increase in the rate of job destruction, or a combination of both. As a by-product of the first-difference estimation, we are able to break down firm-level employment responses to tariff reductions into their expansions and contractions components. Following Davis, Haltiwanger and Schuh (1996), let e_{it} represent the rate of job creation by expansion for firm i between $t-1$ and t, and let c_{it} denote the firm's rate of job destruction by contraction. Using ΔE_{it}, e_{it} and c_{it}

are de ned as

$$e_{it} = \max(\quad E_{it}; 0);$$

$$c_{it} = \max(\quad E_{it}; 0);$$

and thus E_{it} e_{it} c_{it}

Table 5: First-Di erence Estimation, Expansions, and Contractions

	Net employment change			Job expansions			Job contractions		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Foreign tari ($_{it}$)									
First quartile	0.38***	0.45***	-0.03	0.22***	0.25***	0.03	-0.17**	-0.20***	0.06
	(4.17)	(4.34)	(-0.15)	(3.32)	(3.30)	(0.26)	(-2.50)	(-2.85)	(0.36)
Second quartile	0.23***	0.26***	0.11	0.14***	0.16***	0.07	-0.09***	-0.10***	-0.04
	(5.60)	(5.69)	(1.28)	(4.38)	(4.33)	(1.11)	(-3.60)	(-3.74)	(-0.71)
Third quartile	-0.01	0.01	-0.17	0.03	0.04	-0.08	0.04	0.03	0.09
	(-0.30)	(0.26)	(-1.55)	(0.83)	(1.16)	(-0.95)	(1.47)	(0.96)	(1.47)
Fourth quartile	-0.22***	-0.22***	-0.24	-0.19***	-0.18***	-0.26**	0.04	0.04	-0.01
	(-4.52)	(-4.30)	(-1.50)	(-4.65)	(-4.17)	(-2.20)	(1.27)	(1.41)	(-0.13)
Chinese tari ($^{*}_{it}$)									
First quartile	1.26***	1.42***	0.65**	0.70***	0.78***	0.39*	-0.55***	-0.64***	-0.26
	(8.20)	(8.24)	(2.16)	(6.91)	(6.78)	(1.88)	(-5.54)	(-5.48)	(-1.32)
Second quartile	0.41***	0.42***	0.27	0.22***	0.23***	0.11	-0.19***	-0.19***	-0.16
	(5.09)	(4.70)	(1.51)	(3.46)	(3.34)	(0.77)	(-4.06)	(-3.63)	(-1.41)
Third quartile	-0.21***	-0.18**	-0.37*	-0.19***	-0.16**	-0.36**	0.02	0.02	0.02
	(-2.97)	(-2.30)	(-1.90)	(-3.35)	(-2.53)	(-2.24)	(0.43)	(0.43)	(0.13)
Fourth quartile	-0.90***	-0.85***	-1.11***	-0.66***	-0.62***	-0.86***	0.24***	0.23***	0.25*
	(-10.18)	(-9.07)	(-4.58)	(-9.11)	(-7.92)	(-4.63)	(4.35)	(3.97)	(1.67)
Input tari ($_{it}$)									
First quartile	0.75***	0.66**	4.00***	0.67***	0.65***	1.52	-0.09	-0.01	-2.48**
	(2.60)	(2.23)	(3.67)	(3.02)	(2.88)	(1.15)	(-0.52)	(-0.06)	(-2.07)
Second quartile	0.17	0.24	-0.53	0.13	0.17	-0.27	-0.04	-0.07	0.26
	(1.12)	(1.56)	(-0.98)	(1.04)	(1.34)	(-0.92)	(-0.46)	(-0.81)	(0.63)
Third quartile	0.08	0.11	-0.70	0.12	0.12	0.02	0.04	0.01	0.72**
	(0.59)	(0.77)	(-1.46)	(1.10)	(1.08)	(0.06)	(0.49)	(0.15)	(2.55)
Fourth quartile	0.04	0.05	-0.90	-0.02	-0.03	-0.32	-0.06	-0.07	0.58**
	(0.28)	(0.37)	(-1.01)	(-0.17)	(-0.23)	(-0.37)	(-0.71)	(-0.95)	(2.28)
Pure processing rms	Yes	No	Only	Yes	No	Only	Yes	No	Only
Observations	16,984	14,488	2,496	16,984	14,488	2,496	16,984	14,488	2,496
R-squared	0.38	0.39	0.38	0.25	0.25	0.25	0.21	0.21	0.22

Notes: All regressions include year xed e ects and rst-di erences of state-owned status, foreign-owned status, export status, log capital-labor ratio, and log sales as controls. Robust t-statistics (in parentheses) clustered at the rm level. Firms are classi ed into quartiles from low- to high-productivity according to their relative system-GMM TFP. The coe cients are statistically signi cant at the *10%, **5%, or ***1% level.

0.22%. Note that the majority of the e ect of foreign trade liberalization on rm-level employment happens through changes in the rate of job expansions, rather than through job contractions.

Similarly, after a 1 percentage point reduction in Chinese nal-good tari s, Table 5 shows that for the associated 1.26% net job destruction in low-productivity rms (rst quartile), the reduction in the rate of job expansions plays a larger role than the increase in the rate of job contractions | the former reduces employment by 0.7% and the latter by 0.55%. For high-productivity rms (fourth quartile), the associated 0.9% net job creation is driven by a 0.66% increase due to the higher rate of job expansions and by a 0.24% increase due to the reduction in the rate of job contractions. Regarding Chinese input trade liberalization, only $\hat{\lambda}^{1e}$ is statistically signi cant, showing that after a 1 percentage point decline in input tari s, the 0.75% net employment decline in low-productivity rms (rst quartile) is mostly associated with a decline in job expansions (0.67%).

Table 5 shows the estimation of speci cations (35) and (36) for ordinary rms in columns 5 and 8, and for pure processing rms in columns 6 and 9. The results for ordinary rms are very similar to those obtained using all rms in columns 4 and 7. For pure processing rms, the net employment increase in high-productivity rms (fourth quartile) after a decline in foreign tari s is mostly due to an increase in the rate of job expansions. After a decline in Chinese nal-good tari s, the consequences on expansions and contractions for pure processing rms are qualitatively similar to those for ordinary rms. Lastly, the net employment reduction in low-productivity rms that switch from ordinary to pure processing rms | and w0s | an7ms | andrrse(pro)-206(irpro)-2-284(tra)-203s model does not include importing non-exporters, it still provide guidelines to understand these firms' responses.

As shown in Figure 3, in our model a firm self-selects into each type based on its productivity and the cutoff productivity levels: there is a perfect partition of firms so that two firms with the same productivity level always have the same status $s \in \{P, N, I\}$. Thus, within the model (with $\hat{\varphi}_{\mathcal{P}} < \hat{\varphi}_{D} < \hat{\varphi}_{X} < \hat{\varphi}_{\mathcal{I}}$) all pure processing firms are less productive than all ordinary non-importing firms, who are in turn less productive than all ordinary importing firms. In practice, however, there is overlapping across all types of firms (*e.g.*, there is coexistence of high-productivity pure processing firms and low-productivity importing firms), which can be explained by other dimensions of firm heterogeneity such as differences across firms' fixed costs or managerial abilities. Recognizing this important fact, the empirical analysis in this section continues to distinguish between low, medium-low, medium-high, and high-productivity firms, but now *within* each firm type.[12]

Table 6 reports the outcome of our specifications in (32) and (34) extended to account for different β's across the different types of firms. The first four columns show the output for the regression in levels, while the last four columns show the output for the regression in yearly first differences, with the top of each column indicating the type of firm: pure processing firms (P), non-importing exporters (N), importing exporters (I), and importing non-exporters (I–NX).[13]

In the two regressions, all the first-, second-, and fourth-quartile estimates of β for Chinese final-good tariffs are highly statistically significant, showing that for all types of firms, a reduction in Chinese tariffs is associated with job destruction in low- and mid-low productivity firms and with job creation in high-productivity firms. The coefficients on Foreign tariffs for the regression in levels present a similar story, but in general they are smaller in magnitude (when compared to the coefficients on Chinese final-good tariffs) and some of them lose their statistical significance in the first-difference regression. On the other hand, the results for input tariffs are generally weak, with the few statistically significant coefficients from the regression in levels losing their relevance in the first-difference regression.

Figure 4 summarizes the results in Table 6 by showing the statistically significant estimated

[12] Table B.4 in the Appendix provides statistics about the composition of firms in our sample of trading firms. Most firms in our sample are non-importing exporters, accounting for 70.4 percent of all firms in 2000, and for 56.1 percent in 2006. Pure processing firms accounted for 10.4 percent of trading firms in 2000, and for 8.3 percent in 2006. Importing firms made up for the decline in the fraction of pure processing and non-importing exporters from 2000 to 2006, with importing exporters raising their share from 12.5 to 16.8 percent, and importing non-exporters increasing their share from 6.7 to 18.8 percent.

[13] Similar to column 3 in Table 4, pure processing firms face a zero input tariff and hence, there are no input-tariff coefficient estimates for this type of firm in the first column of Table 6. Recall from Table 5 that the first-difference regression would yield input-tariff coefficients for firms that switch to $\mathcal{P}$ status. For purposes of comparison, we exclude input tariffs for pure processing firms in the first-difference regression in Table 6 (we look at responses of switchers in section 4.4).

Table 6: Firm-Level Tariffs and Net Employment Responses by Productivity Quartile and Firm Type

	Log employment (Regression in levels)				Net employment change (Regression in first differences)			
	(P)	(N)	(I)	(I{NX)	(P)	(N)	(I)	(I{NX)
Foreign tariff ($_{it}$)								
First quartile	0.67***	0.63***	0.62***	0.74***	0.24	0.28**	0.52***	0.24
	(3.03)	(3.99)	(4.03)	(2.59)	(1.02)	(2.21)	(3.58)	(0.82)
Second quartile	0.27***	0.39***	0.28***	0.26**	0.07	0.23***	0.25***	0.32**
	(3.07)	(5.62)	(4.46)	(2.26)	(0.89)	(3.48)	(4.59)	(2.35)
Third quartile	-0.22**	0.07	-0.10*	0.05	-0.20**	0.06	0.00	-0.10
	(-2.56)	(1.14)	(-1.66)	(0.43)	(-2.06)	(0.95)	(0.05)	(-0.77)
Fourth quartile	-0.69***	-0.25***	-0.23***	-0.42***	-0.45**	-0.15**	-0.24***	-0.25*
	(-4.77)	(-3.32)	(-3.59)	(-2.95)	(-2.30)	(-2.35)	(-3.46)	(-1.77)
Chinese tariff ($^{*}_{it}$)								
First quartile	1.14***	1.41***	1.20***	1.26***	1.07***	1.31***	1.22***	1.57***
	(5.29)	(7.63)	(5.38)	(3.79)	(4.60)	(6.91)	(6.54)	(4.61)
Second quartile	0.61***	0.41***	0.45***	0.38***	0.64***	0.32***	0.31***	0.49***
	(5.77)	(4.62)	(4.86)	(2.91)	(6.23)	(3.29)	(3.36)	(3.03)
Third quartile	-0.14	-0.14*	-0.05	-0.33**	-0.15	-0.27***	-0.23***	-0.13
	(-1.58)	(-1.72)	(-0.59)	(-2.26)	(-1.55)	(-3.21)	(-2.74)	(-0.87)
Fourth quartile	-0.72***	-0.76***	-0.45***	-1.05***	-0.94***	-0.97***	-0.76***	-1.03***
	(-5.07)	(-8.01)	(-4.55)	(-6.49)	(-5.98)	(-9.67)	(-7.78)	(-6.24)
Input tariff ($_{it}$)								
First quartile		1.18***	1.08***	0.65		0.54	0.47	1.52**
		(2.67)	(2.94)	(1.02)		(1.48)	(1.26)	(2.24)
Second quartile		0.02	0.17	0.62		0.23	0.26	0.02
		(0.08)	(1.06)	(1.55)		(1.15)	(1.53)	(0.04)
Third quartile		0.15	0.10	0.07		0.21	0.02	-0.12
		(0.88)	(0.53)	(0.22)		(1.39)	(0.11)	(-0.28)
Fourth quartile		-0.12	-0.54***	0.41*		0.15	-0.27	0.32
		(-0.93)	(-3.21)	(1.66)		(1.15)	(-1.52)	(1.54)

Notes: This table reports the output of two regressions, one in levels and one in first differences. The top of the column indicates the type of firm: pure processing firms ($\mathcal{P}$), non-importing exporters ($\mathcal{N}$), importing exporters ($\mathcal{I}$), and importing non-exporters ($\mathcal{I}${NX). Regressions include state-owned status, foreign-owned status, export status, log capital-labor ratio, and log sales as controls. The levels regression includes 56,549 observations and the R-squared is 0.43. The first-difference regression includes 16,984 observations and the R-squared is 0.39. Robust t-statistics (in parentheses) clustered at the firm level. Firms are classified into quartiles from low- to high-productivity according to their relative system-GMM TFP. The coefficients are statistically significant at the *10%, **5%, or ***1% level.

responses of firm-level employment — by firm type and productivity quartile — to a 1 percentage point decline in each type of tariff; *i.e.*, Figure 4 shows the negative of all those coefficients from Table 6 that are statistically significant at a 5% level. The figure makes evident the higher importance of Chinese final-good trade liberalization — relative to the other liberalization types — for all types of firms and across productivity quartiles.

Using as guide the theoretical results summarized in Table 2, the destruction in low and mid-

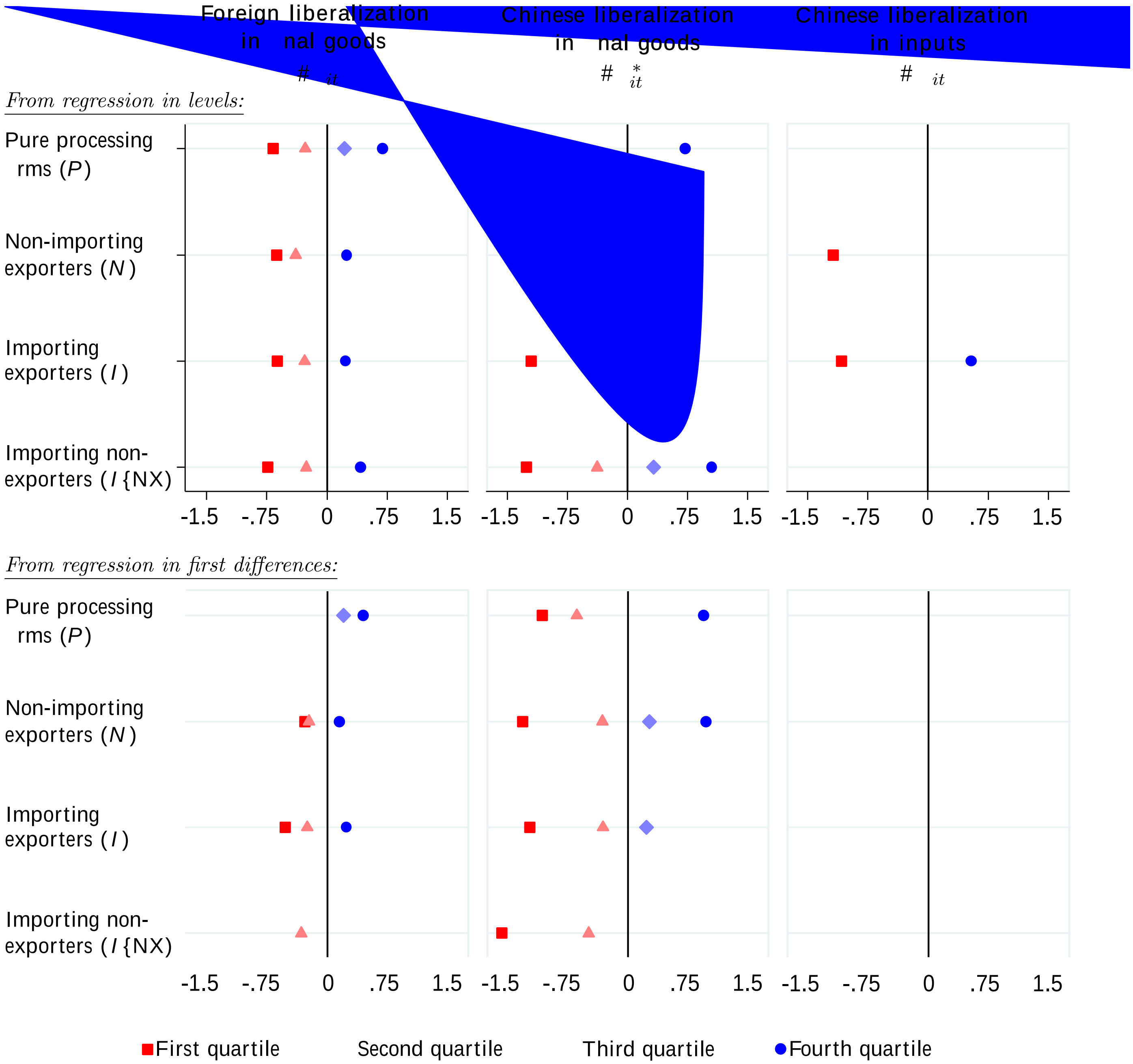


Figure 4: Employment Responses to a 1 Percentage Point Decline in Tari s (Statistically Signi cant at a 5% Level)

low productivity rms after foreign or Chinese trade liberalization in nal goods can be explained by competition e ects: trade liberalization increases competition, driving down aggregate prices | which shifts to the left the residual demand each rm faces | and causing rm-level employment reductions in low-productivity rms. There is lower destruction after a decline in foreign tari s because in that case only the foreign market becomes tougher and there are more countervailing forces, such as an easier competitive environment in the domestic market, the expansive direct effect on exporters (who become instantly more competitive in the foreign market), and possible efficiency gains for new pure processing firms and importers.

After Home trade liberalization in final goods, Table 2 shows sources of job creation only for firms that switch from non-importing to pure processing (from efficiency gains and market size effects) and for firms that switch from importing to non-importing (from task relocation effects). Hence, although the model provides insights on the channels that can explain job creation in high-productivity pure processing firms after a reduction in Chinese final-good tariffs, it faces limitations to explain the estimated job creation in other types of high-productivity firms. Combined with the observed job destruction in low-productivity firms, a potential explanation is the existence of market share reallocation effects from low and mid-low productivity firms to high-productivity firms within each firm type. This is a channel that is absent from our model, which obtains that all firms with the same status have the same employment elasticities to tariff changes.

After Chinese input trade liberalization, the regression in levels show statistically significant job destruction in low-productivity non-importing exporters, which by Table 2 can be explained by tougher competition in both markets. There is also job destruction in low-productivity importing exporters, which is explained by competition effects as well as by task relocation effects. High-productivity importing exporters show statistically significant job creation after input trade liberalization, which can be explained by sufficiently large efficiency gains — their marginal costs decline ($c(\hat{\ }_{\mathcal{I}})$ falls) — that allow them to charge lower prices and capture larger market shares. These results, however, lose their statistical significance in the first difference regression, which only shows job destruction in low productivity importing non-exporters.

Table 7 breaks down the first-difference regression results of Table 6 into its expansions and contractions components. After a decline in Foreign tariffs, an increase in expansions drives job creation in all types of high-productivity firms, while a reduction in expansions and an increase in contractions play a more balanced role in the net job destruction of low- and mid-low productivity firms. Similar results hold for a decline in Chinese final-good tariffs, with the additional result that mid-high productivity (third quartile) firms — with the exception of importing non-exporters — also have statistically significant job expansions. The result that after any type of final-good trade liberalization — but especially after a reduction in Chinese tariffs — job contractions also play an important role on net job destruction in low and mid-low productivity firms indicates that within firm type, there are large labor reallocation effects from low and mid-low productivity firms to mid-high and high-productivity firms. Lastly, after a decline in input tariffs, a reduction in expansions drives job destruction in the least productive importing non-exporters.

Table 7: Firm-Level Employment Expansions and Contractions by Firm Type

	Job expansions				Job contractions			
	(P)	(N)	(I)	(I{NX})	(P)	(N)	(I)	(I{NX})
Foreign tari ($_{it}$)								
First quartile	0.22	0.18*	0.20*	0.27	-0.02	-0.11	-0.32***	0.03
	(1.56)	(1.73)	(1.81)	(1.38)	(-0.12)	(-1.53)	(-2.89)	(0.15)
Second quartile	0.11*	0.13***	0.14***	0.18*	0.04	-0.10**	-0.11***	-0.14
	(1.76)	(2.87)	(2.77)	(1.75)	(0.95)	(-2.36)	(-3.34)	(-1.59)
Third quartile	-0.08	0.09*	0.05	-0.13	0.11**	0.03	0.05	-0.04
	(-1.19)	(1.80)	(1.06)	(-1.27)	(2.13)	(0.81)	(1.04)	(-0.40)
Fourth quartile	-0.35***	-0.14***	-0.17***	-0.27***	0.10	0.01	0.07*	-0.02
	(-2.58)	(-2.66)	(-2.96)	(-2.60)	(1.01)	(0.25)	(1.70)	(-0.25)
Chinese tari ($^{*}_{it}$)								
First quartile	0.67***	0.65***	0.79***	0.77***	-0.40***	-0.65***	-0.43***	-0.80***
	(4.58)	(5.41)	(5.95)	(3.18)	(-2.86)	(-4.73)	(-3.84)	(-4.14)
Second quartile	0.33***	0.17**	0.17**	0.27**	-0.32***	-0.15**	-0.14***	-0.22**
	(4.18)	(2.35)	(2.25)	(2.38)	(-4.94)	(-2.55)	(-2.65)	(-2.39)
Third quartile	-0.17**	-0.22***	-0.19***	-0.16	-0.01	0.05	0.04	-0.03
	(-2.20)	(-3.26)	(-2.86)	(-1.21)	(-0.20)	(0.91)	(0.77)	(-0.31)
Fourth quartile	-0.63***	-0.69***	-0.61***	-0.74***	0.31***	0.28***	0.15**	0.30***
	(-5.03)	(-8.43)	(-7.55)	(-5.54)	(3.65)	(4.60)	(2.36)	(2.80)
Input tari ($_{it}$)								
First quartile		0.50	0.42	1.24**		-0.04	-0.05	-0.27
		(1.54)	(1.52)	(2.40)		(-0.19)	(-0.24)	(-0.66)
Second quartile		0.11	0.21	0.06		-0.12	-0.04	0.04
		(0.73)	(1.46)	(0.18)		(-0.95)	(-0.48)	(0.16)
Third quartile		0.20	0.00	0.19		-0.01	-0.02	0.31
		(1.62)	(0.01)	(0.58)		(-0.10)	(-0.18)	(1.52)
Fourth quartile		0.07	-0.17	0.12		-0.09	0.10	-0.20
		(0.58)	(-1.07)	(0.75)		(-1.18)	(1.00)	(-1.45)

Notes: This table breaks down the results from the last four columns of Table 6 into its expansions and contractions components | the di erence between the expansions and contractions coe cients yield the net employment coe - cient. The top of the column indicates the type of rm: pure processing rms ($\mathcal{P}$), non-importing exporters ($\mathcal{N}$), importing exporters ($\mathcal{I}$), and importing non-exporters ($\mathcal{I}${NX}). Regressions include rst di erences of state-owned status, foreign-owned status, export status, log capital-labor ratio, and log sales as controls. Each regression includes 16,984 observations and the R-squared is 0.25 for the job expansions regression and is 0.21 for the job contractions regression. Robust t-statistics (in parentheses) clustered at the rm level. Firms are classi ed into quartiles from low- to high-productivity according to their relative system-GMM TFP. The coe cients are statistically signi cant at the *10%, **5%, or ***1% level.

4.4 Employment Responses of Switchers

The summary of our model in Table 2 includes a description of the employment responses to trade liberalization for rms that change their status to either pure processing (P), non-importing exporter (N), or importing exporter (I). This section looks at how switchers in our data respond to each type of tari , and relies on the model's implications to guide the interpretation of the observed empirical responses. Using rst-di erence regressions (for net employment changes, expansions, and contractions), Table 8 presents our results for switching firms.

For firms that switch to pure processing status, there is statistically significant job destruction by contraction for low-productivity firms after foreign trade liberalization. According to Table 2, the predicted job destruction by contraction is a consequence of the task relocation effect. However, the net employment effect is not statistically significant, likely as a consequence of expansions due to efficiency gains (firms have reductions in their marginal costs, which allow them to charge lower prices and capture larger market shares) and access to foreign markets that are larger than the no-longer accessible domestic market.

For switchers to P after Chinese liberalization in final goods (a reduction in *), we observe large and statistically significant net job creation for both mid-high and high-productivity firms. The main driver of the net effect is a decline in the rate of job contractions, but job expansions also play a significant role for the most productive firms. From Table 2, the net job creation for these switchers is likely a consequence of efficiency gains and a larger foreign market size. Note that there is also mildly statistically significant evidence of less job contraction for low and mid-low productivity switchers, though the predicted net job creation is not statistically significant. To sum up, these switching Chinese firms saw the decline in domestic tariffs as an opportunity to restructure and expand: facing a threat in the domestic market due to lower *, these Chinese firms decided to escape competition in the domestic market altogether by switching to pure processing status and, while focusing on a narrower set of tasks, expanded their employment to meet foreign demand.

For firms that switch to non-importing exporter status (N), there is statistically significant net job destruction in mid-low and mid-high productivity firms after a decline in foreign tariffs, whereas there are net job destruction in low-productivity firms and net job creation in mid-high and high productivity firms after a decline in Chinese final-good tariffs. From Table 2, the model does not predict switchers to N (from P or I), and therefore, the net job destruction in switchers to N is explained by channels that are not captured by our model, such as market share reallocations within each firm type. The net job creation in high-productivity N switchers after Chinese liberalization in final goods can also be explained by within-type market share reallocations, but also by strong task relocation effects from firms that stop importing inputs.

For switchers to importing exporter status (I), there is statistically significant net job creation (driven mostly by expansions) in high-productivity firms after reductions in either foreign tariffs or Chinese final-good tariffs. According to Table 2, the employment growth in these firms after a decline in foreign tariffs implies that job creation from easier domestic competition, the direct positive effect on exporters, and efficiency gains dominate the job destruction associated with task

Table 8: Estimation of Employment Response of Switchers

	Switchers to pure processing rm (*P*)	Switchers to non-importing exporter (*N*)	Switchers to importing exporter (*I*)

relocation effects and the tougher competitive environment abroad. The model does not predict switchers to I after Chinese liberalization in final goods (it predicts destruction in I firms due to tougher environments at home and abroad, along with switchers from I to N). An explanation is that these firms switch to I status to become more efficient competitors in both markets: facing tougher environments in both markets, the opportunity cost of restructuring to reduce marginal costs (by procuring inputs from abroad) declines. As firms switch to I, those with high productivity increase their employment as a result of efficiency gains and within-type reallocation effects.

5 Robustness

In the previous estimations, all types of trade liberalization were treated as exogenous. However, tariff formation could be endogenous in the sense that firm employment could have a reverse causality effect on tariff changes: with a fall in employment, workers could blame free trade policies and form labor unions to lobby the government for temporary trade protection (Bagwell and Staiger, 1990; Grossman and Helpman, 1994). Although this happens in developed countries like the United States (Goldberg and Maggi, 1999), it is less likely to happen in China because its labor unions are symbolic organizations (see, *e.g.*, Branstetter and Feenstra, 2002 and Chen, Yu and Yu, 2017).[14] Nevertheless, for the sake of completeness, we use an instrumental variables (IV) approach to control for such possible reverse causality.

Identifying a qualified instrument for tariffs is always a challenging task. Following Trefler (2004) and Amiti and Davis (2011), we use one-year lagged tariffs as instruments of the first difference in tariffs. Abstracting from firm type, Table 9 presents the IV second-stage results for the first difference of our specification in (32), with one-year lags of firm-level Chinese final-good tariffs, Chinese input tariffs, and foreign tariffs serving as instruments of their corresponding first-difference values. Column 1 in Table 9 shows first-difference OLS estimates, using normalized TFP as our measure of productivity (as in column 7 of Table 3). Column 3, which presents the IV estimation, shows coefficients that are all very close to their counterparts in column 1. All the estimates for are positive and significant, whereas all the estimates for are negative, larger in magnitude, and significant. Such results are consistent with our findings in the previous tables.

As described above, our firm-level Chinese final-good tariffs are constructed using equation (30), which makes the strong assumption that exported and domestic shares of a product are identical. However, China plays an important role in global supply chains and produces some intermediate goods that cannot be used in the domestic production sector, and as a consequence, the product

[14] In addition, the case for tariff endogeneity is weaker for firm-level specifications. Using plant-level specifications for employment growth in Canada, Trefler (2004) strongly rejects tariff endogeneity and mentions that "this likely reflects the fact that tariffs, even if endogenous to the industry, are exogenous to the plant."

Table 9: First-Difference IV Estimation

	OLS		IV				
	Relative SGMM	*De Loecker*	*Relative SGMM*				*De Loecker*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Foreign tariff ($_{it}$)	0.51***	0.402***	0.44***	0.39	0.48***	0.14	0.23
	(4.75)	(3.30)	(3.36)	(1.58)	(3.04)	(1.03)	(1.15)
Productivity	-1.78***	-0.750***	-1.57***	-1.23	-1.81***	-0.60	-0.39
	(-4.92)	(-3.30)	(-3.51)	(-1.57)	(-3.26)	(-1.35)	(-1.00)
Chinese tariff ($^{*}_{it}$)	2.36***	0.723***	2.08***	2.56***	1.77***	2.70***	1.10**
	(11.84)	(3.41)	(7.68)	(5.00)	(5.29)	(11.26)	(2.30)
Productivity	-8.97***	-1.756***	-9.22***	-11.43***	-8.05***	-9.45***	-3.37***
	(-14.37)	(-4.91)	(-10.60)	(-6.59)	(-7.97)	(-12.52)	(-3.74)
Input tariff ($_{it}$)	0.85**	0.597	1.22**	0.12	1.93***	1.02*	0.54
	(2.22)	(1.43)	(2.26)	(0.12)	(2.99)	(1.89)	(0.48)
Productivity	-2.47**	-1.100	-3.58**	-0.21	-5.67***	-2.99	-0.76
	(-2.03)	(-1.40)	(-1.96)	(-0.07)	(-2.58)	(-1.64)	(-0.33)
Chinese tariff level	Firm	Firm	Firm	Firm	Firm	Industry	Firm
Included industries	All	All	All	High GSC	Low GSC	All	All
Observations	16,975	9,709	16,975	6,021	10,954	14,848	9,709

Notes: All regressions include year fixed effects and first-differences of state-owned status, foreign-owned status, export status, log sales, and log capital per worker as controls. Robust t-statistics (in parentheses) clustered at the firm level. The coefficients are statistically significant at the *10%, **5%, or ***1% level.

composition of Chinese exports may be very different from the composition of products sold in the domestic market (Kee and Tang, 2016). Since this problem would bias the measure of firm-level final-good tariffs differently depending on the industry, we experiment with two robustness checks.

First we separate all firms into two groups: those belonging to highly-integrated global supply chain (GSC) sectors, and those belonging to lowly-integrated GSC sectors. After calculating each results remain robust.

Thus far, firm productivity is assumed to be exogenous and would not be affected by trade liberalization. However, there is a growing literature exploring firm-level productivity improvements in response to trade liberalization. Ignoring such productivity gains from trade liberalization may generate some estimation bias. To address this concern, we follow De Loecker (2013) and develop an augmented Olley-Pakes TFP by allowing firm-level productivity to react to changes in both foreign and home tariffs over time.[16] Hence, the OLS estimates in column 2 and the IV estimates in column 7 use "De Loecker's TFP" to measure firm productivity. Although the magnitudes of the coefficients are not directly comparable to those in columns 1 and 3 — because of the different productivity measures — they yield qualitatively similar results for the effects of foreign tariffs and Chinese final-good tariffs (the coefficients on inputs tariffs are statistically insignificant under De Loecker's TFP).

Lastly, Table 10 presents an IV robustness check that splits firms by status (pure processing firms, non-importing firms, importing firms, and importing non-exporters) and uses the high-TFP indicator as our measure of productivity. The table shows first-difference IV regressions for net employment changes using two sets of firms. The first four columns report the estimation results for all trading firms, which are comparable to the first-difference OLS estimates shown in the last four columns of Table 6. Note that although some of the estimated coefficients for low-productivity firms lose statistical significance, the IV estimation results are very close to the OLS results for high-productivity firms. The last four columns in Table 10 verify whether ownership status matters by estimating a separate IV regression for foreign-invested firms. The results are qualitatively similar to those presented in the first four columns. Hence, our main estimation results remain robust.

6 Conclusion

Using firm-level tariff measures, this paper separates out the effects of foreign and Chinese trade liberalization in final goods, as well as of Chinese trade liberalization in inputs, on Chinese employment in trading firms. We distinguish firms according to their productivity and type — pure processing, non-importing exporter, importing exporter, and importing non-exporter — and found that *(i)* for all types of firms, reductions in Chinese and foreign final-good tariffs are associated with job destruction in low-productivity firms and job creation in high-productivity firms, *(ii)* that after a reduction in input tariffs, there is job destruction in low-productivity firms, but not statistically significant job creation in high-productivity firms, and *(iii)* that of the three types of liberalization,

[16] Similar to De Loecker (2013), a firm's productivity process is given by $\varphi_{it+1} = g(\varphi_{it}, \tau_{it}, \tau^*_{it}, \lambda_{it}) + \varsigma_{it+1}$ where ς_{it+1} is the productivity innovation. This process adopts a fourth-order polynomial form, $g(\cdot) = \sum_{sm} \beta_{sm}(\varphi^s_{it}\tau^m_{it} + \varphi^s_{it}\tau^{*m}_{it} + \varphi^s_{it}\lambda^m_{it})$ for $s \in \{1,2,3,4\}$ and $m \in \{1,2,3,4\}$, with $E(\varsigma_{it+1}\tau_{it}) = 0$, $E(\varsigma_{it+1}\tau^*_{it}) = 0$, and $E(\varsigma_{it+1}\lambda_{it}) = 0$.

Table 10: First-Difference IV Estimation by Type of Firm

	All firms				Foreign invested firms			
	(P)	(N)	(I)	(I{NX)	(P)	(N)	(I)	(I{NX)
Foreign tariff ($_{it}$)								
First quartile	0.43	0.01	0.16	0.91**	0.58	0.26	0.25	0.71**
	(1.20)	(0.08)	(0.90)	(2.27)	(1.41)	(1.46)	(1.27)	(2.14)
Second quartile	0.10	0.24**	0.09	0.44**	0.14	0.40***	0.12	0.21
	(0.80)	(2.23)	(1.05)	(2.12)	(1.04)	(2.96)	(1.36)	(0.88)
Third quartile	-0.19	0.08	-0.11	-0.10	-0.16	0.04	-0.10	-0.19
	(-1.33)	(0.92)	(-1.12)	(-0.47)	(-0.98)	(0.42)	(-0.92)	(-0.68)
Fourth quartile	-0.75***	-0.15	-0.32***	-0.12	-0.74***	-0.12	-0.39***	-0.37*
	(-3.24)	(-1.38)	(-2.72)	(-0.49)	(-2.79)	(-0.83)	(-2.74)	(-1.70)
Chinese tariff ($^{*}_{it}$)								
First quartile	0.40	0.75**	0.73***	0.63	0.38	0.51*	0.58**	0.37
	(1.18)	(2.47)	(2.60)	(1.25)	(0.96)	(1.78)	(1.98)	(0.73)
Second quartile	0.03	-0.40**	-0.40**	0.01	0.13	-0.36**	-0.41**	-0.04
	(0.19)	(-2.50)	(-2.52)	(0.03)	(0.69)	(-2.01)	(-2.34)	(-0.17)
Third quartile	-0.62***	-0.90***	-0.79***	-0.39	-0.51**	-0.78***	-0.70***	-0.52*
	(-3.61)	(-5.62)	(-4.79)	(-1.42)	(-2.55)	(-4.23)	(-3.75)	(-1.65)
Fourth quartile	-1.14***	-1.48***	-1.20***	-1.47***	-1.02***	-1.38***	-1.02***	-1.45***
	(-4.39)	(-7.12)	(-6.17)	(-4.72)	(-3.52)	(-5.36)	(-4.59)	(-4.49)
Input tariff ($_{it}$)								
First quartile		0.05	-0.34	1.55		-0.31	-0.58	0.98
		(0.09)	(-0.74)	(1.30)		(-0.32)	(-1.12)	(0.95)
Second quartile		-0.16	-0.22	-0.47		-0.49	-0.21	-0.58
		(-0.56)	(-1.07)	(-1.00)		(-1.33)	(-0.87)	(-1.10)
Third quartile		-0.44*	-0.51*	-0.41		-0.62*	-0.61*	-0.64
		(-1.94)	(-1.70)	(-0.86)		(-1.78)	(-1.84)	(-1.02)
Fourth quartile		0.08	-0.26	1.03*		-0.24	-0.61	0.02
		(0.23)	(-0.79)	(1.83)		(-0.50)	(-1.40)	(0.04)

Notes: This table reports the output of two first-difference IV regressions, one using all trading firms, and the other using foreign-invested firms. The top of the column indicates the type of firm: pure processing firms ($\mathcal{P}$), non-importing exporters ($\mathcal{N}$), importing exporters ($\mathcal{I}$

A possible explanation to this result is the existence of *escape-competition* effects as described by Aghion *et al.* (2005): facing tougher competition, some firms decide to invest and expand as a way to "escape competition". This type of effect can be included in our model by introducing a lumpy investment decision with non-convex adjustment costs: tougher competition causes a reduction in the opportunity cost of investing, driving some firms to invest and expand. Another possible explanation is the existence of market share reallocations from low- to high-productivity firms within firm type. This is absent from our model because all firms of the same type have identical employment elasticities to tariff changes. Model's extensions that would capture within-type reallocations include assuming random fixed costs of trading activities, or assuming preferences with endogenous markups.

Due to data limitations, our analysis focuses on the intensive margin of employment: job creation and destruction due to expansions or contractions of existing trading firms. Hence, we miss all the job creation and destruction due to births and deaths of firms. Although more recent Chinese firm-level data is more reliable for the study of the extensive margin of employment, gathering and processing this data is a challenge by itself; this forces us to leave the study of the responses of the extensive margin of Chinese employment to trade liberalization as a future project.

References

Acemoglu, D., D. Autor, D. Dorn, G. H. Hanson, and B. Price (2016): \Import Competition and the Great US Employment Sag of the 2000s," *Journal of Labor Economics*, 34(S1), S141{S198.

Acemoglu, D., and D. H. Autor (2011): \Skills, Tasks and Technologies: Implications for Employment and Earnings," in *Handbook of Labor Economics*, vol. 4B, pp. 1043{1171.

Ackerberg, D. A., K. Caves, and G. Frazer (2015): \Identi cation Properties of Recent Production Function Estimators," *Econometrica*, 83(6), 2411{2451.

Aghion, P., N. Bloom, R. Blundell, R. Griffith, and P. Howitt (2005): \Competition and Innovation: An Inverted-U Relationship," *Quarterly Journal of Economics*, 120(2), 701{728.

Ahn, J., A. K. Khandelwal, and S.-J. Wei (2011): \The Role of Intermediaries in Facilitating Trade," *Journal of International Economics*, 84(1), 73{85.

Amiti, M., and D. R. Davis (2011): \Trade, Firms, and Wages: Theory and Evidence," *Review of Economic Studies*, 79(1), 1{36.

Arkolakis, C. (2010): \Market Penetration Costs and the New Consumers Margin in International Trade," *Journal of Political Economy*, 118(6), 1151{1199.

Autor, D. H., D. Dorn, and G. H. Hanson (2013): \The China Syndrome: Local Labor Market E ects of Import Competition in the United States," *American Economic Review*, 103(6), 2121{68.

Bagwell, K., and R. Staiger (1990): \A Theory of Managed Trade," *American Economic Review*, 80(4), 779{95.

Blundell, R., and S. Bond (1998): \Initial Conditions and Moment Restrictions in Dynamic Panel Data Models," *Journal of Econometrics*, 87(1), 115 { 143.

Brandt, L., and P. M. Morrow (2017): \Tari s and the Organization of Trade in China," *Journal of International Economics*, 104, 85{103.

Brandt, L., J. Van Biesebroeck, and Y. Zhang (2012): \Creative Accounting or Creative Destruction? Firm-Level Productivity Growth in Chinese Manufacturing," *Journal of Development Economics*, 97(2), 339{351.

Branstetter, L. G., and R. C. Feenstra (2002): \Trade and Foreign Direct Investment in China: A Political Economy Approach," *Journal of International Economics*, 58(2), 335{358.

Cai, H., and Q. Liu (2009): \Competition and Corporate Tax Avoidance: Evidence from Chinese Industrial Firms," *Economic Journal*, 119(537), 764{795.

Chaney, T. (2008): \Distorted Gravity: The Intensive and Extensive Margins of International Trade," *American Economic Review*, 98(4), 1707{21.

Chen, B., M. Yu, and Z. Yu (2017): \Measured Skill Premia and Input Trade Liberalization: Evidence from Chinese Firms," *Journal of International Economics*, 109, 31{42.

Combes, P.-P., G. Duranton, L. Gobillon, D. Puga, and S. Roux (2012): \The Productivity Advantages of Large Cities: Distinguishing Agglomeration From Firm Selection," *Econometrica*, 80(6), 2543{2594.

Dai, M., M. Maitra, and M. Yu (2016): \Unexceptional Exporter Performance in China? The Role of Processing Trade," *Journal of Development Economics*, 121, 177{189.

Davis, S. J., J. C. Haltiwanger, and S. Schuh (1996): *Job Creation and Destruction*. The MIT Press, Cambridge, MA.

De Loecker, J. (2013): \Detecting Learning by Exporting," *American Economic Journal: Microeconomics*, 5(3), 1{21.

Feenstra, R., H. Ma, and Y. Xu (2017): \U.S. Exports and Employment," mimeo, University of California, Davis.

Feenstra, R., and A. Sasahara (2017): \The China Shock, Exports and U.S. Employment: A Global Input-Output Analysis," mimeo, University of California, Davis.

Feenstra, R. C., and G. H. Hanson (1996): \Foreign Investment, Outsourcing, and Relative Wages," in *The Political Economy of Trade Policy: Papers in Honor of Jagdish Bhagwati*, ed. by R. C. Feenstra, G. M. Grossman, and D. A. Irwin. MIT Press, Cambridge, MA.

——— (1997): \Foreign Direct Investment and Relative Wages: Evidence from Mexico's Maquiladoras," *Journal of International Economics*, 42(3-4), 371{393.

Feenstra, R. C., and G. H. Hanson (2005): \Ownership and Control in Outsourcing to China: Estimating the Property-Rights Theory of the Firm," *Quarterly Journal of Economics*, 120(2), 729{761.

Feenstra, R. C., Z. Li, and M. Yu (2014): \Exports and Credit Constraints under Incomplete Information: Theory and Evidence from China," *Review of Economics and Statistics*, 96(4), 729{744.

Feng, L., Z. Li, and D. L. Swenson (2016): \The Connection Between Imported Intermediate Inputs and Exports: Evidence from Chinese rms," *Journal of International Economics*, 101, 86{101.

Gandhi, A., S. Navarro, and D. A. Rivers (2020): \On the Identi cation of Gross Output Production Functions," *Journal of Political Economy*, 128(8), 2973{3016.

Goldberg, P. K., and G. Maggi (1999): \Protection for Sale: An Empirical Investigation," *American Economic Review*, 89(5), 1135{1155.

Groizard, J. L., P. Ranjan, and A. Rodriguez-Lopez (2014): \O shoring and Jobs: The Myriad Channels of In uence," *European Economic Review*, 72, 221{239.

——— (2015): \Trade Costs and Job Flows: Evidence from Establishment-Level Data," *Economic Inquiry*, 53(1), 173{204.

Grossman, G. M., and E. Helpman (1994): \Protection for Sale," *American Economic Review*, 84(4), 833{50.

Grossman, G. M., and E. Rossi-Hansberg (2008): \Trading Tasks: A Simple Theory of O shoring," *American Economic Review*, 98(5), 1978{97.

Hsieh, C.-T., and Z. M. Song (2015): \Grasp the Large, Let Go of the Small: The Transformation of the State Sector in China," *Brookings Papers on Economic Activity*, Spring, 295{346.

Kee, H. L., and H. Tang (2016): \Domestic Value Added in Exports: Theory and Firm Evidence from China," *American Economic Review*, 106(6), 1402{1436.

Levinsohn, J., and A. Petrin (2003): \Estimating Production Functions Using Inputs to Control for Unobservables," *Review of Economic Studies*, 70(2), 317{341.

Lileeva, A., and D. Trefler (2010): \Improved Access to Foreign Markets Raises Plant-Level Productivity... for Some Plants," *Quarterly Journal of Economics*, 125(3), 1051{1099.

Ludema, R. D., A. M. Mayda, Z. Yu, and M. Yu (2021): \The Political Economy of Protection in GVCs: Evidence from Chinese Micro Data," *Journal of International Economics*, 131, 103479.

Ma, H., X. Qiao, and Y. Xu (2015): \Job Creation and Job Destruction in China during 1998{2007," *Journal of Comparative Economics*, 43(4), 1085{1100.

Melitz, M. J. (2003): \The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, 71(6), 1695{1725.

Mion, G., and L. Zhu (2013): \Import Competition from and O shoring to China: A Curse or Blessing for Firms?," *Journal of International Economics*, 89(1), 202 { 215.

Olley, G. S., and A. Pakes (1996): \The Dynamics of Productivity in the Telecommunications Equipment Industry," *Econometrica*, 64(6), 1263{97.

Pierce, J. R., and P. K. Schott (2016): \The Surprisingly Swift Decline of US Manufacturing Employment," *American Economic Review*, 106(7), 1632{1662.

Qiu, L. D., and M. Yu (2020): \Managerial E ciency and Product Line Decision under Market Competition and Expansion," *Journal of Economic Behavior and Organization*, forthcoming.

Topalova, P., and A. Khandelwal (2011): \Trade Liberalization and Firm Productivity: The Case of India," *Review of Economics and Statistics*, 93(3), 995{1009.

Trefler, D. (2004): \The Long and Short of the Canada-U. S. Free Trade Agreement," *American Economic Review*, 94(4), 870{895.

Yu, M. (2015): \Processing Trade, Tari Reductions, and Firm Productivity: Evidence from Chinese Firms," *Economic Journal*, 125(585), 943{988.

A Theoretical Appendix: Proofs

Proof of Lemma 1. We know that for every s, there exists a cutoff $\hat{\alpha}_s$ so that tasks in the range $[0, \hat{\alpha}_s)$ are produced inside the firm (with hired domestic labor), and tasks in the range $[\hat{\alpha}_s, 1]$ are procured using outside materials. From (3) and given $\hat{\alpha}_s$, it follows that $y_s(\alpha) = l$ if $\alpha < \hat{\alpha}_s$ and $y_s(\alpha) = A_{Ms} a_M(\alpha) m$ if $\alpha \geq \hat{\alpha}_s$, so that $Y_s = \left[\int_0^1 y_s(\alpha)^{\frac{\theta-1}{\theta}} d\alpha\right]^{\frac{\theta}{\theta-1}}$ can be rewritten as

$$Y_s = \left(\int_0^{\hat{\alpha}_s} l(\alpha)^{\frac{\theta-1}{\theta}} d\alpha + \int_{\hat{\alpha}_s}^1 [A_{Ms} a_M(\alpha) m(\alpha)]^{\frac{\theta-1}{\theta}} d\alpha\right)^{\frac{\theta}{\theta-1}}. \tag{A-1}$$

Optimality conditions requiere that $\frac{dY_s}{dl(\alpha)} = \frac{dY_s}{dl(\alpha')}$ and $\frac{dY_s}{dm(\alpha)} = \frac{dY_s}{dm(\alpha')}$ and therefore, $l(\alpha) = l(\alpha')$ and $a_M(\alpha)^{1-\theta} m(\alpha) = a_M(\alpha')^{1-\theta} m(\alpha')$.

Let L_s and M_s denote the total amounts of labor and materials used for the production of the task aggregator Y_s, so that

$$L_s = \int_0^{\hat{\alpha}_s} l(\alpha) d\alpha, \tag{A-2}$$

$$M_s = \int_{\hat{\alpha}_s}^1 m(\alpha) d\alpha. \tag{A-3}$$

Given that $l(\alpha) = l(\hat{\alpha}_s)$, it follows from (A-2) that $L_s = \hat{\alpha}_s l(\hat{\alpha}_s)$, and then

$$l(\alpha) = \frac{L_s}{\hat{\alpha}_s}. \tag{A-4}$$

Similarly, we know that $a_M(\alpha)^{1-\theta} m(\alpha) = a_M(\hat{\alpha}_s)^{1-\theta} m(\hat{\alpha}_s)$, which plugged into (A-3) yields $M_s = a_M(\hat{\alpha}_s)^{1-\theta} m(\hat{\alpha}_s) \int_{\hat{\alpha}_s}^1 a_M(\alpha)^{\theta-1} d\alpha$. It follows that

$$m(\alpha) = \frac{a_M(\alpha)^{\theta-1} M_s}{\int_{\hat{\alpha}_s}^1 a_M(\alpha)^{\theta-1} d\alpha}. \tag{A-5}$$

Plugging in (A-4) and (A-5) into (A-1) yields

$$Y_s = \left(\hat{\alpha}_s^{\frac{1}{\theta}} L_s^{\frac{\theta-1}{\theta}} + \phi_s(\hat{\alpha}_s)^{\frac{1}{\theta}} M_s^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}}. \tag{A-6}$$

where

$$\phi_s(\hat{\alpha}_s) \equiv \int_{\hat{\alpha}_s}^1 [A_{Ms} a_M(\alpha)]^{\theta-1} d\alpha. \tag{A-7}$$

Note that if $\theta = 1$, $\phi_s(\hat{\alpha}_s) = 1 - \hat{\alpha}_s$.

The second step is to obtain the unit cost for Y_s, which we call $c(\hat{\alpha}_s)$. For a firm with status s, $c(\hat{\alpha}_s)$ is the minimum cost, $L + p_{M_s} M_s$, such that $Y_s = 1$. The Lagrangean is then given by

$$\mathcal{L} = L + p_{M_s} M_s + \lambda \left[1 - \left(\hat{\alpha}_s^{\frac{1}{\theta}} L_s^{\frac{\theta-1}{\theta}} + \phi_s(\hat{\alpha}_s)^{\frac{1}{\theta}} M_s^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}}\right].$$

The rst order conditions are

$$1 \quad \$ \quad \hat{\alpha}_s^{\frac{1}{\theta}} L_s^{\frac{\theta-1}{\theta}} + {}_s(\hat{\alpha}_s)^{\frac{1}{\theta}} M_s^{\frac{\theta-1}{\theta}} {}^{\frac{1}{\theta-1}} \hat{\alpha}_s^{\frac{1}{\theta}} L_s^{-\frac{1}{\theta}} = 0 \tag{A-8}$$

$$p_{Ms} \quad \$ \quad \hat{\alpha}_s^{\frac{1}{\theta}} L_s^{\frac{\theta-1}{\theta}} + {}_s(\hat{\alpha}_s)^{\frac{1}{\theta}} M_s^{\frac{\theta-1}{\theta}} {}^{\frac{1}{\theta-1}} {}_s(\hat{\alpha}_s)^{\frac{1}{\theta}} M_s^{-\frac{1}{\theta}} = 0 \tag{A-9}$$

$$\hat{\alpha}_s^{\frac{1}{\theta}} L_s^{\frac{\theta-1}{\theta}} + {}_s(\hat{\alpha}_s)^{\frac{1}{\theta}} M_s^{\frac{\theta-1}{\theta}} = 1. \tag{A-10}$$

From (A-8) and (A-9) we get

$$M_s = \frac{{}_s(\hat{\alpha}_s) L_s}{p_{Ms}^{\theta} \hat{\alpha}_s} \tag{A-11}$$

which combined with (A-10) yields

$$L_{s,Y_s=1} = \frac{\hat{\alpha}_s}{\hat{\alpha}_s + {}_s(\hat{\alpha}_s) p_{Ms}^{1-\theta}{}^{\frac{\theta}{\theta-1}}}; \tag{A-12}$$

$$M_{s,Y_s=1} = \frac{{}_s(\hat{\alpha}_s) p_{Ms}^{-\theta}}{\hat{\alpha}_s + {}_s(\hat{\alpha}_s) p_{Ms}^{1-\theta}{}^{\frac{\theta}{\theta-1}}}. \tag{A-13}$$

It follows that $c(\hat{\alpha}_s) = L_{s,Y_s=1} + p_{Ms} M_{s,Y_s=1}$ is

$$c(\hat{\alpha}_s) = \left[\hat{\alpha}_s + {}_s(\hat{\alpha}_s) p_{Ms}^{1-\theta}\right]^{\frac{1}{1-\theta}}. \tag{A-14}$$

From (4) we know that $p_{Ms} = A_{Ms} a_M(\hat{\alpha}_s)$, which along with (A-7) implies that ${}_s(\hat{\alpha}_s) p_{Ms}^{1-\theta} = \int_{\hat{\alpha}_s}^{1} \left[\frac{a_M(\hat{\alpha}_s)}{a_M(\alpha)}\right]^{1-\theta} d$. Hence, we rewrite (A-14) as

$$c(\hat{\alpha}_s) = \left\{\hat{\alpha}_s + \int_{\hat{\alpha}_s}^{1} \frac{a_M(\hat{\alpha}_s)}{a_M(\ )}^{1-\theta} d \right\}^{\frac{1}{1-\theta}} < 1. \tag{A-15}$$

Taking the derivative of $c(\hat{\alpha}_s)$ with respect to $\hat{\alpha}_s$ we get

$$\frac{dc(\hat{\alpha}_s)}{d\hat{\alpha}_s} = \left\{\int_{\hat{\alpha}_s}^{1} \frac{a_M(\hat{\alpha}_s)}{a_M(\ )}^{1-\theta} d \right\} \frac{c(\hat{\alpha}_s)^{-\theta} a'_M(\hat{\alpha}_s)}{a_M(\hat{\alpha}_s)} > 0;$$

because $a_M(\ )$ is strictly increasing in . Note from (A-15) that $\lim_{\hat{\alpha}_s \to 1} c(\hat{\alpha}_s) = 1$. Given that $\hat{\alpha}_{\mathcal{P}} < \hat{\alpha}_{\mathcal{I}} < \hat{\alpha}_{\mathcal{N}}$, it is also the case that $c(\hat{\alpha}_{\mathcal{P}}) < c(\hat{\alpha}_{\mathcal{I}}) < c(\hat{\alpha}_{\mathcal{N}})$. □

Proof of Lemma 2. From the proof of Lemma 1 we know that the rm-level demand for domestic labor to produce for market r of a Home rm with productivity φ and status s is given by $L_{rs}(\varphi) = \hat{\alpha}_s c(\hat{\alpha}_s)^{\theta} Y_{rs}(\varphi)$. Given the production function and the iceberg trade cost the rm faces when exporting, the amount of task aggregator it requires to produce for market r is $Y_{rs}(\varphi) = \frac{\tau^{\mathbb{1}\{r=X\}} z_{rs}(\varphi)}{\varphi}$. Equations (27) and (28) then follow after noting that $z_{rs}(\varphi) = \frac{\sigma \pi_{rs}(\varphi)}{p_{rs}(\varphi)}$, with r $_{rs}(\varphi)$ given by (8), and $p_{rs}(\varphi) = \frac{\sigma}{\sigma-1} \frac{\tau^{\mathbb{1}\{r=X\}} c(\hat{\alpha}_s)}{\varphi}$. The two exceptions are a consequence of the ordering of the cuto levels ($\hat{\alpha}_{\mathcal{P}} < \hat{\alpha}_{D} < \hat{\alpha}_{X} < \hat{\alpha}_{\mathcal{I}}$) and of the assumption that pure processing rms are not allowed to access the domestic market. □

B Supporting Tables and Figures

Table B.1: Numerical Comparative Statics to Tari Reductions

	Benchmark ($\tau = \tau^* = 2$, $\lambda = 1.6$)	Foreign trade liberalization ($\tau = 1.6$)	Home trade liberalization in nal goods ($\tau^* = 1.6$)	Home trade liberalization in inputs ($\lambda = 1.4$)
$\hat{\ }_{\mathcal{I}}$	0.498	0.498	0.498	0.438
P	0.789	0.802	0.748	0.747
P^*	0.747	0.698	0.745	0.735
$\hat{\ }_{\mathcal{P}}$	0.544	0.465	0.545	0.553
$\hat{\ }_{D}$	0.674	0.926	0.778	0.758
$\hat{\ }_{X}$	1.204	1.031	1.208	1.224
$\hat{\ }_{\mathcal{I}}$	1.494	1.424	1.560	1.257
$\hat{\ }^*_{D}$	0.498	0.533	0.500	0.506
$\hat{\ }^*_{X}$	0.990	0.973	0.836	1.045
$\hat{\ }_{\mathcal{P}}$	0.283	0.283	0.283	0.283
$\hat{\ }_{\mathcal{N}}$	0.683	0.683	0.683	0.683
$\hat{\ }^*$	0.556	0.556	0.556	0.556

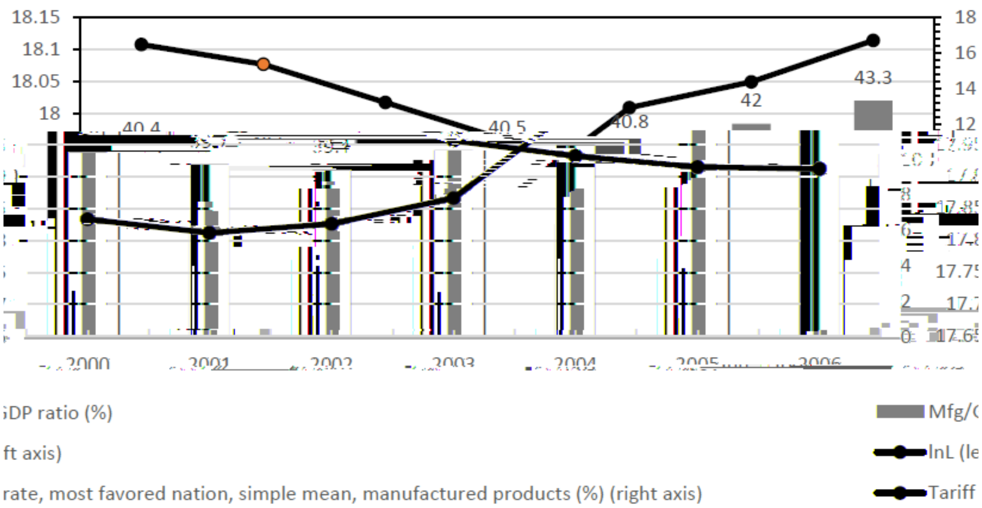


Figure B.1: Chinese Employment in the Manufacturing Sector and the MFN Tari Rate

Table B.2: Summary Statistics for Firm-Level Tariffs

Year	Foreign Tariffs (τ_{it})		Chinese Tariffs (τ^*_{it})		Input Tariffs (λ_{it})	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
2000	7.71	7.20	15.57	12.03	2.54	4.90
2001	8.16	7.72	12.39	9.40	2.37	5.06
2002	8.72	8.00	9.63	8.22	1.68	3.53
2003	7.46	6.88	8.82	7.51	1.94	3.70
2004	6.91	6.76	7.59	7.08	1.87	3.59
2005	6.90	6.64	7.00	6.78	1.71	3.53
2006	7.61	7.14	7.46	6.46	2.18	3.72
All years	7.47	7.10	8.29	7.65	1.98	3.82

Table B.3: Summary Statistics of Key Variables (2000–2006)

	Mean	Std. Dev.
Log of Firm Employment	5.54	1.18
System-GMM TFP	2.57	.408
Relative System-GMM TFP	.277	.086
High TFP Indicator	.517	.499
Log of Firm Sales	10.84	1.38
SOE Indicator	.015	.121
Foreign Indicator	.739	.439
Exporter Indicator	.849	.357

Table B.4: The Types of Chinese Trading Firms

	Fraction of each firm type (within sample)	
	2000	2006
Pure processing firms (P)	10.4	8.3
Non-importing exporters (N)	70.4	56.1
Importing exporters (I)	12.5	16.8
Importing non-exporters	6.7	18.8