Input Trade and Job Flows

Jose L. Groizard, Priya Ranjan, and Jose Antonio Rodriguez-Lopez*

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Abstract

We present theory and evidence of the impact of input trade costs on job flows. We construct a heterogeneous-firm model of trade in intermediate inputs that derives effects of input trade costs on both the extensive (due to births and deaths of firms) and intensive (due to expansions and contractions of firms) margins of employment. After a decline in input trade costs, the model predicts job destruction by death and contraction for non-importing firms, an ambiguous response for importing firms, a decline in the number of firms, and overall job destruction. Using a longitudinal database containing the universe of manufacturing establishments in California from 1992 to 2004, we find the relationship between job flows and input trade costs to be largely consistent with the theoretical predictions of our model.

Keywords: heterogeneous firms, job flows, input trade costs.
JEL codes: F12, F14, F16.

1 Introduction

The recent surge in input trade by U.S. firms coincided with large changes in domestic employment levels. In the U.S. computer and peripheral equipment industry, for example, the rise in input trade coincided with the sharpest decline in employment in the industry's history: according to the Quarterly Census of Employment & Wages (QCEW) of the Bureau of Labor Statistics (BLS), the industry lost about 44% of its workforce from 2001 to 2010. In comparison, the number of establishments in the industry declined by 28% over the same period. The large difference between the change in employment and the change in the number of establishments suggests different levels of importance for the intensive and extensive margins of employment—the intensive margin refers to job flows due to *expansions* and *contractions* of existing firms' employment, and the extensive margin refers to job flows due to *births* and *deaths* of firms. To what extent are the changes in job flows related to better input trade conditions? In this paper we analyze the impact of trade liberalization—as measured by lower input trade costs—on each of the components of the intensive and extensive margins of employment.

For this purpose, first we introduce a model of trade in intermediate inputs and job flows whose main ingredients are heterogeneous firms à la Melitz (2003) and heterogeneous input trade costs in the spirit of Grossman and Rossi-Hansberg (2008). In this model, a change in the fixed or variable cost of trading inputs has an impact on the four components of job flows: job creation by the expansion of existing firms, job creation by the birth of firms, job destruction by the contraction of existing firms, and job destruction by the death of firms. We then provide empirical evidence consistent with the model's predictions using a longitudinal database that includes the universe of establishments in California's manufacturing industry from 1992 to 2004.

Our model has two sectors: a differentiated-good sector and a homogeneous-good sector that serves as the numeraire. Firms in the differentiated-good sector are heterogeneous with respect to their productivity and assemble goods using a continuum of inputs. As in Melitz (2003), a differentiated-good firm knows its productivity only after incurring a sunk entry cost. If the productivity draw is good enough to cover the fixed cost of operating, then the firm undertakes production. Otherwise, it exits immediately. Moreover, after learning its productivity, a firm also has to decide what fraction of inputs it wants to produce domestically and what fraction to import. There are both fixed and variable costs of trading inputs. The inputs are ordered such that the variable cost of trading is higher for higher-indexed inputs. In this setting, we show that only some high-productivity firms import inputs.

The model shows that a decrease in the variable cost of trading inputs affects job flows at the intensive margin through three channels. First, the fraction of traded inputs increases, which reduces the domestic employment of importing firms. We call this the job-relocation effect. Second, importing firms become more productive as a result of lower input costs. This allows them to increase their market share and hence to increase their domestic employment. This is the productivity effect of input trade. Lastly, as the competitive environment becomes

tougher due to the decline in prices of importing firms, profits are negatively affected, and firms reduce their employment. We call this the market-access effect. Since non-importing firms experience only the market-access effect, they reduce their employment (job destruction by contraction). Due to the offsetting productivity effect, the employment response of importing firms is ambiguous.

At the extensive margin of employment, the model implies a decrease in the steady-state mass of firms as the variable cost of input trade declines. This is caused by the exit of some low productivity non-importing firms, which cannot survive the competition from (the now more productive) importing firms. Hence, there is net job destruction at the extensive margin. Overall, the net effect of a decline in the input trade cost on the differentiated-good sector's employment is job destruction. That is, the net job destruction at the extensive margin dominates any possible positive effect at the intensive margin.

From a broader perspective, the theoretical contribution of our paper lies in analyzing the impact of a decrease in input trade costs on the reallocation resources within a firm, across firms within an industry, and across industries. In particular, we identify job-relocation and productivity effects that lead to within-firm reallocation of resources, while the market-access effect leads to reallocation across firms within an industry. The model also implies a decrease in the mass of firms in the differentiated goods industry, which contributes to a reallocation of resources away from this industry. That is, resources move away from the industry experiencing a reduction in the input trading cost.

The model's implications translate into four empirical predictions. After a decline in input trade costs, the model predicts *(i)* job destruction by contraction in low-productivity firms, and an ambiguous response in high-productivity firms; *(ii)* an increase in the death probability of low-productivity firms; *(iii)* a decline in the number of firms in the industry; and *(iv)* net job destruction at the extensive margin, an ambiguous effect at the intensive margin, and net job destruction overall.

We have access to a longitudinal establishment-level data set that allows us to study the relationship between job flows and input trade costs. Given data constraints, our empirical exercise is not a formal test of the mechanisms identified in the model, but attempts to verify if the relationship between job flows and input trade costs is consistent with the predictions of the model.

Our data is an extract of the National Establishment Time Series (NETS) database that contains the universe of manufacturing establishments in California from 1992 to 2004. After showing that employment changes in California's manufacturing industry closely track national manufacturing employment changes, we use employment levels from the NETS data to create our establishment-level job-flow variables. Each establishment is classified into one of 390 manufacturing industries and, based on the establishment's sales per worker, we create a measure of relative productivity with respect to the establishment's industry peers.

Our input trade costs are created as follows. We first calculate industry output tariffs from the U.S. trade database of Feenstra, Romalis, and Schott (2002), and then we compute each industry's input tariff as a weighted average of the output tariffs. Following the approach

of Amiti and Konings (2007), we use the U.S. input-output matrix to calculate the weight of industry j's output tariff in the input tariff of industry i, as the share of industry j in industry i's total purchases.

We divide the empirical analysis in two parts: an establishment-level estimation (for the first and second predictions), and an industry-level estimation (for the third and fourth predictions). Moreover, in each of the regressions we control for output trade costs. This allows us to compare the empirical relevance for job flows of the channels identified in our model, against the empirical relevance of the channels implied by heterogeneous-firm models of trade in final goods.

Our establishment-level estimation results are consistent with the first and second predictions of the model. A decline in input trade costs is related to fewer job expansions and more job contractions for low-productivity establishments, and the opposite for high-productivity establishments. For the net effect at the intensive margin, we observe net job expansions even for the median-productivity establishment. This result suggests a strong productivity effect, which dominates the job-relocation and market-access effects for establishments with productivity levels on or above the median. Consistent with the second prediction, we find statistically significant evidence of an increase in the probability of low-productivity establishments dying after a decline in input trade costs. With respect to the effects of output trade costs in the establishment-level estimation, we find evidence consistent with the predictions on job flows given by heterogeneous-firm models of trade in final goods. However, at the intensive margin of employment, input trade costs are far more important than output trade costs for almost every type of establishment. In the probability-of-death regressions, although the input-trade-cost effect is larger in magnitude, the difference between it and the output-trade-cost effect is not statistically significant.

In our theoretical model, we do not take into account industry-level heterogeneity. Empirically, however, it is important to recognize that the effects of trade costs can differ from industry to industry. Hence, in the industry-level estimation, we introduce two measures of industry comparative advantage that allow us to capture a different effect for each industry. The first measure of comparative advantage is based on the ratio of non-production workers to total employment, and the second is based on total factor productivity growth. We find empirical evidence consistent with the third and fourth predictions of our model only for industries with comparative disadvantage. For these industries, the evidence we find is similar to the story described for the U.S. computer manufacturing industry in the opening paragraph of this paper: after a decline in input trade costs, the number of establishments and the level of employment decreases; however, the death of establishments explains only a small fraction of total job destruction.[1] As in the establishment-level estimation, the industry-level effects of input trade costs are stronger than the effects of output trade costs.

The paper is organized as follows. Section 2 highlights our paper's contribution relative to

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[1] We are implicitly assuming that the establishments that died in the U.S. computer manufacturing industry are the smallest (and least productive) ones. Given the large empirical literature on firm heterogeneity (see, for example, Bernard, Jensen, Redding, and Schott, 2007), this is a safe assumption, as an important stylized fact is that more productive firms are also larger.

the extant literature. Section 3 presents the model and section 4 shows its implications for the responses of job flows to changes in input trade costs. Section 5 shows some facts about the U.S. manufacturing industry and presents a brief description of the NETS's California data. In section 6, we perform the establishment- and industry-level estimations of the relationships between job flows and input trade costs. Finally, section 7 concludes.

2 Related Literature

In the Melitz (2003) model, firms employ only domestic labor and trade liberalization is modeled as a reduction in the variable cost of trading *final* goods. The model solves for two cutoff levels of productivity: one determines the tradability of the good in the domestic market, while the other—larger than the first one—determines the tradability of the good in the export market. A decline in the iceberg trade cost increases the cutoff level for selling domestically, while reducing the exporting cutoff level: although lower-productivity firms are now able to export, the competitive environment becomes tougher and some low-productivity (non-exporting) firms are forced to exit. These changes affect gross job flows. Bernard, Redding, and Schott (2007) explicitly address the predictions on gross job flows of Melitz's model in their Heckscher-Ohlin heterogeneous-firm model. They find that after trade liberalization in final goods, there is gross job destruction from two sources: the death of firms with productivity levels between the old a new domestic cutoff level, and the contraction of surviving non-exporting firms. On the other hand, there is gross job creation by expansion of existing and new exporting firms. Bernard, Redding, and Schott (2007) also find that the net employment effect of final-good trade liberalization is job creation in industries with comparative advantage, and job destruction in industries with comparative disadvantage.

In an important departure, this paper models trade liberalization as a reduction in input trade costs. Because of this difference, our model derives effects on gross job flows that are absent in the analysis of Bernard, Redding, and Schott (2007). In particular, our model obtains within-firm effects arising from the input-trade structure: the job-relocation effect and the productivity effect.[2] In the standard Melitz framework there is an aggregate-productivity increase after trade liberalization in final goods (due to both a selection effect—driven by the exit of low-productivity firms—and a market-share reallocation towards high-productivity firms), but the effective productivity of each firm never changes. In contrast, in our framework the reduction in input trade costs raises the effective productivity of some firms by allowing them to import inputs at a cheaper cost. Hence, after a decline in input trade costs, aggregate productivity increases in our model not only through the exit of low-productivity firms—which are driven out by the market-access effect of input trade liberalization—and market-share reallocations towards more productive firms, but also through the endogenous increase in the productivity of firms that import inputs.

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[2]The input-trade structure in our model is related to the trade-in-tasks structure of the model of Grossman and Rossi-Hansberg (2008). However, their model does not consider firm heterogeneity and hence, an extensive-margin channel is absent from their analysis.

Although in our theoretical model we abstract from trade in final goods (the effects on job flows would be similar to the effects described by Bernard, Redding, and Schott, 2007), in the empirical part we do distinguish between input trade costs and output trade costs, and compare their effects on gross job flows.

The within-firm productivity effect obtained in our model has strong empirical support. Amiti and Konings (2007), for example, use plant-level data from Indonesia and show that a decline in input tariffs increases plant-level productivity.[3] Moreover, they find that the input tariff effect is twice as large as the output tariff effect. More recently, Topalova and Khandelwal (2011) show similar results using firm-level data from India, with the difference that in India's case the positive effect of a decline in input tariffs on firm-level productivity is more than ten times larger than the effect of a similar decline in output tariffs.[4] In this paper, we do not look into the responses of firm-level productivity measures to input trade costs. Instead, we derive theoretically how the productivity effect, the relocation effect, and the market-access effect—all driven by a reduction in input trade costs—map into firm-level employment responses, and look for evidence of these responses in establishment-level job flows while controlling for output trade costs.

The focus on gross job flows, rather than on net employment changes, for the analysis of the effects of trade liberalization on the labor market is particularly relevant in a world with heterogeneous firms. It is not only true that net employment changes hide large changes in gross job flows (see Davis, Faberman, and Haltiwanger, 2006), but also the magnitude and direction of employment adjustments differ from firm to firm. Using Chilean plant-level data from 1979 to 1986, a period of trade liberalization, Levinsohn (1999) documents substantial differences in the rates of job creation and destruction across plants of different sizes: although the smallest plants are three times more likely to destroy jobs by firm death than the largest plants, the smallest plants have lower rates of both job creation by expansion and job destruction by contraction.[5] Similarly, Biscourp and Kramarz (2007) use French firm-level manufacturing data from 1986 and 1992 and find that there is a stronger relationship between import growth and job destruction for large firms than for small firms.

A related area of research has studied the effects of international factors on gross job flows. Klein, Schuh, and Triest (2003) analyze the effects of real exchange rate changes on job flows using industry-level data for the U.S. manufacturing sector from 1974 to 1993. They decompose the real exchange rate into its trend and cyclical components and find that the trend component has a similar effect on job creation and job destruction (with a nil net effect on employment), while the cyclical component has a net effect on employment only through job destruction. They also find that labor reallocation effects are larger in industries that are more

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[3]See also the references cited therein.

[4]In a related paper using the same Indian data, Goldberg, Khandelwal, Pavcnik, and Topalova (2010) find that a reduction in input tariffs increases the range of goods that a firm produces. In particular, they find that from 1989 to 1997, the decline in input tariffs in India accounted for 31% of the observed expansion in within-firm product scope.

[5]In advance of the heterogeneous-firm models of Bernard, Eaton, Jensen, and Kortum (2003) and Melitz (2003), Levinsohn concludes his paper by pointing out the need to include heterogeneous firms in international trade models in order to account for the observed differences in employment responses.

open to trade. Along the same lines, Moser, Urban, and di Mauro (2010) study the impact of real exchange rate changes on job flows using establishment-level data for Germany from 1993 to 2005. Working first with a balanced panel (with no establishment births or deaths), they find that the bulk of the employment adjustment to a stronger real exchange rate occurs through less job creation rather than through increased job destruction. This result, they argue, is due to rigid labor regulations that make job destruction by contraction very costly for German firms. Once they take into account firms' deaths—through bankruptcy—job destruction becomes relevant.

After a decline in input trade costs, our model predicts an increase in the death likelihood of low-productivity firms. The empirical approach we follow to see this pattern in data takes the form of a binary regression at the establishment level, where the dependent variable takes the value of 1 in the year an establishment dies (and zero otherwise). Bernard, Jensen, and Schott (2006b) work with a similar probability-of-death regression using plant-level data of U.S. manufacturing industries from 1987 to 1997. They find that—as predicted by heterogeneous-firm models of trade in final goods—a decline in trade costs increases the death probability of firms, with a larger increase for low-productivity firms. Given that the objective of Bernard, Jensen, and Schott (2006b) is to test several predictions of the seminal heterogeneous-firm models of Bernard, Eaton, Jensen, and Kortum (2003) and Melitz (2003), they focus their empirical analysis on output trade costs. In our probability-of-death regressions, however, we are able to gauge the importance of both input and output trade costs.

In a related paper—and closer in spirit to a story of trade in intermediate inputs—Bernard, Jensen, and Schott (2006a) study the impact of imports from low-wage countries on plant survival probabilities and employment growth in the U.S. manufacturing industry from 1977 to 1997. They find a negative relationship between plant survival rates and imports from low-wage countries. As well, they find that greater import penetration from low-wage countries has a negative impact on the employment growth of surviving firms, with a smaller effect for capital-intensive plants.[6]

3   The Model

In this section we present our model with heterogeneous firms and heterogeneous input trade costs. The model assumes a country with two sectors: a differentiated-good sector and a homogeneous-good sector. Production in the homogeneous-good sector uses only domestic labor, but heterogeneous firms in the differentiated-good sector can import a fraction of their inputs.

We begin by describing consumer preferences and the production structure, then we solve the firm's input-trade decision problem and derive some results on average prices, productivity, and the composition of firms, and lastly, we describe the free-entry condition and solve the model.

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[6]Supporting the findings of Bernard, Jensen, and Schott (2006a), but without looking at job flows, Ebenstein, Harrison, McMillan, and Phillips (2009) find that offshoring to low-wage countries negatively affects U.S. employment, though the effect is small.

3.1 Preferences and Production Structure

Consumers' preferences are defined over a continuum of differentiated goods in the set Ω and a homogeneous good. In particular, let us assume that the utility function for the representative consumer has the quasi-linear form:

$$U = \mu \ln Z + x, \tag{1}$$

where $Z = \left(\int_{\omega \in \Omega} z^c(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right)^{\frac{\sigma}{\sigma-1}}$ is an aggregator of differentiated goods and x represents the consumption of the homogeneous—and numeraire—good. In Z, $z^c(\omega)$ denotes the consumption of variety ω and $\sigma > 1$ represents the elasticity of substitution between differentiated goods. The parameter μ captures the intensity of preference for differentiated goods and, given quasi-linear preferences, is also the amount of expenditure on these goods.

From the utility function in (1), the representative consumer's demand function for variety ω is given by

$$z^c(\omega) = \frac{p(\omega)^{-\sigma}}{P_Z^{1-\sigma}} \mu, \tag{2}$$

where $p(\omega)$ is the price of variety ω and $P_Z = \left(\int_{\omega \in \Omega} p(\omega)^{1-\sigma} d\omega \right)^{\frac{1}{1-\sigma}}$ is the price of the basket of differentiated goods, Z.

Labor is the only factor of production. Each worker-consumer has one unit of labor to devote to production activities. The total size of the workforce is L. The production function for the numeraire good is simple: one unit of labor is required to produce one unit of the good. Hence—assuming that the market for the numeraire good is perfectly competitive—the domestic wage equals 1. Since each worker spends μ on differentiated goods, we assume $0 < \mu < 1$. Therefore, the total expenditure on differentiated goods is μL, and the market demand for variety ω is

$$z^D(\omega) = \frac{p(\omega)^{-\sigma}}{P_Z^{1-\sigma}} \mu L. \tag{3}$$

Firms in the differentiated-good sector are heterogeneous. The productivity of a producer is denoted by φ, and the distribution of the productivity levels of all differentiated-good producers is given by $K(\varphi)$, where $\varphi \in [\varphi_{\min}, \infty)$. As in Melitz (2003), each firm must pay a sunk entry cost of f_e in terms of the numeraire good, after which it will observe its realization of productivity drawn from $K(\varphi)$.

Each differentiated good is produced using a continuum of inputs in the interval $[0, 1]$. A firm with productivity φ can decide whether or not to import its inputs below $\alpha^*(\varphi)$, where $\alpha^*(\varphi) \in [0, 1]$.[7] In particular, the production function for a firm with productivity φ is given by $z(\varphi) = \varphi Y(\varphi)$, where

$$Y(\varphi) = \exp\left(\int_0^{\alpha^*(\varphi)} \ln y_f(\varphi, \alpha) d\alpha + \int_{\alpha^*(\varphi)}^1 \ln y_d(\varphi, \alpha) d\alpha \right) \tag{4}$$

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[7]Note that if $\alpha^*(\varphi) = 1$, the firm is producing its good only with foreign labor—after covering any type of fixed cost. This is equivalent to the import of a finished good.

is an inputs aggregator, with $y_f(\varphi, \alpha)$ denoting the firm's requirement of foreign input α, and $y_d(\varphi, \alpha)$ denoting the firm's requirement of domestic input α.

Let us assume that there is a fixed cost of operation, f. We denote the profit of a firm, gross of the fixed cost of operation, by π. Therefore, we can define the zero-profit cutoff productivity level, φ^*, as the level of productivity such that

$$\pi(\varphi^*) = f. \tag{5}$$

Firms with productivity below φ^* do not produce and exit immediately.

There are fixed and variable costs of trading inputs. If the firm decides to import inputs, it must pay a fixed cost of f_o units of the numeraire good. The foreign wage is given by $w < 1$ (also in terms of the numeraire). Moreover, foreign labor is not a perfect substitute for domestic labor. In particular, the production function for input α with country of origin r, for $r \in \{d, f\}$, for a firm with productivity φ is given by

$$y_r(\varphi, \alpha) = \begin{cases} \ell_d(\varphi) & \text{if } r = d \\ \frac{\ell_f(\varphi)}{\lambda h(\alpha)} & \text{if } r = f, \end{cases} \tag{6}$$

where $\ell_r(\varphi)$ denotes the amount of domestic (d) or foreign (f) labor devoted to the production of input α and, as in the model of Grossman and Rossi-Hansberg (2008), $\lambda h(\alpha) > 1$ accounts for the additional costs of making foreign-produced input α compatible with domestic inputs. The term $\lambda h(\alpha)$ involves a general component, λ, and an input-specific component, $h(\alpha)$. The inputs are ordered by their trade cost so that $h(\alpha)$ is strictly increasing in α. It follows that the marginal cost of input α equals 1 if the firm uses domestic labor, and $w\lambda h(\alpha)$ if the firm uses foreign labor.

Let $L_r(\varphi)$ denote the amount of labor from country r hired by a domestic firm with productivity φ. If it imports, it employs $\ell_f(\varphi) = \frac{L_f(\varphi)}{\alpha^*(\varphi)}$ in the production of each imported input and $\ell_d(\varphi) = \frac{L_d(\varphi)}{1 - \alpha^*(\varphi)}$ in the production of each domestic input. Hence, substituting the expressions in (6) into (4), we can rewrite the production function in terms of foreign and domestic labor as

$$z(\varphi) = \varphi \left(\frac{g(\alpha^*(\varphi))}{\lambda^{\alpha^*(\varphi)}} \right) \left(\frac{L_f(\varphi)}{\alpha^*(\varphi)} \right)^{\alpha^*(\varphi)} \left(\frac{L_d(\varphi)}{1 - \alpha^*(\varphi)} \right)^{1 - \alpha^*(\varphi)}, \tag{7}$$

where

$$g(\alpha^*(\varphi)) = \exp \left(- \int_0^{\alpha^*(\varphi)} \ln h(\alpha) d\alpha \right). \tag{8}$$

Note that if the firm does not import, $\alpha^*(\varphi) = 0$ and $z(\varphi)$ is just $\varphi L_d(\varphi)$. On the other hand, if $\alpha^*(\varphi) = 1$, $z(\varphi)$ equals $\frac{1}{\lambda}\varphi g(1) L_f(\varphi)$. But how does a firm with productivity φ choose $\alpha^*(\varphi)$? We now look into the import decisions of firms in the differentiated-good sector.

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3.2 The Firm's Decision to Import Inputs

The firm's decision to import inputs can be broken into two stages. In the first stage, a firm with productivity φ decides on the fraction of inputs, $\alpha^*(\varphi)$, to import. Given $\alpha^*(\varphi)$, in the second stage the firm decides on $L_d(\varphi)$ and $L_f(\varphi)$—the amount of domestic and foreign labor, respectively, to hire. The firm's problem is solved backwards. In this section we present the most important results and leave the details of the solution for section A.1 in the Appendix.[8]

Given the fixed cost of importing inputs, f_o, there exists an importing-inputs cutoff productivity level, φ_o^*, which divides existing firms into importing and non-importing firms: a firm imports inputs if and only if its productivity is no less than φ_o^* (*i.e.* $\alpha^*(\varphi) = 0$ if $\varphi < \varphi_o^*$). From the first-stage solution, we obtain that a firm with productivity $\varphi \geq \varphi_o^*$ imports a fraction $\alpha^* = h^{-1}\left(\frac{1}{w\lambda}\right)$ of inputs. This condition says that in the production of the marginal input, α^*, the firm is indifferent between hiring domestic or foreign labor.[9] Note that α^* does not depend on the firm's productivity, φ; that is, the proportion of inputs being imported is the same for all importing firms ($\alpha^*(\varphi) = \alpha^*$ if $\varphi \geq \varphi_o^*$).

From the second-stage solution, the domestic and foreign labor demands of a firm with productivity φ are, respectively, given by

$$L_d(\varphi) = (1 - \alpha^*(\varphi))\left(\frac{\sigma - 1}{\sigma}\right)^{\sigma} [\gamma(\alpha^*(\varphi), \lambda)\varphi P_Z]^{\sigma-1} \mu L \tag{9}$$

$$L_f(\varphi) = \alpha^*(\varphi)\left(\frac{\sigma - 1}{\sigma}\right)^{\sigma} [\gamma(\alpha^*(\varphi), \lambda)\varphi P_Z]^{\sigma-1}\left(\frac{\mu L}{w}\right), \tag{10}$$

where

$$\gamma(\alpha^*(\varphi), \lambda) \equiv \frac{g(\alpha^*(\varphi))}{(w\lambda)^{\alpha^*(\varphi)}}. \tag{11}$$

For non-importing firms, since $\alpha^*(\varphi) = 0$, we obtain $\gamma(0, \lambda) = 1$ because $g(0) = 1$. For importing firms, the term $\gamma(\alpha^*, \lambda)$ accounts for the (within-firm) productivity effect identified by Grossman and Rossi-Hansberg (2008). In the Appendix we prove that $\gamma(\alpha^*, \lambda) > 1$ for $\alpha^* \in (0, 1]$.

As φ_o^* separates out non-importing and importing firms, the gross-profit difference between an importing firm with productivity φ_o^* and a non-importing firm with the same productivity level must be identical to the fixed cost of importing inputs, f_o.[10] In the Appendix, we show that the gross profit of a firm with productivity φ is given by

$$\pi(\varphi) = \frac{[(\sigma - 1)\gamma(\alpha^*(\varphi), \lambda)\varphi P_Z]^{\sigma-1}}{\sigma^{\sigma}}\mu L. \tag{12}$$

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[8]The Appendix is available at http://www.socsci.uci.edu/~jantonio.

[9]The marginal cost of producing input α^* using domestic labor is 1, while the marginal cost of producing input α^* using foreign labor is $w\lambda h(\alpha^*)$.

[10]For firms with productivity levels below φ_o^*, gross profits of importing firms are larger than gross profits for non-importing firms, but the difference is not large enough to cover the fixed cost of importing inputs, f_o.

Hence, it follows that the cutoff φ_o^* satisfies

$$\left[1 - \frac{1}{\gamma(\alpha^*, \lambda)^{\sigma-1}} \right] \pi(\varphi_o^*) = f_o. \tag{13}$$

Assuming that $\varphi^* < \varphi_o^*$, so that there is a set of firms with productivity levels between φ^* and φ_o^*, which produce but do not import inputs, we divide equation (13) by (5) to obtain a relationship between the cutoff rules φ_o^* and φ^* given by

$$\varphi_o^* = \Gamma \varphi^*, \tag{14}$$

where

$$\Gamma \equiv \Gamma(\gamma(\alpha^*, \lambda), f, f_o) = \left[\frac{f_o}{f[\gamma(\alpha^*, \lambda)^{\sigma-1} - 1]} \right]^{\frac{1}{\sigma-1}}. \tag{15}$$

Note that in order for $\varphi^* < \varphi_o^*$, we need to satisfy that $f_o > f[\gamma(\alpha^*, \lambda)^{\sigma-1} - 1]$ so that $\Gamma > 1$. We assume this to be the case in the rest of the paper. Intuitively, equation (15) captures the fact that the larger the fixed cost of importing inputs, f_o, the greater the gap between the importing-inputs cutoff and the zero-profit cutoff. On the other hand, the greater the productivity benefits of importing inputs captured in $\gamma(\alpha^*, \lambda)$, the smaller the gap between the importing-inputs cutoff and the zero-profit cutoff. In the latter case, most of the surviving firms are likely to import inputs. A higher fixed cost of operation, f, also reduces the gap between the two cutoffs, essentially by making the zero-profit cutoff higher.

3.3   Prices, Average Productivity, and the Mass of Firms

As is usual in heterogeneous-firm models, we assume that the productivity of firms is Pareto distributed in the interval $[\varphi_{\min}, \infty)$. That is, the cumulative distribution function is $K(\varphi) = 1 - \left(\frac{\varphi_{\min}}{\varphi} \right)^\eta$, and the probability density function is given by $k(\varphi) = \eta \frac{\varphi_{\min}^\eta}{\varphi^{\eta+1}}$, where η is the parameter of productivity dispersion (a higher η implies less heterogeneity). As in the models of Chaney (2008) and Ghironi and Melitz (2005), which assume CES preferences and a Pareto distribution for productivity, our model requires that $\eta > \sigma - 1$ for a solution to exist.

With CES preferences, a firm's price is just a fixed markup over its marginal cost. Accordingly, from equation (A-5) in the Appendix, we obtain that the price of a firm with productivity φ is

$$p(\varphi) = \frac{\sigma}{\sigma - 1} \left[\frac{1}{\gamma(\alpha^*(\varphi), \lambda)\varphi} \right], \tag{16}$$

where $\frac{1}{\gamma(\alpha^*(\varphi), \lambda)\varphi}$ is the firm's marginal cost.

The aggregate price for the basket of differentiated goods, P_Z, is then given by

$$P_Z = \left[N \int_{\varphi^*}^{\infty} p(\varphi)^{1-\sigma} k(\varphi \mid \varphi \geq \varphi^*) d\varphi \right]^{\frac{1}{1-\sigma}}, \tag{17}$$

where N denotes the mass of active firms, and $k(\varphi \mid \varphi \geq \varphi^*)$ is the productivity distribution

of firms conditional on successful entry; that is,

$$k(\varphi \mid \varphi \geq \varphi^*) = \frac{k(\varphi)}{1 - K(\varphi^*)} = \eta \frac{\varphi^{*\eta}}{\varphi^{\eta+1}}. \tag{18}$$

Substituting equations (11) and (16) into equation (17), we rewrite the aggregate price as

$$P_Z = N^{\frac{1}{1-\sigma}} \frac{\sigma}{\sigma - 1} \left[\frac{1}{\bar{\varphi}} \right], \tag{19}$$

where

$$\bar{\varphi} = \left[\int_{\varphi^*}^{\varphi_o^*} \varphi^{\sigma-1} k(\varphi \mid \varphi \geq \varphi^*) d\varphi + \int_{\varphi_o^*}^{\infty} [\gamma(\alpha^*, \lambda)\varphi]^{\sigma-1} k(\varphi \mid \varphi \geq \varphi^*) d\varphi \right]^{\frac{1}{\sigma-1}}$$

is the average productivity of domestic active producers. Using equations (14), (15) and (18) in the previous equation, we obtain

$$\bar{\varphi} = \left[\frac{\eta}{\eta - \sigma + 1} \left(1 + \frac{f_o}{\Gamma^\eta f} \right) \right]^{\frac{1}{\sigma-1}} \varphi^*. \tag{20}$$

We can also derive an expression for the mass of firms, N. Substituting equation (19) into (12), we rewrite $\pi(\varphi)$ as

$$\pi(\varphi) = \frac{\mu L}{N \sigma} \left[\frac{\gamma(\alpha^*(\varphi), \lambda)\varphi}{\bar{\varphi}} \right]^{\sigma-1}. \tag{21}$$

Hence, given that $\gamma(\alpha^*(\varphi^*), \lambda) = \gamma(0, \lambda) = 1$ (as $\varphi^* < \varphi_o^*$), the zero-profit condition in equation (5) is equivalent to

$$\frac{\mu L}{N \sigma} \left[\frac{\varphi^*}{\bar{\varphi}} \right]^{\sigma-1} = f. \tag{22}$$

Solving for $\frac{\varphi^*}{\bar{\varphi}}$ in equation (20) and plugging in the result in (22), we solve for N as

$$N = \frac{\eta - \sigma + 1}{\eta \sigma} \left(\frac{\Gamma^\eta}{\Gamma^\eta f + f_o} \right) \mu L. \tag{23}$$

Note that N is increasing in Γ. In section 3.2 we point out that Γ is decreasing in $\gamma(\alpha^*, \lambda)$, so that φ^* and φ_o^* get closer to each other when the productivity effect—as measured by $\gamma(\alpha^*, \lambda)$—increases. It follows that N is also decreasing in $\gamma(\alpha^*, \lambda)$, as a larger productivity effect allows importing firms to capture a larger share of the market through lower prices, displacing low-productivity firms.

3.4 The Free-Entry Condition and Equilibrium

As in Melitz (2003), entry is unbounded. Every period, a potential firm will enter if the value of entry is no less than the required sunk entry cost, f_e. Given that the potential entrant knows

its productivity only after entry, the pre-entry expected profit for each period is given by

$$\bar{\pi} = \int_{\varphi^*}^{\varphi_o^*} [\pi(\varphi) - f]k(\varphi)d\varphi + \int_{\varphi_o^*}^{\infty} [\pi(\varphi) - f - f_o]k(\varphi)d\varphi,$$

which, using equation (21) and the Pareto distribution for productivity, can be written as

$$\bar{\pi} = \left[\frac{\varphi_{\min}}{\varphi^*}\right]^{\eta} \left[\frac{\mu L}{N\sigma} - f - \frac{f_o}{\Gamma^{\eta}}\right]. \tag{24}$$

At the end of every period, an exogenous death shock hits a fraction δ of the existing firms. Therefore, the value of entry is given by $\frac{\bar{\pi}}{\delta}$. Given unbounded entry, the free-entry condition is given by

$$\frac{\bar{\pi}}{\delta} = f_e. \tag{25}$$

Lastly, substituting equation (24) into (25) and replacing N by its equilibrium value in (23), we solve for the equilibrium cutoff productivity level as

$$\varphi^* = \varphi_{\min} \left[\frac{\sigma - 1}{\delta f_e(\eta - \sigma + 1)} \left(f + \frac{f_o}{\Gamma^{\eta}}\right)\right]^{\frac{1}{\eta}}. \tag{26}$$

The model is complete. Once we obtain the equilibrium levels of φ^*, α^*, and N, we can solve for the rest of the variables.

In steady state, the firms that die every period due to the exogenous death shock are exactly replaced by the mass of successful entrants. That is, if N_e denotes the mass of entrants every period, we have that $(1 - K(\varphi^*))N_e = \delta N$, where the left side represents the mass of successful entrants and the right side represents the mass of dying firms. Using the Pareto distribution of productivity and the equilibrium levels of φ^* and N, we can solve for N_e as

$$N_e = \frac{\sigma - 1}{\sigma \eta} \frac{\mu L}{f_e}. \tag{27}$$

Therefore, in this model the mass of entrants is constant. As changes in trade costs (λ and f_o) do not affect N_e, changes in the mass of successful entrants, $(1 - K(\varphi^*))N_e$, only occur through the effects of trade costs on φ^*.

4 Input Trade Costs and Job Flows

In this section we discuss the model's implications for the effects of a change in input trade costs on the intensive and extensive margins of employment in the differentiated-good sector. First, we describe the different channels through which input trade costs affect job flows and present a set of propositions containing the model's main results, and second, we indicate how these propositions translate into testable empirical predictions.

4.1   The Model's Main Results

Our measures of input trade costs are the general component of the variable cost of importing inputs, λ, and the fixed cost of importing inputs, f_o. Recall that the importing cost of a unit of input α is $w\lambda h(\alpha)$ for $\alpha \in [0,1]$ (where $h(\alpha)$ is the input-specific component of the importing cost), so that a decrease in λ implies a proportional decline in the importing costs of all inputs. We focus on the impact of a change in λ, and leave the discussion of a change in f_o for the end of the section.

The expression for the demand for domestic labor of a firm with productivity φ is given in equation (9). Upon substituting equation (19) into (9), and then using (22), we can rewrite the demand for domestic labor as

$$L_d(\varphi) = (1 - \alpha^*(\varphi))(\sigma - 1)f \left[\frac{\gamma(\alpha^*(\varphi), \lambda)\varphi}{\varphi^*} \right]^{\sigma-1}, \tag{28}$$

where $\alpha^*(\varphi)$ equals α^* for an importing firm and 0 for a non-importing firm, and $\gamma(\alpha^*(\varphi), \lambda)$ equals $\gamma(\alpha^*, \lambda) > 1$ for an importing firm and 1 for a non-importing firm. Using this information, we can write $L_d(\varphi)$ according to the firm's import status, so that $L_d(\varphi) = L_d^d(\varphi)$ if the firm employs only domestic labor, and $L_d(\varphi) = L_d^o(\varphi)$ if the firm imports inputs. Hence,

$$L_d(\varphi) = \begin{cases} L_d^d(\varphi) = (\sigma - 1)f \left[\frac{\varphi}{\varphi^*} \right]^{\sigma-1} & \text{if } \varphi \in [\varphi^*, \varphi_o^*) \\ L_d^o(\varphi) = (1 - \alpha^*)(\sigma - 1)f \left[\frac{\gamma(\alpha^*, \lambda)\varphi}{\varphi^*} \right]^{\sigma-1} & \text{if } \varphi \in [\varphi_o^*, \infty). \end{cases} \tag{29}$$

Therefore, the elasticity of demand for domestic labor with respect to the general input trade cost, λ, of an existing firm with productivity φ is given by

$$\zeta_{L_d(\varphi), \lambda} = \begin{cases} \zeta_{L_d^d(\varphi), \lambda} = -(\sigma - 1)\zeta_{\varphi^*, \lambda} & \text{if } \varphi \in [\varphi^*, \varphi_o^*) \\ \zeta_{L_d^o(\varphi), \lambda} = -\frac{\alpha^*}{1 - \alpha^*}\zeta_{\alpha^*, \lambda} + (\sigma - 1)\zeta_{\gamma(\alpha^*, \lambda), \lambda} - (\sigma - 1)\zeta_{\varphi^*, \lambda} & \text{if } \varphi \in [\varphi_o^*, \infty), \end{cases} \tag{30}$$

where each $\zeta_{\cdot, \lambda}$ represents an elasticity with respect to λ. Note that equation (30) shows the labor demand response of an existing firm that does not change its import status after a change in λ. It misses, however, the labor demand response of a firm whose import status changes: an initially non-importing firm that starts to import, and *vice versa*. More explicitly, in equation (30) we use the importing-inputs cutoff rule, φ_o^*, to separate non-importing and importing firms, but φ_o^* also changes with λ.[11] In particular, given that $\varphi_o^* = \Gamma \varphi^*$, it follows that $\zeta_{\varphi_o^*, \lambda} = \zeta_{\Gamma, \lambda} + \zeta_{\varphi^*, \lambda}$. Therefore, if φ_o^* declines after a change in λ, those firms between the new and old φ_o^* face a discontinuity in their domestic labor demands as they begin to import inputs. Throughout the rest of the section, we point out the differences between the labor demand responses of firms that change their import status and firms that do not change it.

At the intensive margin, we can identify three effects on the demand for domestic la-

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[11] Evidently, φ^* also changes with λ, and hence, equation (30) also ignores the domestic employment loss of a firm that dies (if its productivity is below a new and higher φ^*), and the domestic employment gain of a newborn firm (after a decrease in φ^*). These are employment changes at the extensive margin and are discussed below.

bor when λ changes: a *job-relocation effect*, a *productivity effect*, and a *market-access effect*. The first two effects lead to within-firm reallocation of resources, while the market-access effect leads to reallocation of resources across firms within the industry. For firms that do not change their import status, these three effects are respectively given by $-\frac{\alpha^*}{1-\alpha^*}\zeta_{\alpha^*,\lambda}$, $(\sigma-1)\zeta_{\gamma(\alpha^*,\lambda),\lambda}$, and $-(\sigma-1)\zeta_{\varphi^*,\lambda}$ in equation (30). For the firms that change their import status, the effects are respectively accounted for by the magnitude of α^*, the magnitude of $\gamma(\alpha^*,\lambda)$, and the change in φ^*. The following lemma presents results that will help us in the analysis of these intensive-margin effects.

Lemma 1. *The elasticities of α^*, $\gamma(\alpha^*,\lambda)$, φ^*, and Γ with respect to λ are given by*

i) $\zeta_{\alpha^*,\lambda} = -\frac{h(\alpha^*)}{\alpha^* h'(\alpha^*)} < 0,$

ii) $\zeta_{\gamma(\alpha^*,\lambda),\lambda} = -\alpha^* < 0,$

iii) $\zeta_{\varphi^*,\lambda} = -\alpha^* \left(\frac{\Gamma^{\sigma-1}f+f_o}{\Gamma^\eta f+f_o} \right) \in (-\alpha^*, 0),$

iv) $\zeta_{\Gamma,\lambda} = \alpha^* \left(\frac{\Gamma^{\sigma-1}f+f_o}{f_o} \right) > \alpha^*.$

In our setup, a decrease in the variable cost of trading inputs leads to a greater fraction of inputs being imported, that is, $\zeta_{\alpha^*,\lambda} < 0$. Since the jobs associated with the production of these inputs are relocated abroad, we use the term "job relocation" to refer to this effect on domestic labor demand. A decrease in the input trade cost improves the productivity of firms engaged in input trade (as they can purchase abroad a particular input at a lower cost). As a result, $\gamma(\alpha^*,\lambda)$ increases as λ declines; that is, $\zeta_{\gamma(\alpha^*,\lambda),\lambda} < 0$. The increased productivity of importing firms allows them to steal market share from non-importing firms, and hence to expand domestic employment. Thus, we label the associated domestic employment change as "productivity effect." The lost market share for non-importing firms—with its negative effect on gross profits—implies that the productivity required to exactly meet the fixed cost of production is larger. That is, the cutoff productivity level below which firms exit, φ^*, rises after a decline in λ ($\zeta_{\varphi^*,\lambda} < 0$). Hence, we label the change in domestic employment associated with the change in φ^* a "market-access effect." Lastly, Γ—the proportional wedge between φ^* and φ_o^*—declines after the decrease in λ (*i.e.* $\zeta_{\Gamma,\lambda} > 0$). Moreover, $\zeta_{\Gamma,\lambda}$ dominates $\zeta_{\varphi^*,\lambda}$, which implies that $\zeta_{\varphi_o^*,\lambda} = \zeta_{\Gamma,\lambda} + \zeta_{\varphi^*,\lambda} > 0$, so that less productive firms start importing inputs after the decline in λ. Using equation (30) and Lemma 1, we can write the following proposition for the effect of a change in the variable cost of trading inputs on firm-level expansions and/or contractions of employment.

Proposition 1. *(Input trade costs and firm-level employment)*

For domestic active producers (with productivity no less than φ^*), a decline in λ decreases the demand for domestic labor of non-importing firms, and has an ambiguous effect on the demand for domestic labor of (new and existing) importing firms.

Proposition 1 concerns firm-level decisions on job creation by expansion, and job destruction by contraction. For firms that do not change their import status, the results are

given by the signs of $\zeta_{L_d^d(\varphi),\lambda}$ and $\zeta_{L_d^o(\varphi),\lambda}$ in equation (30). In particular, the proposition states that $\zeta_{L_d^d(\varphi),\lambda} > 0$, and that the sign is ambiguous for $\zeta_{L_d^o(\varphi),\lambda}$. Note that for non-importing firms, only the market-access effect matters after a decline in λ. These firms release labor (job destruction by contraction) as they lose market share to more productive importing firms. For old importing firms, the productivity effect generates an increase in the demand for domestic labor after a decline in λ. This effect dominates the contraction in domestic labor implied by the market-access effect (see proof in the Appendix). However, the fraction of imported inputs increases, so that importing firms release domestic labor that was employed in the production of inputs between the old and new α^*. In the end, the effect on the demand for domestic labor is ambiguous for old importing firms. For firms that start importing inputs after the decline in λ (those firms whose labor demand changes from $L_d^d(\varphi)$ to $L_d^o(\varphi)$ due to the decrease in φ_o^*), we observe similar opposing effects. On the one hand, we observe that as φ^* increases (market-access effect) and $\alpha^*(\varphi)$ changes from 0 to α^* (job-relocation effect), the demand for domestic labor decreases. On the other hand, as $\gamma(\alpha^*(\varphi),\lambda)$ moves from 1 to $\gamma(\alpha^*,\lambda)$ (productivity effect), the demand for domestic labor increases. As with old importing firms, the final effect on the demand for domestic labor is ambiguous for new importing firms.

A change in input trade costs affects the number of firms in the economy and hence affects employment through the extensive margin as well. From the end of section 3.4, note that we can write N as

$$N = (1 - K(\varphi^*))\frac{N_e}{\delta}, \tag{31}$$

where the number of entrants, N_e, is constant and given by (27). The following proposition describes the changes in the mass of active firms when λ declines.

Proposition 2. *(Input trade costs and the mass of active firms)*

The mass of firms, N, declines after a decrease in λ. This decline is completely accounted for by the death of firms between the old and new φ^*.

Note that a change in the input trade cost affects N only through its effect on the probability of successful entry, $1 - K(\varphi^*)$. As φ^* increases after a decrease in λ, it follows that $1 - K(\varphi^*)$ declines, and those firms between the old and new φ^* die. This result implies net job destruction at the extensive margin after a decline in λ.[12]

Now, we can separate out the extensive- and intensive-margin components of net employment changes for the industry as a whole. The employment level in the differentiated-good sector is given by $L_Z = N\bar{L}_d$, where $\bar{L}_d = \int_{\varphi^*}^{\infty} L_d(\varphi)k(\varphi \mid \varphi \geq \varphi^*)d\varphi$ denotes the average domestic employment of active firms. Using equations (31) and (18), we rewrite the total employment in the differentiated-good sector as $L_Z = \frac{N_e}{\delta}\int_{\varphi^*}^{\infty} L_d(\varphi)k(\varphi)d\varphi$. Thus, we get

$$L_Z = \frac{N_e}{\delta}\left[\int_{\varphi^*}^{\varphi_o^*} L_d^d(\varphi)k(\varphi)d\varphi + \int_{\varphi_o^*}^{\infty} L_d^o(\varphi)k(\varphi)d\varphi\right]. \tag{32}$$

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[12]Although there is job creation from successful entrants, in steady state these jobs exactly replace the job losses of firms receiving the death shock.

Taking the derivative of equation (32) with respect to λ (using Leibniz's rule), we find that the effect of λ on L_Z can be decomposed into its extensive- and intensive-margin components as

$$\frac{dL_Z}{d\lambda} = \underbrace{\left[-L_d^d(\varphi^*)k(\varphi^*)\frac{d\varphi^*}{d\lambda} \right] \frac{N_e}{\delta}}_{\text{Net extensive margin}} +$$

$$\underbrace{\left[(L_d^d(\varphi_o^*) - L_d^o(\varphi_o^*))k(\varphi_o^*)\frac{d\varphi_o^*}{d\lambda} + \int_{\varphi^*}^{\varphi_o^*} \frac{dL_d^d(\varphi)k(\varphi)}{d\lambda} d\varphi + \int_{\varphi_o^*}^{\infty} \frac{dL_d^o(\varphi)k(\varphi)}{d\lambda} d\varphi \right] \frac{N_e}{\delta}}_{\text{Net intensive margin}}. \qquad (33)$$

The following proposition looks at each of the components of equation (33).

Proposition 3. *(Input trade costs and net changes in employment)*
A decline in λ has the following effects on domestic employment in the differentiated-good sector:

   i) *net job destruction at the extensive margin;*

   ii) *an ambiguous net effect at the intensive margin: although there is job destruction by contraction in surviving non-importing firms, there is an ambiguous effect for new and existing importing firms;*

   iii) *in spite of the intensive-margin ambiguity, there is net job destruction overall.*

The first part of Proposition 3—which is also implied by Proposition 2—refers to the positive sign of the net-extensive-margin component in equation (33): following a decline in λ, the net-extensive-margin component accounts for the destruction of domestic jobs due to the death of firms between the old and new φ^*. The second part of Proposition 3 concerns the signs and relative magnitudes of the three net-intensive-margin components in equation (33). The first net-intensive-margin term accounts for domestic employment changes of firms that change their import status, while the second and third terms account for domestic employment expansions or contractions of firms that do not change their import status (existing non-importing firms in the second term, and existing importing firms in the third term). Expanding the results in Proposition 1, we obtain that even though surviving non-importing firms destroy domestic labor by contraction after a decline in λ (positive sign for the second term), the ambiguous domestic employment response of new and existing importing firms (ambiguous signs for the first and third terms) carries over to the overall net intensive-margin effect. Lastly, the third part of Proposition 3 refers to the positive sign of $\frac{dL_Z}{d\lambda}$: after a decline in λ, there is net destruction of domestic employment as the job destruction at the extensive margin cancels out any possible job creation at the intensive margin.

The implications of a decline in the fixed cost of importing inputs, f_o, on job flows are, in general, similar to the effects of a decline in λ. The following proposition describes these results.

Proposition 4. *(The fixed cost of importing inputs and employment)*

　After a decline in f_o:

  i) *there is a decrease in the demand for domestic labor of active firms that do not change their import status, and an ambiguous response in the demand for domestic labor of firms that change their import status (new importing firms);*

  ii) *the mass of firms and domestic employment respond as in Propositions 2 and 3, with the exception of a job-destruction response (by contraction) of existing importing firms—as opposed to an ambiguous response in Proposition 3 ii).*

　　Compared to the effects of a decline in λ, the key difference in Proposition 4 comes from the fact that there are no productivity and job-relocation effects for continuing importing firms—note that α^* and $\gamma(\alpha^*, \lambda)$ do not depend on f_o. As with the employment of continuing non-importing firms, the only effect for continuing importing firms is the market-access effect and hence, their employment decreases after a decline in f_o. Nevertheless, the productivity and job-relocation effects are present for firms that switch from no importing to importing inputs, and the impact of a decline in f_o on their domestic employment is ambiguous.

4.2　The Model's Reduced-Form Predictions

Ideally, one would like to test the predictions of the model using firm-level data on job flows and input-trade variables (*e.g.* import status and the fraction of imported inputs by firm). However, we do not have firm-level input-trade data and hence, we rely on reduced-form predictions based on firm-level variables on job flows and productivity, and industry-level input trade costs. Drawing on the previous propositions, we obtain the following reduced-form relationships between input trade costs and job flows.

Empirical predictions. *A decline in variable input trade costs causes:*

  1. *job destruction by contraction in low-productivity firms and an ambiguous response (either job creation by expansion or job destruction by contraction) in high-productivity firms;*

  2. *an increase in the death likelihood of low-productivity firms;*

  3. *a decline in the number of firms in the industry;*

  4. *net job destruction at the extensive margin, an ambiguous net effect at the intensive margin, and net job destruction overall.*

　　Under the premise that less productive firms are less likely to import inputs than more productive firms, Prediction 1 follows directly from Proposition 1. Predictions 2 and 3 come from Proposition 2, as the least productive firms are expected to die after a decline in input trade costs, driving a decrease in the number of firms. Lastly, Prediction 4 follows Proposition 3. With respect to the empirical implications of Proposition 4, Predictions 2, 3, and 4 also

hold for a decline in the fixed cost of importing inputs; the only difference lies in a part of Prediction 1, as in this case some of the high-productivity firms unambiguously destroy labor by contraction. In the empirical exercise below, however, we consider only variable input trade costs, and hence focus on the four predictions listed above.

5   The U.S. Manufacturing Industry and the California Data

If we want to understand the relationship between trade costs and job flows in the United States, manufacturing is the key sector to study.[13] Although we do not have access to firm-level employment data for the entire country, we use an extract of the National Establishment Time Series (NETS) database, which contains the universe of establishments in California's manufacturing industry from 1992 to 2004.

In this section, first we describe general facts about the U.S. manufacturing industry; second, we present evidence of the high correlation between employment in California and in the entire country; third, to verify the reliability of California's NETS data, we compare it to aggregate employment measures for California from the Quarterly Census of Employment and Wages (QCEW) of the Bureau of Labor Statistics (BLS); and fourth, using our data, we present some stylized facts about the evolution of the different components of job flows.

Figure 1 presents general facts about the U.S. manufacturing industry. Figure 1a shows the evolution of the employment level and real GDP in manufacturing since 1949. The volatility of the employment level is substantial. Moreover, from 2000 to 2003, the manufacturing industry suffered its largest employment change in a three-year period, with a loss of about 2.86 million jobs.[14] Although this represents the loss of 16.4% of manufacturing jobs, the real GDP in the industry fell only about 1.8% over the period. By 2007, even though the employment level had continued to decline at a moderate pace (nearly reaching its 1949 levels), real GDP was 13.5% higher than in 2000. Therefore, the decline in the importance of manufacturing in total U.S. GDP—as observed in Figure 1b—does not mean that U.S. manufacturing production is shrinking, but just that it is growing at a slower rate than other sectors of the economy. Figure 1b shows, however, that manufacturing imports have increased dramatically as proportion of U.S. GDP since 1990, reaching more than 11% by 2008, and very close to the domestic manufacturing production's share of GDP.

California has the country's largest economy and population. In 2007, the state accounted for 13.1% of U.S. GDP and 12% of the country's population, according to the Bureau of Economic Analysis (BEA) and the Census Bureau.[15] It accounted for 11.3% of U.S. manufac-

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[13]According to data from the United States International Trade Commission (USITC), U.S. manufacturing imports accounted for about 92% of the U.S. total non-oil imports for each year from 1990 to 2008. In 2007, the size of U.S. manufacturing imports was 11.2% as proportion of GDP. Putting this number in perspective with respect to the three major trading partners of the U.S., 11.2% of the U.S. GDP in 2007 was equivalent—according to the World Economic Outlook of the International Monetary Fund—to 108% of Canada's GDP, 46% of China's GDP, and 151% of Mexico's GDP.

[14]For the entire labor force there was a loss of about 1.52 million jobs during the same period.

[15]According to the IMF's WEO database, the size of California's economy in 2007 (in nominal U.S. dollars) would place it as the eighth-largest economy in the world—just below Italy and above Spain, Canada, Brazil, and Russia.
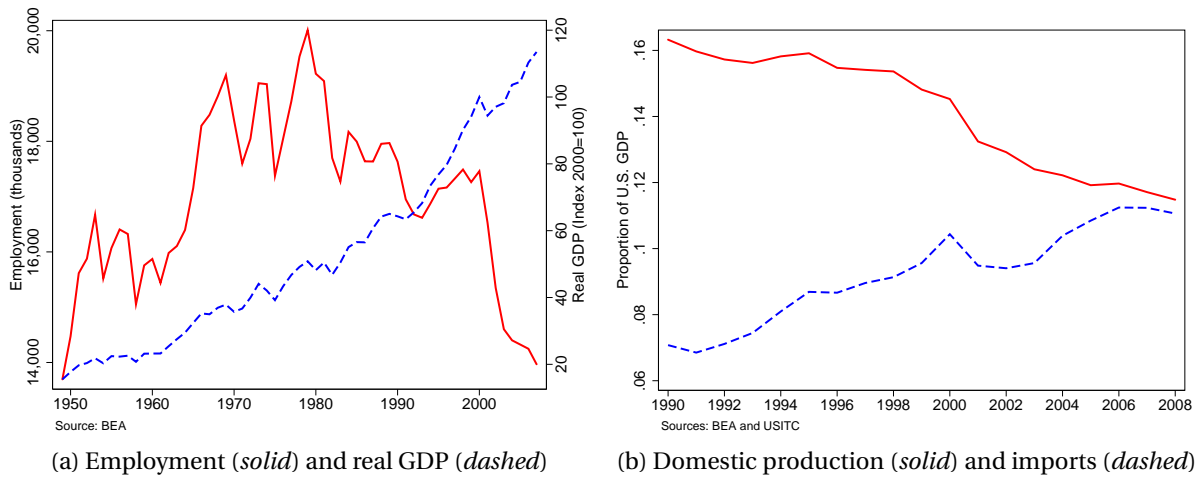
(a) Employment (*solid*) and real GDP (*dashed*)

(b) Domestic production (*solid*) and imports (*dashed*)

Figure 1: The manufacturing industry in the U.S.

(a) QCEW: U.S. (*solid*) and California (*dashed*)
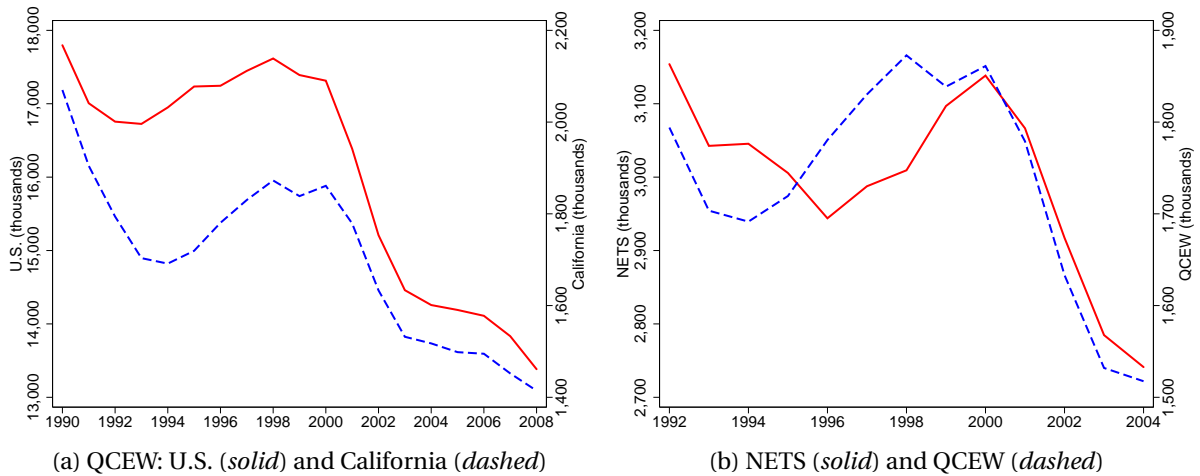

(b) NETS (*solid*) and QCEW (*dashed*)

Figure 2: Employment in California's manufacturing industry

turing production in 1990, and for 11% by 2008. For our empirical analysis on job flows to be representative of the U.S. economy, we must demonstrate that California's manufacturing employment is highly correlated with national manufacturing employment. Using data from the QCEW, Figure 2a presents the national and California's manufacturing employment from 1990 to 2008. California's share of U.S. manufacturing employment was about 11.6% in 1990 and 10.6% by 2008. The correlation coefficient between California's and the U.S. employment-level series is 0.93. Moreover, the correlation coefficient between the series' first differences—the employment change from year to year—is 0.81. Hence, employment levels and employment changes in California's manufacturing industry track very well the national manufacturing employment. Given this close relationship, we also expect that the job flows behavior in California mirrors the job flows behavior in the rest of the country.

To verify the reliability of our job flows data, we compare California's manufacturing employment levels from the QCEW and the NETS. Figure 2b shows the two series from 1992 to 2004. The correlation is 0.82 for the employment levels and 0.68 for the first differences. Al-

19

Table 1: Job Flows Decomposition in California's Manufacturing Industry

	1992-1995	1993-1996	1994-1997	1995-1998	1996-1999
Employment at initial year	3,154,004	3,042,614	3,045,497	3,005,669	2,943,955
Employment at final year	3,005,669	2,943,955	2,987,589	3,009,322	3,096,931
Change in employment					
Due to expansions	331,996	373,782	404,602	446,388	431,332
Due to contractions	-330,212	-315,076	-315,817	-299,356	-240,156
Due to births	261,941	285,588	300,333	268,853	306,224
Due to deaths	-412,060	-442,953	-447,026	-412,232	-344,424
Net changes					
Expansions-Contractions	1,784	58,706	88,785	147,032	191,176
Births-Deaths	-150,119	-157,365	-146,693	-143,379	-38,200
Net employment creation	-148,335	-98,659	-57,908	3,653	152,976
	1997-2000	**1998-2001**	**1999-2002**	**2000-2003**	**2001-2004**
Employment at initial year	2,987,589	3,009,322	3,096,931	3,138,357	3,066,571
Employment at final year	3,138,357	3,066,571	2,917,241	2,784,782	2,741,185
Change in employment					
Due to expansions	417,172	341,024	320,243	284,628	297,535
Due to contractions	-244,535	-284,767	-363,408	-386,536	-324,939
Due to births	353,832	373,596	295,118	210,197	150,339
Due to deaths	-375,701	-372,604	-431,643	-461,864	-448,321
Net changes					
Expansions-Contractions	172,637	56,257	-43,165	-101,908	-27,404
Births-Deaths	-21,869	992	-136,525	-251,667	-297,982
Net employment creation	150,768	57,249	-179,690	-353,575	-325,386

though they are highly correlated, there is a substantial difference between the total employment levels in the two series: the NETS data reports on average 73% more employees than the QCEW data. Neumark, Zhang, and Wall (2007) and Neumark, Wall, and Zhang (2011) provide an assessment of the NETS database and investigate, among other things, the difference in total employment levels between NETS and the QCEW. They report that the difference arises because the BLS data excludes self-employed workers and proprietors, and because NETS has better coverage of small establishments. With respect to the lower correlation for employment changes, they find that there is some stickiness in the NETS data, and this is reflected in year-to-year changes. For three-year windows, they obtain a correlation of 0.86 between the two series. To sum up, we have strong evidence showing that the NETS data is a reliable source for the analysis of job flows in the U.S. manufacturing industry.

We can now present some stylized facts about the evolution of job flows in our data. Table 1 shows the decomposition of job flows in California's manufacturing industry in three-year windows. As in the work of Davis and Haltiwanger (1992), we obtain that net employment changes conceal substantial gross job flows on both the intensive and extensive margins of

(a) Job creation decomposition

(b) Job creation shares (average)

(c) Job destruction decomposition
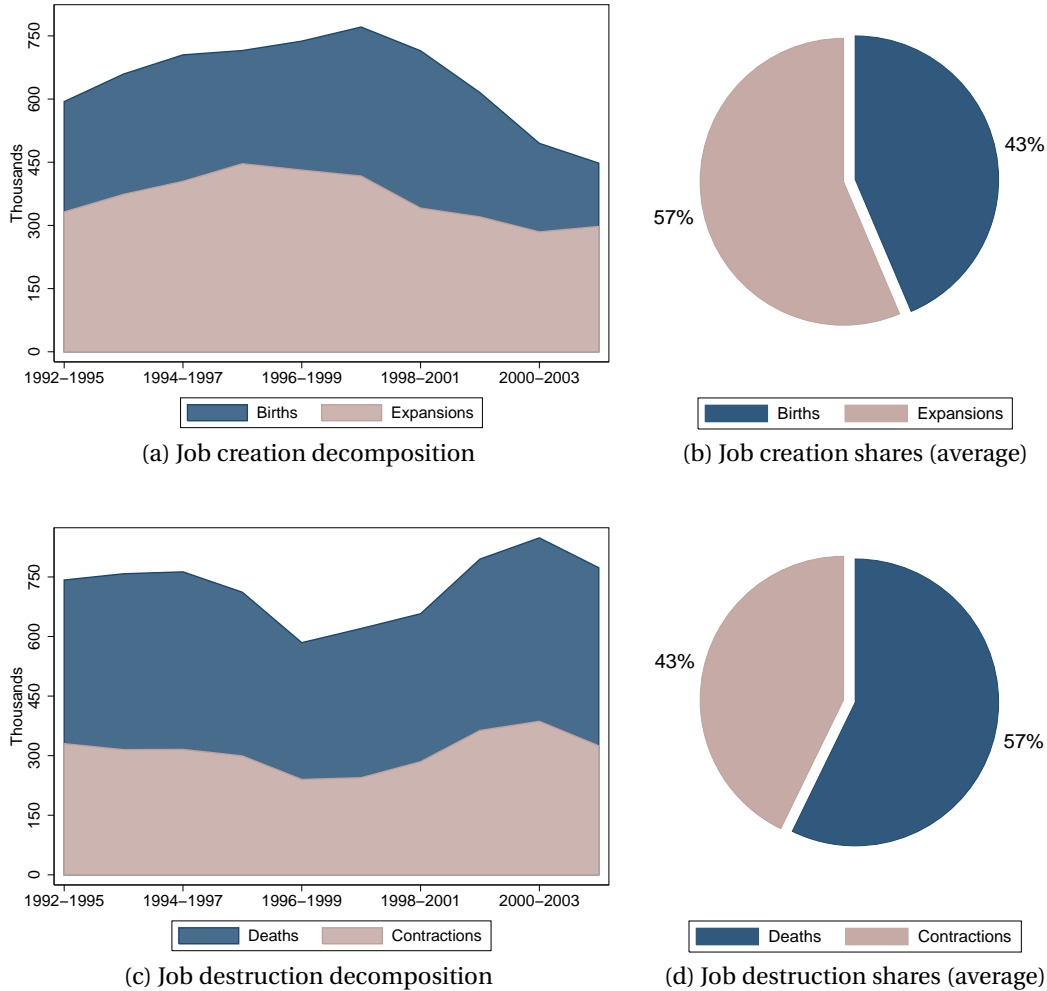
(d) Job destruction shares (average)

Figure 3: Employment creation and destruction in California's manufacturing industry (three-year windows)

employment. Figures 3 and 4 summarize these results.

Figure 3a presents the sources of job creation. We observe that job creation reached its peak in the period 1997-2000 and then started a sharp decline, driven mostly by the decrease in establishment births. Moreover, Figure 3b shows that expansions of existing establishments were the principal source of job creation from 1992 to 2004, with an average share of 57%. On the other hand, Figure 3c shows that job destruction declined towards the second half of the 1990s and then increased substantially during the 2000s. In Figure 3d we obtain that on average 57% of job destruction is accounted for by the death of firms. Therefore, a first stylized fact about job flows in the manufacturing industry is that from 1992 to 2004, the intensive margin of employment dominates in job creation, while the extensive margin dominates in job destruction.

Lastly, Figure 4 shows net employment changes at the intensive and extensive margins, and overall. Note first that the net effect at the intensive margin of employment (job creation by expansions minus job destruction by contractions) was positive up to the period 1998-
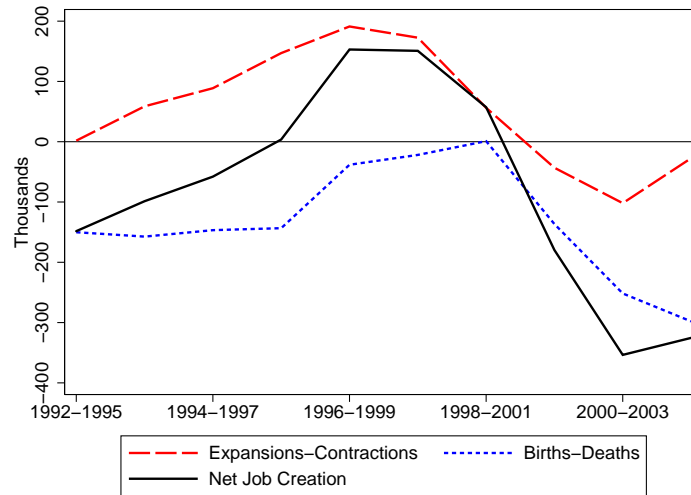
Figure 4: Net employment creation in California's manufacturing industry

2001 and has become negative since then. On the other hand, the net effect at the extensive margin of employment (job creation by births minus job destruction by deaths) was negative throughout our three-year windows, with the exception of the period 1998-2001, when it was positive but very close to zero. With respect to overall net employment changes, we observe that the period of net job creation in the last part of the 1990s was driven by the intensive margin, while the periods of net job destruction were dominated by the extensive margin. Hence, we can write our second and third stylized facts about job flows in the manufacturing industry. The second stylized fact is that the period of net job creation during the *dot-com bubble* was driven by the intensive margin of employment. From Table 1, note that the intensive margin improvements over that period were driven in about similar amounts by increases in job creation by expansions and decreases in job destruction by contractions. The third stylized fact is that the most important period of net job destruction in the history of the manufacturing industry (at the beginning of the 2000s) was driven mostly by the extensive margin of employment. As seen in Table 1, the worsening of the extensive margin over that period was the result of reinforcing changes in job destruction by deaths and job creation by births, but the decline in job creation by births was much more important.

6   Estimation

This section presents the empirical analysis of the effects of input trade costs on the intensive and extensive margins of employment. Input trade costs are constructed for each industry using the output tariffs and the input-output table as is described in detail below. Besides a tariff component, input trade costs comprise non-tariff components (*e.g* non-tariff trade barriers). Nevertheless, and as mentioned by Trefler (2004), as long as there is a positive correlation between tariff and non-tariff barriers, a decline in our tariff-based input-trade-cost

measure would capture the general extent of input trade liberalization.[16,17] Moreover, while average tariffs for the U.S. are low, Yi (2003) shows that the possibility of vertical specialization creates a multiplier effect that is reflected in huge increases in trade volumes even for small declines in tariffs.

Our empirical approach also controls for output trade costs, which allows us to gauge the relative importance of the theoretical channels identified in our model (for changes in input trade costs) with respect to the theoretical effects on job flows obtained in the model of Bernard, Redding, and Schott (2007) (for changes in output trade costs).

We begin with a description of the establishment- and industry-level variables used in our analysis, with special emphasis on the construction of job flows and (input and output) trade-cost variables. Then, we split the estimation procedure into two parts: an establishment-level estimation to test Predictions 1 and 2, and an industry-level estimation to test Predictions 3 and 4.

6.1 Description of Variables

The empirical analysis relies on establishment- and industry-level variables for the period 1992 to 2004. We obtain the establishment-level variables from NETS, and we obtain the industry-level variables from the most updated versions of the trade database of Feenstra, Romalis, and Schott (2002) and of the NBER productivity database (see Bartelsman and Gray, 1996).

As mentioned before, we have access to a subset of NETS—a longitudinal establishment-level national database—which includes annual data for every establishment that was located in California in any year between 1992 and 2004. Each establishment has a unique identifier and is carefully followed throughout the years.[18] A distinguishing feature of NETS is that it is not a representative sample of business establishments, but the universe of them. Each establishment is classified by NETS according to its primary, secondary, and tertiary Standard Industrial Classification (SIC) code at the eight-digit level. We use the SIC primary code to match each establishment to a unique industrial sector at the four-digit SIC level. We drop from our database all the non-manufacturing establishments.[19] Hence, each establishment in this analysis belongs to one of 390 four-digit SIC manufacturing industries. For each establishment we create job-flow and productivity variables.

The job-flow variables are created from reported employment levels. Following Davis, Haltiwanger, and Schuh (1998), we calculate establishment-level growth rates of employment

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[16]Trefler (2004) uses U.S. and Canadian tariffs in his plant-level employment regressions. He argues that even if small, these tariffs are positively related to non-tariff barriers and hence, they capture the essence of the U.S.-Canada free trade agreement.

[17]To the extent that the recent developments in transportation and communication technology have lowered the cost of trading inputs, which are not captured by changes in input tariffs, our input-trade-cost measure is going to underestimate the true change in the cost of importing inputs.

[18]In our dataset, an establishment is tracked all the years it is active as long as it was located in California for one or more years.

[19]As we should expect, employment changes in the traded sector of the economy have a counterpart in the non-traded sector. Ebenstein, Harrison, McMillan, and Phillips (2009) explore the mechanism of labor migration from the traded to the non-traded sector and its impact on wages.

using a midpoint-method formula. Denote the employment level of establishment i, from industry j, in year t by E_{ijt}. Then, the employment growth rate for this establishment from $t-1$ to t is given by

$$\hat{E}_{ijt} = \frac{E_{ijt} - E_{ijt-1}}{\overline{E}_{ijt}}, \tag{34}$$

where $\overline{E}_{ijt} = \frac{1}{2}(E_{ijt} + E_{ijt-1})$. Note that $\hat{E}_{ijt} \in [-2, 2]$, with a value of -2 reflecting job destruction by establishment death, and a value of 2 reflecting job creation by establishment birth. Values in $(-2, 2)$ indicate job destruction by contraction (negative values), job creation by expansion (positive values), or no change in the establishment's employment level (a value of zero).

We can decompose $\hat{E}_{ijt}$ to obtain variables for the different components of job flows. Let jc_{ijt} and jd_{ijt} represent the rates of job creation and destruction, respectively, for establishment i, from industry j, between $t-1$ and t. Given $\hat{E}_{ijt}$, we define them as $jc_{ijt} = \max(\hat{E}_{ijt}, 0)$ and $jd_{ijt} = \max(-\hat{E}_{ijt}, 0)$. Decomposing further jc_{ijt} and jd_{ijt} into the four components of job flows—those due to births (b_{ijt}) and deaths (d_{ijt}) at the extensive margin, and those due to expansions (e_{ijt}) and contractions (c_{ijt}) at the intensive margin—we have

$$
\begin{aligned}
b_{ijt} &= jc_{ijt} \cdot \mathbb{1}\{jc_{ijt} = 2\} \\
d_{ijt} &= jd_{ijt} \cdot \mathbb{1}\{jd_{ijt} = 2\} \\
e_{ijt} &= jc_{ijt} \cdot \mathbb{1}\{jc_{ijt} < 2\} \\
c_{ijt} &= jd_{ijt} \cdot \mathbb{1}\{jd_{ijt} < 2\},
\end{aligned}
$$

where $\mathbb{1}\{\cdot\}$ is an indicator function. Note that the following expressions always hold: $\hat{E}_{ijt} = jc_{ijt} - jd_{ijt}$, $jc_{ijt} = b_{ijt} + e_{ijt}$, and $jd_{ijt} = d_{ijt} + c_{ijt}$.

Our testable predictions 1 and 2 mention that the effect of a change in input trade costs on firm-level job flows depends on each firm's productivity level. To verify this empirically, we require a variable measuring the relative productivity of each establishment. Using reported sales and employment levels from NETS, we construct the relative productivity variable based on the ranking of the establishment's sales per worker with respect to all the establishments in the same four-digit SIC industry.[20] Hence, we denote the relative productivity of establishment i, from industry j, at time t by Ψ_{ijt}, where $\Psi_{ijt} \in (0, 2)$, taking the value of 1 for the establishment with the median value of sales per worker in industry j at time t. This variable is symmetric, with the lowest-productivity establishments in the industry taking values close to zero, while the highest-productivity establishments take values close to 2.

At the industry level, the most important explanatory variables are input and output trade

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[20]It would be preferable to use a productivity measure based on establishment-level total factor productivity. Unfortunately, though good at tracking establishments' employment levels and sales, NETS provides few variables on establishments' characteristics. In particular, NETS does not report either capital stock or investment levels. Also, we cannot calculate a value-added measure of productivity because we do not have data on establishments' materials consumption. Nevertheless, for Japan's manufacturing industry, Tomiura (2007) shows that irrespective of the productivity measure used (either sales per worker, value-added labor productivity, or total factor productivity), the productivity ordering of firms by globalization modes does not change. Given these findings, we are confident that our results would be robust to the use of alternative measures of firm productivity.

costs. Using the updated U.S. trade database of Feenstra, Romalis, and Schott (2002), for each four-digit SIC industry we use the average tariff rate as our measure of output trade costs. That is, the output trade cost for industry j in year t, τ_{jt}^{O}, is the ratio of duties collected by U.S. customs authorities to the free-on-board customs value of imports.

We follow Amiti and Konings (2007) and Goldberg, Khandelwal, Pavcnik, and Topalova (2010), and construct an input tariff rate for each industry as a weighted average of output tariff rates. Then, the input trade cost for industry j in year t, τ_{jt}^{I}, is given by

$$\tau_{jt}^{I} = \sum_{k} \omega_{kj} \tau_{kt}^{O},$$

where the weight ω_{kj} is the ratio of industry j's input purchases from industry k to the total input purchases of industry j. We compute the weights from the U.S. input-output tables created by the Bureau of Economic Analysis (BEA). There are two important remarks with respect to our input trade-cost measure: first, it is based on cost shares irrespective of whether inputs are domestic or imported; and second, we keep the weights constant over time. With respect to the first remark, Amiti and Konings (2007) highlight that this is the correct measure of input trade costs—as opposed to a measure with weights based on shares of imported inputs—because it gives more weight to the tariffs of inputs that are used more intensively in an industry, whether those inputs are imported or not.[21] With respect to the second remark, although input-output tables are calculated every five years for the U.S. and it would be possible to link them using interpolation methods, keeping the weights constant over time prevents an endogeneity bias caused by the movements in opposite directions of output trade costs and weights.[22] We use the 1987 U.S. input-output table to calculate the weights for the input trade costs used in our benchmark regressions, and perform robustness checks using the 1997 input-output table.

Besides the key variables described above, the estimation methods in the following sections include other control variables. From NETS, we control for an establishment's age and sales per worker (deflated by industry-level price indexes); and from the NBER productivity database of Bartelsman and Gray (1996)—updated through 2004—we control for several industry-level characteristics: the value and price of shipments, the price of materials, industry employment levels, and industry total factor productivity (TFP). The purpose of these industry-level variables is to control for the effects of labor demand shocks. Also, in the industry-level estimation section below, we introduce industry-level job-flow rates and measures of comparative advantage.

At the end, after merging the NETS data with the trade and productivity industry data,

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[21]As an example, Amiti and Konings (2007) point out that if "an industry is intensive in rubber usage, the relevant tariff is the tariff on rubber, irrespective of whether the rubber is imported."

[22]To illustrate this point, consider an extreme example of an industry A that employs inputs from industries B and C, with respective cost shares of 0.6 and 0.4. If we assume that the initial tariffs are 0.5 for industry B and 0.1 for industry C, the initial input tariff rate is 0.34. Now suppose that when the tariff for industry B declines to 0.4, the cost share in industry A rises to 0.9. If we keep the weights constant, the new input tariff is 0.28, reflecting the decline in input trade costs. On the other hand, if we use the new cost shares, the new input tariff would be 0.37, which is above the original input tariff—missing entirely the decline in trade costs. Amiti and Konings (2007) and Goldberg, Khandelwal, Pavcnik, and Topalova (2010) also keep the weights constant over time.

our dataset contains 124,896 establishments from 390 four-digit SIC industries in the period between 1992 and 2004.

6.2 Establishment-Level Estimation

In this section we perform an establishment-level regression analysis to test the reduced-form Predictions 1 and 2, while also controlling for output trade costs. Our approach allows for a direct comparison of the effects of input and output trade costs. Moreover, this analysis sheds light on the relative importance of the three effects of input trade costs on job flows identified in section 4.1: the job-relocation effect, the productivity effect, and the market-access effect.

6.2.1 Intensive-Margin Estimation

Prediction 1 states that a decline in input trade costs causes job destruction by contraction in the least productive firms, and an ambiguous effect in the most productive firms. As this is a firm-level prediction at the intensive margin, the econometric model we estimate is

$$y_{ijt} = \beta_I^y \triangle \tau_{jt-1}^I + \rho_I^y \triangle \tau_{jt-1}^I \Psi_{ijt-1} + \beta_O^y \triangle \tau_{jt-1}^O + \rho_O^y \triangle \tau_{jt-1}^O \Psi_{ijt-1} + \vartheta Z_{ijt-1} + \theta_i + v_t + \varepsilon_{ijt}, \quad (35)$$

where $y_{ijt} \in \{e_{ijt}, c_{ijt}, e_{ijt}-c_{ijt}\}$ is the intensive-margin job-flow measure for establishment i in industry j at time t, $\triangle \tau_{jt-1}^I$ and $\triangle \tau_{jt-1}^O$ are lagged variables for the change in input and output trade costs for industry j, Ψ_{ijt-1} is our relative productivity variable lagged one period, Z_{ijt-1} is a vector of lagged establishment- and industry-level characteristics, θ_i and v_t account for establishment and time fixed effects, and ε_{ijt} is an error term. The purpose of including a lag in the right-hand side of equation (35) is simply to prevent situations in which a change in the dependent variable happens before a change in one or more of the explanatory variables.[23]

For the changes in input and output trade costs, $\triangle \tau_{jt}^I$ and $\triangle \tau_{jt}^O$, we use three-year average annual changes; that is, $\triangle \tau_{jt}^I = \frac{\tau_{jt}^I - \tau_{jt-3}^I}{3}$, with an analogous expression for $\triangle \tau_{jt}^O$. The motivation for using three-year average changes is twofold: first, it accounts for a lagged response of firm-level employment to changes in trade costs, and second, it considers the apparent stickiness in the NETS data mentioned in section 5. As a robustness check, in Appendix B we re-estimate equation (35) using one-year changes in input and output trade costs.

The dependent variable can be e_{ijt} (for job expansions), c_{ijt} (for job contractions), or $e_{ijt}-c_{ijt}$ (for the net intensive-margin effect). The parameters of interest in each regression are β_I^y and ρ_I^y, for $y \in \{e, c, e-c\}$, because they characterize the intensive-margin response of an establishment—given its productivity—to a change in input trade costs. In particular, the semi-elasticity of job flow component y with respect to input trade costs for an establishment

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[23]For example, a change in employment might happen in February, while a change in trade costs might occur in November of the same year. Without a lag, these changes would be treated as contemporaneous even though the trade-cost change occurs later. We follow the same reasoning in all the regression specifications that appear in the rest of the paper.

with relative productivity Ψ is given by

$$\beta_I^y + \rho_I^y \Psi,$$

for $\Psi \in (0,2)$. Hence, after a one percentage point increase in input trade costs, job flow y changes by about β_I^y percent for the least productive firm, by $\beta_I^y + \rho_I^y$ percent for the median firm, and by about $\beta_I^y + 2\rho_I^y$ percent for the most productive firm. We can then compare the input-trade-cost semi-elasticity of a firm with productivity Ψ against $\beta_O^y + \rho_O^y \Psi$, which is that firm's output-trade-cost semi-elasticity.

Table 2 presents the results of the intensive-margin fixed-effects regressions. We report robust standard errors clustered at the establishment level. Given the construction of the growth measures for job flows, the coefficients for the net-intensive-margin regression are equivalent to the difference between the job-expansion and job-contraction regressions' coefficients. In each regression, both of the coefficients on input trade costs are statistically significant at a 1% level. Moreover, they are consistent with Prediction 1: for a decrease in input trade costs, the least productive establishments decrease their job expansions and increase their job contractions, while the opposite happens for the most productive establishments. Even for the median establishment (with a relative productivity of 1), a decline in input trade costs causes a positive net effect at the intensive margin of job flows ($\hat{\beta}_I^{e-c} + \hat{\rho}_I^{e-c} < 0$). These results suggest that a within-firm productivity effect does exist, which dominates the market-access and job-relocation effects for the most productive (and even for the median) establishments.

Both coefficients on output trade costs are also statistically significant in each regression and have the same signs as the input-trade-costs coefficients. However, the output-trade-costs coefficients are smaller in magnitude. Figure 5 presents a detailed comparison of the effects of input and output trade costs on the intensive margin of job flows for each level of establishment relative productivity. For $y \in \{e, c, e\text{–}c\}$, the figures on the left present $\hat{\beta}_I^y + \hat{\rho}_I^y \Psi$ and $\hat{\beta}_O^y + \hat{\rho}_O^y \Psi$ with 95% confidence bands, and the figures on the right show their difference, $\hat{\beta}_I^y + \hat{\rho}_I^y \Psi - (\hat{\beta}_O^y + \hat{\rho}_O^y \Psi)$, also with 95% confidence bands. In the three cases, the effect of input trade costs is more important than the effect of output trade costs for both the least and more productive establishments. Note, for example, that for the least productive establishment ($\Psi \to 0$ from the right), the input-trade-cost effect is 2.4 times as large as the output-trade-cost effect on job expansions, 3.7 times as large for contractions, and 2.8 times as large for the net intensive margin; while for the most productive establishment ($\Psi \to 2$ from the left), the input-trade-cost effect is 1.9 times as large as the output-trade-cost effect for expansions, 30 times as large for contractions, and 4 times as large for the net intensive margin. For the median establishment, the input- and output-trade-cost effects are statistically different for job contractions and the net intensive margin, but not for job expansions. Indeed, for job expansions the effects are not different for a wide range that covers the median and a large segment of productivity levels above the median. Hence, for the median establishment, the statistically significant difference between the input- and output-trade-cost effects at the net intensive margin is driven by the opposite responses of job contractions: while the me-

Table 2: Intensive-Margin Estimation

Dependent variable (at time t) indicated in columns

Regressor (at t–1)	Job expansions (e)	Job contractions (c)	Net intensive margin (e–c)
△(Input trade cost)	2.660***	-1.895***	4.555***
	(0.327)	(0.305)	(0.469)
△(Input trade cost)×	-2.614***	2.564***	-5.178***
(Relative productivity)	(0.290)	(0.256)	(0.406)
△(Output trade cost)	1.087***	-0.513***	1.600***
	(0.175)	(0.157)	(0.243)
△(Output trade cost)×	-1.215***	0.310**	-1.524***
(Relative productivity)	(0.161)	(0.134)	(0.219)
Establishment characteristic			
△log(Sales per worker)	0.007***	-0.011***	0.018***
	(0.001)	(0.001)	(0.002)
Age	-0.002***	-0.001***	-0.001***
	((0.000)	(0.000)	(0.000)
Industry characteristic			
△log(Value of shipments)	0.013**	-0.008*	0.021***
	(0.005)	(0.005)	(0.008)
△log(Price of shipments)	-0.013	-0.031***	0.018
	(0.011)	(0.010)	(0.016)
△log(Price of materials)	-0.013	0.020**	-0.033**
	(0.010)	(0.010)	(0.015)
△log(Employment)	0.003	-0.005	0.008
	(0.004)	(0.004)	(0.006)
△log(TFP)	0.012	-0.006	0.018*
	(0.008)	(0.007)	(0.011)
Observations	758,812	758,812	758,812
Establishments	124,896	124,896	124,896

Notes: Regressions include establishment and time fixed effects. Robust standard errors (in parentheses) are clustered at the establishment level. The coefficients are statistically significant at the *10%, **5%, or ***1% level.

dian establishment decreases its job destruction by contraction after a one-percentage-point decline in input trade costs ($\hat{\beta}_I^c + \hat{\rho}_I^c > 0$), it will destroy more labor by contraction after a one-percentage-point decline in output trade costs ($\hat{\beta}_O^c + \hat{\rho}_O^c < 0$).

Overall, for firm-level expansion and contraction's decisions, the previous results not only are consistent with Prediction 1, but they also highlight the greater importance of input trade costs—and their implied channels of influence—compared to output trade costs. That is, we do obtain empirical support for the effects of final-good trade costs on intensive-margin job flows described by Bernard, Redding, and Schott (2007) in a standard Melitz model—job contractions of less productive firms and job expansions of more productive firms. Nevertheless, the effects of input trade costs are in general larger.
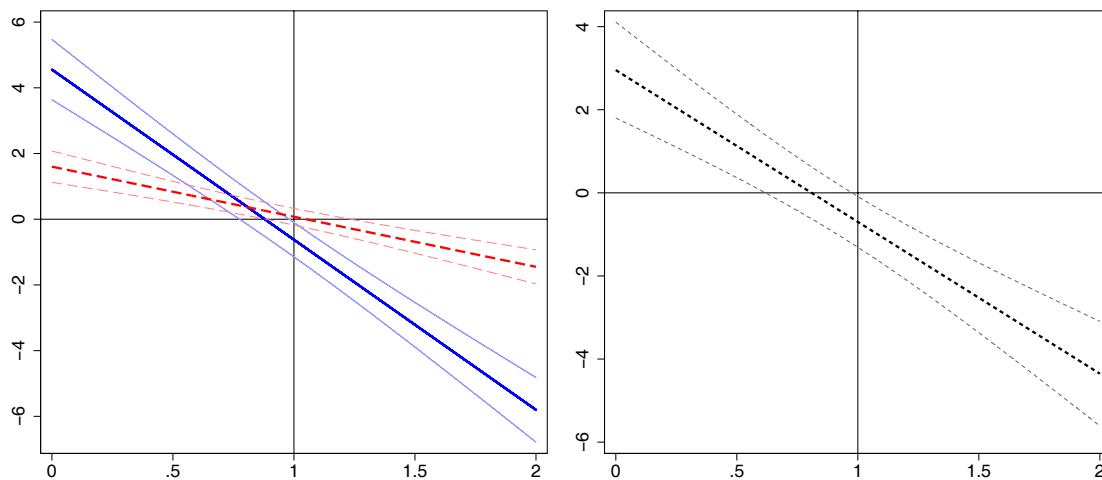
For the rest of the explanatory variables in Table 2, we obtain that the coefficients on both
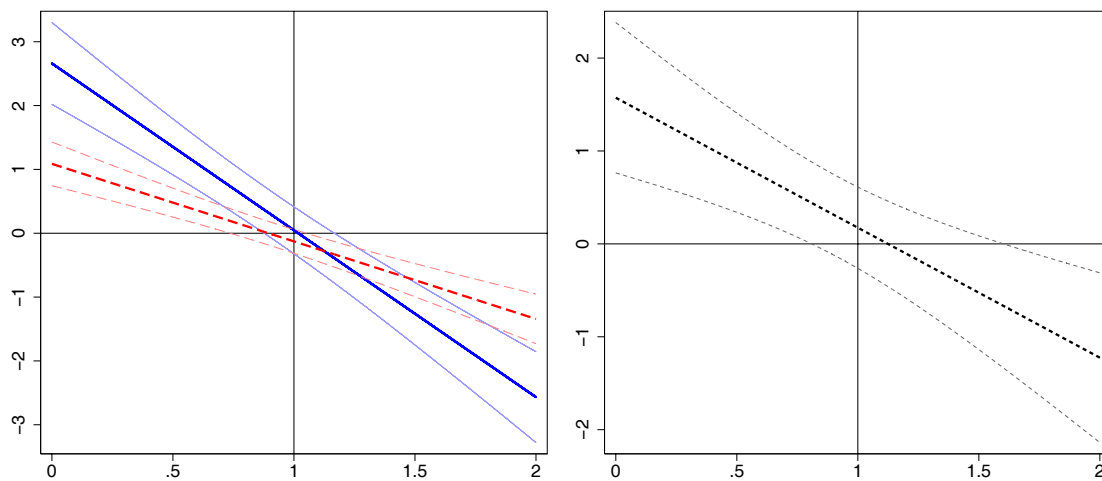
(a) Job expansions: semi-elasticities (left) and their difference (right)
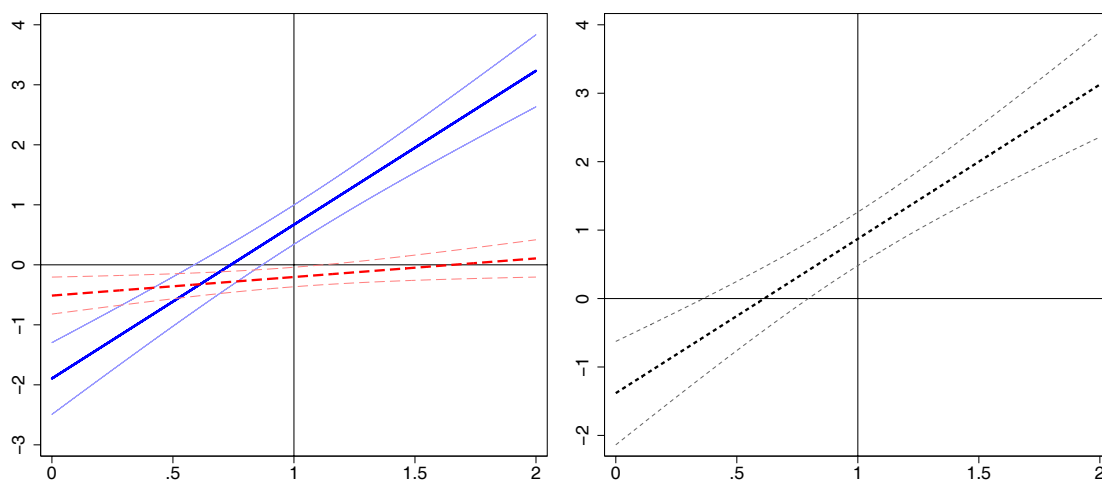
(b) Job contractions: semi-elasticities (left) and their difference (right)

(c) Net intensive margin: semi-elasticities (left) and their difference (right)

Figure 5: Semi-elasticities with respect to input trade costs (*solid*) and output trade costs (*dashed*), their difference (*dotted*), and 95% confidence bands — Relative productivity on the x-axis (median=1)

establishment-level controls are statistically significant at a 1% level. Increases in sales per worker are associated with more job expansions, fewer job contractions, and hence a positive effect at the intensive margin. The coefficients on age are all negative, suggesting that as firms get older, they reduce their rates of both job expansion and job contraction, with the former being larger in magnitude. For the industry-level controls, we obtain coefficients with expected signs but with limited statistical significance. Given that we are controlling for the growth in the price of shipments, the coefficients on the growth of the value of shipments indicate the response of establishment-level job flows to the level of physical output in the industry. Then, for higher growth in an industry, we obtain more job expansions, fewer job contractions, and hence a net positive effect at the intensive margin. An increase in the price of materials causes more job contractions and a negative net effect. And lastly, an increase in total factor productivity causes a net positive effect at the intensive margin.

In Appendix B, we perform four types of robustness checks for our intensive-margin results. First, as mentioned above, we re-estimate equation (35) using one-year changes in trade costs (instead of three-year average annual changes). Second, we re-estimate equation (35) using weights for input trade costs based on the 1997 input-output table (instead of the 1987 U.S. input-output table). These two checks allow us to verify if our benchmark results are sensitive to the measures of trade costs used. Third, we re-estimate equation (35) using three-year windows. The purpose of this check is to verify if the year-to-year stickiness of the NETS data mentioned in section 5 is an important determinant of the results. Fourth, we verify if our results are sensitive to the establishment- and industry-level controls included. In all four cases, our results remain strong.

6.2.2 Death-Likelihood Estimation

The reduced-form Prediction 2 suggests that a decline in input trade costs should be associated with an increase in the death probability of low-productivity firms. To test this prediction we estimate the binary regression model given by

$$\Pr(D_{ijt}{=}1) = F\left(\beta_I^D \triangle\tau_{jt-1}^I + \rho_I^D \triangle\tau_{jt-1}^I \Psi_{ijt-1} + \beta_O^D \triangle\tau_{jt-1}^O + \rho_O^D \triangle\tau_{jt-1}^O \Psi_{ijt-1} + \vartheta Z_{ijt-1} + \theta_j + v_t\right),$$
(36)

where $D_{ijt} = \frac{d_{ijt}}{2}$ takes the value of 1 if establishment i from industry j died at time t (and zero otherwise), and the explanatory variables are defined as in section 6.2.1. We estimate equation (36) using probit and logit regression models, and thus $F(\cdot)$ denotes the cumulative distribution function of either the standard normal distribution or the logistic distribution. The regression model includes industry fixed effects instead of establishment fixed effects.[24]

The effect of input trade costs on the death probability of an establishment with relative productivity Ψ is determined by $\beta_I^D + \rho_I^D \Psi$, for $\Psi \in (0,2)$. However, as these parameters belong to a nonlinear regression model, they do not represent semi-elasticities. The same is true for the output-trade-cost effect on the establishment's death probability, $\beta_O^D + \rho_O^D \Psi$.

Table 3 presents the results for the death-likelihood regressions. The probit and logit mod-

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[24]The probit and logit models cannot be estimated with establishment fixed effects due to the so-called incidental parameters problem (see Wooldridge, 2005).

Table 3: Death-Likelihood Estimation

Regressor (at t–1)	Probit	Logit
△(Input trade cost)	-6.610**	-13.400**
	(2.837)	(5.752)
△(Input trade cost)×	2.302	4.599
(Relative productivity)	(2.187)	(4.412)
△(Output trade cost)	-4.468***	-8.983***
	(1.330)	(2.601)
△(Output trade cost)×	2.329**	4.635**
(Relative productivity)	(1.089)	(2.134)
Establishment characteristic		
△log(Sales per worker)	0.003	0.004
	(0.008)	(0.015)
Age	-0.012***	-0.028***
	(0.000)	(0.000)
Industry characteristic		
△log(Value of shipments)	0.052	0.115
	(0.054)	(0.107)
△log(Price of shipments)	-0.068	-0.132
	(0.094)	(0.189)
△log(Price of materials)	0.136	0.295
	(0.103)	(0.208)
△log(Employment)	-0.082*	-0.162*
	(0.043)	(0.086)
△log(TFP)	-0.004	-0.013
	(0.079)	(0.158)
Observations	758,812	758,812
Establishments	124,896	124,896

Notes: Regressions include industry and time fixed effects. Robust standard errors (in parentheses) are clustered at the establishment level. The coefficients are statistically significant at the *10%, **5%, or ***1% level.

els give similar results in terms of signs and the coefficients' statistical significance. For the input-trade-cost effect on an establishment's death probability, the coefficients have the expected signs ($\hat{\beta}_I^D < 0$ and $\hat{\rho}_I^D > 0$). That is, after a decline in input trade costs, there is a larger increase in the death probability of low-productivity establishments. However, the interaction term is not statistically significant. On the other hand, for the output-trade-cost effect, both coefficients have the expected signs ($\hat{\beta}_O^D < 0$ and $\hat{\rho}_O^D > 0$) and are statistically significant.

Figure 6 presents the input- and output-trade-cost effects—along with 95% confidence bands—using the coefficients of the probit regression.[25] Consistent with Prediction 2, in Figure 6a we observe that although $\hat{\beta}_I^D + \hat{\rho}_I^D \Psi < 0$ for every Ψ—a decline in input trade costs is associated with an increase in the death probability of every type of establishment—the effect is smaller in magnitude and not statistically significant for the most productive estab-

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[25]We obtain similar plots if we use the coefficients from the logit regression.

(a) The effects of input trade costs (*solid*) and output trade costs (*dashed*)
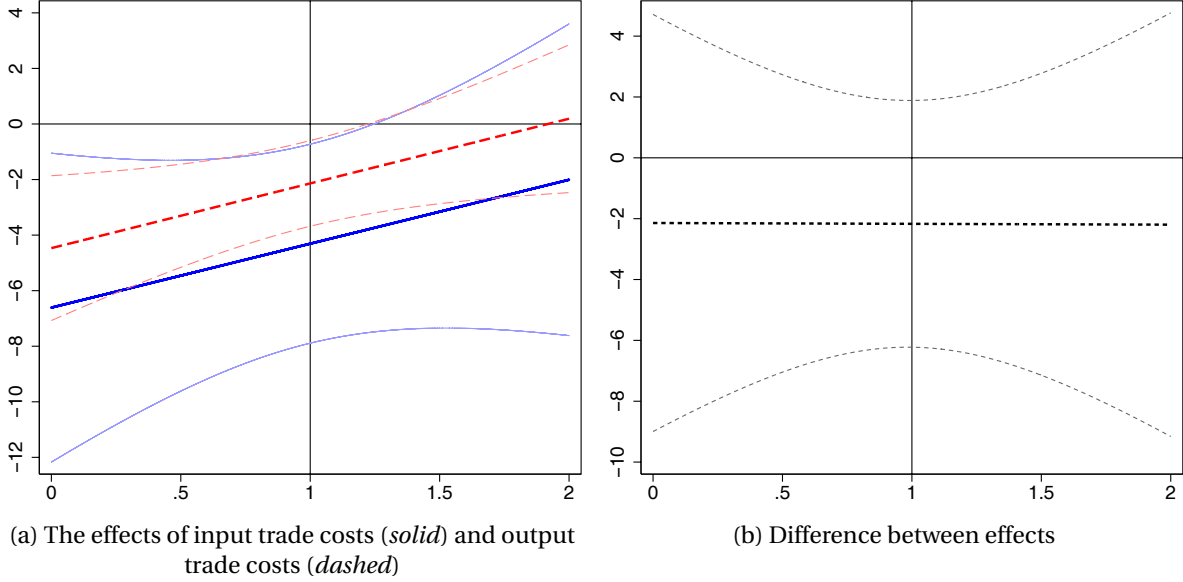
(b) Difference between effects

Figure 6: The effects of trade costs in a Probit death-likelihood regression, with 95% confidence bands — Relative productivity on the x-axis (median=1)

lishments. Comparing the two trade-cost effects, Figures 6a and 6b show that despite the larger magnitude of the input-trade-cost effect, the difference between them is not statistically significant for every value of Ψ.

Our results for the effect of output trade costs on the death probability of establishments are similar to the results of Bernard, Jensen, and Schott (2006b), and hence provide support for the theoretical channels identified in the heterogeneous-firm models of trade in final goods of Bernard, Eaton, Jensen, and Kortum (2003) and Melitz (2003). But also, our results show that we should not ignore the effect of input trade costs and its implied channel of influence. In our model, firms die after a decline in input trade costs because of the market-access effect: as low-productivity firms lose market share to new and existing importing firms, their profits decline, and firms that are not able to cover their fixed costs of production die.

Among the coefficients on the establishment- and industry-level control variables, only age and the change in industry employment are statistically significant (in both the probit and logit regressions). The coefficient on age implies that as an establishment gets older, the probability of dying declines. Similarly, the coefficient on the change in industry employment shows that establishments in expanding industries are less likely to die.

In Appendix B we perform the same robustness checks we did for the intensive-margin regressions in section 6.2.1. In each of the alternative specifications, we obtain results that are similar to the results presented here.

6.3   Industry-Level Estimation

In this section we do an industry-level regression analysis to test the reduced-form Predictions 3 and 4. After a decline in input trade costs, Prediction 3 states that the number of

establishments decreases, and Prediction 4 states that there is job destruction at the extensive margin, an ambiguous effect at the intensive margin, and overall net job destruction. As before, we control for output trade costs. Moreover, following Bernard, Redding, and Schott (2007), who find in their model that responses of industry-level employment to changes in trade costs depend on comparative advantage, we create variables of industry-level comparative advantage and interact them with input and output trade costs. Before presenting the econometric model, first we describe the industry-level measures that we use as our dependent variables, and then we discuss our comparative-advantage variables.

Let N_{jt} and E_{jt} denote, respectively, the number of active establishments and the employment level in industry j at time t. Hence, the growth rate of the number of establishments in industry j from time $t-1$ to time t is $\hat{N}_{jt} = \frac{N_{jt} - N_{jt-1}}{N_{jt-1}}$, with a similar expression for the industry's employment growth rate, $\hat{E}_{jt}$. To test Prediction 3, the only dependent variable we need is $\hat{N}_{jt}$. On the other hand, to test Prediction 4 we need to decompose $\hat{E}_{jt}$ into its industry-level job-flow components. In particular, as the change in the employment level in industry j from time $t-1$ to time t, ΔE_{jt}, is due to establishments' expansions, contractions, births and deaths, we can write $\hat{E}_{jt}$ as

$$\hat{E}_{jt} = e_{jt} - c_{jt} + b_{jt} - d_{jt},$$

where e_{jt} denotes the contribution of expansions to the industry's employment growth rate, and the same for contractions (c_{jt}), births (b_{jt}), and deaths (d_{jt}). We calculate each term as the change in the industry's employment due to the particular job-flow type (in absolute value) divided by the industry's total employment in $t-1$. We obtain all these measures by doing an aggregation of the NETS data at the four-digit SIC level.

Based on the database of Bartelsman and Gray (1996), we create two rankings of comparative advantage for U.S. industries. Under the premise that the U.S. is a country with relative abundance of skilled labor, the first comparative-advantage ranking is based on the ratio of non-production workers to total employment. To create this ranking, we get the ratio of non-production workers for each industry in 1992 (the first year in our NETS data), and then order the industries in the interval $(0, 2)$: the industry with the lowest level takes a value close to zero, the median industry takes the value of 1, and the industry with the highest level takes a value close to 2. Hence, we expect that industries with rankings close to 0 are in comparative disadvantage, while we expect the opposite for industries with rankings close to 2. We use Υ_{1j} to denote the first ranking of comparative advantage for industry j. The second comparative-advantage ranking is based on total factor productivity growth: we expect industries that have become more productive to be better prepared to compete in an international setting. Then, we rank industries by their total factor productivity growth in the period between 1980 and 1992, and place them in the interval $(0, 2)$ using the same procedure as with the other ranking. We denote the TFP growth ranking for industry j with Υ_{2j}.

The econometric model to estimate is

$$y_{jt} = \beta_I^y \triangle \tau_{jt-1}^I + \sum_m \rho_{Im}^y \triangle \tau_{jt-1}^I \Upsilon_{mj} + \beta_O^y \triangle \tau_{jt-1}^O + \sum_m \rho_{Om}^y \triangle \tau_{jt-1}^O \Upsilon_{mj} + \vartheta Z_{jt-1} + \theta_j + v_t + \varepsilon_{jt}, \quad (37)$$

33

where $y_{jt} \in \left\{ \hat{N}_{jt}, \hat{E}_{jt}, e_{jt}, c_{jt}, e_{jt}{-}c_{jt}, b_{jt}, d_{jt}, b_{jt}{-}d_{jt} \right\}$ is the dependent variable for industry j at time t, $\triangle\tau^I_{jt-1}$ and $\triangle\tau^O_{jt-1}$ are defined as in section 6.2.1, $\Upsilon_{mj} \in (0,2)$, for $m \in \{1,2\}$, is the industry j's value in ranking m of comparative advantage, Z_{jt-1} is a vector of lagged industry-level characteristics, θ_j and v_t account for industry and time fixed effects, and ε_{jt} is an error term.

In a spirit similar to the establishment-level regressions, the parameters that describe the effects of input trade costs on dependent variable y are β^y_I, ρ^y_{I1}, and ρ^y_{I2}. In particular, for an industry with measures of comparative advantage given by Υ_1 and Υ_2, the semi-elasticity of y with respect to input trade costs is

$$\beta^y_I + \rho^y_{I1}\Upsilon_1 + \rho^y_{I2}\Upsilon_2,$$

for $\Upsilon_1 \in (0,2)$ and $\Upsilon_2 \in (0,2)$. Thus, the input-trade-cost semi-elasticity is close to β^y_I for an industry in severe comparative disadvantage (with Υ_1 and Υ_2 close to zero), is $\beta^y_I + \rho^y_{I1} + \rho^y_{I2}$ for an industry in the median in both comparative-advantage rankings, and is $\beta^y_I + 2\rho^y_{I1} + 2\rho^y_{I2}$ for an industry with very high comparative advantage (with Υ_1 and Υ_2 close to 2). We can then compare the input-trade-cost semi-elasticity for this industry, against its output-trade-cost semi-elasticity, which is given by $\beta^y_O + \rho^y_{O1}\Upsilon_1 + \rho^y_{O2}\Upsilon_2$.

An important consideration in our industry-level estimation is the possibility that industries' lobbying groups might look for trade protection when there are employment losses, making tariff rates endogenous.[26] Hence, besides including industry and time fixed effects, which control for unobserved industry characteristics and other general trade policy changes, we estimate equation (37) using an instrumental variables (IV) approach.[27] Under the premise that industries in disadvantage lobby for more protection, Trefler (1993) suggests the use of industry-level comparative-advantage measures to instrument for trade barriers. However, in our case these measures are not valid instruments, as one of the main arguments in our industry-level estimation is that comparative advantage matters for industry-level job flows. Hence, we rely on the use of lagged values of changes in trade costs and lagged levels of average trade costs as instruments (see Appendix B for an instruments' list and more details).

Table 4 presents the industry-level estimation results. We estimate each IV fixed-effects regression using as weights the number of establishments in each industry in 1992. We present robust standard errors clustered at the industry level. Each regression in Table 4 satisfies the requirements of relevance and exogeneity of the instruments. Our IV regressions have identical first-stage results, as they have the same endogenous variables and use the same instruments and control variables. With respect to the instruments' relevance, the first-stage

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[26]There is a large literature on endogenous trade protection. Theoretically, the model of "protection for sale" of Grossman and Helpman (1994) provides a framework to analyze this issue. Using U.S. data, Goldberg and Maggi (1999) find support for the Grossman-Helpman model. Also for the U.S., Trefler (1993) finds that estimates for the effect of trade protection on imports are much larger once endogeneity is taken care of.

[27]As it is unlikely that individual establishments affect trade policy, we do not consider the problem of endogenous protection in our establishment-level estimation. Supporting this view, Trefler (2004) uses plant-level data from Canada, and finds that endogeneity of tariffs is strongly rejected in his plant-level specifications for employment growth and labor productivity. As he puts it, "this likely reflects the fact that tariffs, even if endogenous to the industry, are exogenous to the plant."

Table 4: Industry-Level Estimation

Dependent variable (at time t) indicated in columns

Regressor (at t−1)	Number of establishments ($\hat{N}$)	Employment net growth ($\hat{E}$)	Expansions (e)	Contractions (c)	Net intensive margin (e−c)	Births (b)	Deaths (d)	Net extensive margin (b−d)
Δ(Input trade cost)	15.685**	21.009*	9.893*	-0.625	10.518	9.583	-0.908	10.491
	(7.234)	(12.629)	(5.992)	(3.317)	(7.206)	(9.170)	(4.357)	(10.518)
Δ(Input trade cost) × Υ_1	-11.596**	-15.188**	-4.123	0.854	-4.977	-6.279	3.932	-10.211*
	(4.739)	(7.563)	(3.111)	(1.966)	(3.826)	(4.776)	(2.698)	(6.008)
Δ(Input trade cost) × Υ_2	-6.079	-4.211	-5.583	1.005	-6.589	1.286	-1.092	2.378
	(3.960)	(6.715)	(3.501)	(2.103)	(4.210)	(5.414)	(2.200)	(5.790)
Δ(Output trade cost)	-3.565*	-9.699*	-5.105***	-0.230	-4.875**	-6.552	-1.728	-4.824
	(1.953)	(5.274)	(1.724)	(1.285)	(2.449)	(4.568)	(1.171)	(4.671)
Δ(Output trade cost) × Υ_1	2.757	8.199***	2.624***	-1.249*	3.872***	4.605	0.278	4.327
	(1.897)	(3.132)	(0.967)	(0.666)	(1.158)	(2.847)	(0.808)	(2.884)
Δ(Output trade cost) × Υ_2	1.346	3.187	2.809**	0.199	2.610	2.022	1.445	0.577
	(1.589)	(2.976)	(1.235)	(0.975)	(1.835)	(2.192)	(0.921)	(2.365)
Industry characteristic								
Δlog(Value of shipments)	0.023	0.029	0.023	-0.011	0.033	0.011	0.015	-0.004
	(0.026)	(0.037)	(0.017)	(0.016)	(0.025)	(0.016)	(0.017)	(0.026)
Δlog(Price of shipments)	0.045	0.167*	-0.036	-0.084	0.048	0.036	-0.082**	0.119*
	(0.053)	(0.099)	(0.043)	(0.053)	(0.081)	(0.044)	(0.039)	(0.064)
Δlog(Price of materials)	-0.125***	-0.190**	-0.032	-0.009	-0.023	-0.018	0.150***	-0.168**
	(0.044)	(0.079)	(0.043)	(0.037)	(0.060)	(0.058)	(0.053)	(0.074)
Δlog(Ratio of NP workers)	-0.005	-0.021	-0.004	0.007	-0.011	0.006	0.017	-0.011
	(0.018)	(0.034)	(0.016)	(0.011)	(0.021)	(0.019)	(0.014)	(0.023)
Δlog(TFP)	-0.028	0.093	0.039	-0.042	0.081*	-0.033	-0.044	0.012
	(0.043)	(0.069)	(0.032)	(0.028)	(0.046)	(0.036)	(0.032)	(0.051)
log(Employment)$_{t-2}$	-0.037***	-0.385**	-0.087***	0.047***	-0.134***	-0.224	0.027***	-0.251
	(0.011)	(0.168)	(0.010)	(0.010)	(0.015)	(0.170)	(0.008)	(0.169)
Observations	4,206	4,206	4,206	4,206	4,206	4,206	4,206	4,206
Industries	390	390	390	390	390	390	390	390
Hansen's J-test p-value	0.534	0.693	0.348	0.449	0.625	0.803	0.606	0.751

Notes: Regressions include industry and time fixed effects. Robust standard errors (in parentheses) are clustered at the industry level. The coefficients are statistically significant at the *10%, **5%, or ***1% level.

results—presented in Appendix B—strongly reject the null hypothesis of underidentification and show very large F-statistics (between 35 and 66).[28] With respect to the instruments' exogeneity, the last row in each column in Table 4 presents the p-value from Hansen's J-test of overidentifying restrictions. The null hypothesis that the instruments are exogenous cannot be rejected for any of the regressions (the larger the p-value, the better).

The first column in Table 4 concerns Prediction 3. In that regression, two of the three estimated coefficients on input trade costs are statistically significant at a 5% level. The third coefficient—on the interaction between the change in input trade costs and the TFP ranking—has the same sign as the interaction term based on the ratio of non-production workers. These estimates stress the importance of comparative advantage for Prediction 3: after a decline in input trade costs, there is a decrease in the number of establishments only in industries with comparative disadvantage (with low levels for Υ_1 and Υ_2). Figure 7 looks further into the relationship between comparative advantage and the response of the number of establishments to changes in trade costs. Assuming that $\Upsilon_1 = \Upsilon_2 = \Upsilon$, Figure 7a presents $\hat{\beta}_I^{\hat{N}} + (\hat{\rho}_{I1}^{\hat{N}} + \hat{\rho}_{I2}^{\hat{N}})\Upsilon$ and $\hat{\beta}_O^{\hat{N}} + (\hat{\rho}_{O1}^{\hat{N}} + \hat{\rho}_{O2}^{\hat{N}})\Upsilon$, along with 95% confidence bands. Note that the semi-elasticity with respect to input trade costs is negative and statistically significant at a 5% level for industries with comparative advantage (with a large Υ), implying an increase in the number of establishments after a decline in input trade costs. This result for industries with comparative advantage does not support Prediction 3, suggesting that the effect of input trade costs on the entry of firms varies by the type of industry. In comparison, the estimated semi-elasticities with respect to output trade costs move in the opposite direction and are much smaller in magnitude, though they are not statistically significant at a 5% level for any level of comparative advantage. Figure 7b shows that the difference between the input- and output-trade-cost effects is statistically different from zero for most levels of comparative advantage.

The rest of the columns in Table 4 concern Prediction 4. For the net effect on employment growth, note that the signs and relative magnitudes of the three estimated coefficients on input trade costs are similar to the coefficients for the input-trade-cost effect on the number of establishments. The first coefficient is, however, statistically significant only at a 10% level. A plot of the input-trade-cost semi-elasticities looks very similar to what we observe in Figure 7a, but the 95% confidence band contains the value of zero for every level of comparative advantage—a 90% confidence band, on the other hand, does not contain the value of zero for levels of Υ below 0.32. Hence, after a decline in input trade costs, we obtain a statistically significant (at a 10% level) decrease in employment only for industries with substantial comparative disadvantage.

In the rest of the regressions in Table 4, the estimated coefficients on input trade costs are weak in terms of statistical significance: only two coefficients are statistically significant at a

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[28]A rejection of the null hypothesis of underidentification implies that the instruments are correlated with the endogenous variables; *i.e.* they are relevant. With clustered standard errors, the underidentification test is based on the Kleibergen-Paap rk LM statistic. We obtain a value of 42.73 for the statistic, with a p-value of zero. We cannot carry out the weak identification test suggested by Stock and Yogo (2005) for two reasons: (1) we have six endogenous variables, while Stock and Yogo present critical values for up to three endogenous regressors; and (2) the Stock-Yogo approach only applies for the homoskedastic case, while we assume heteroskedasticity.
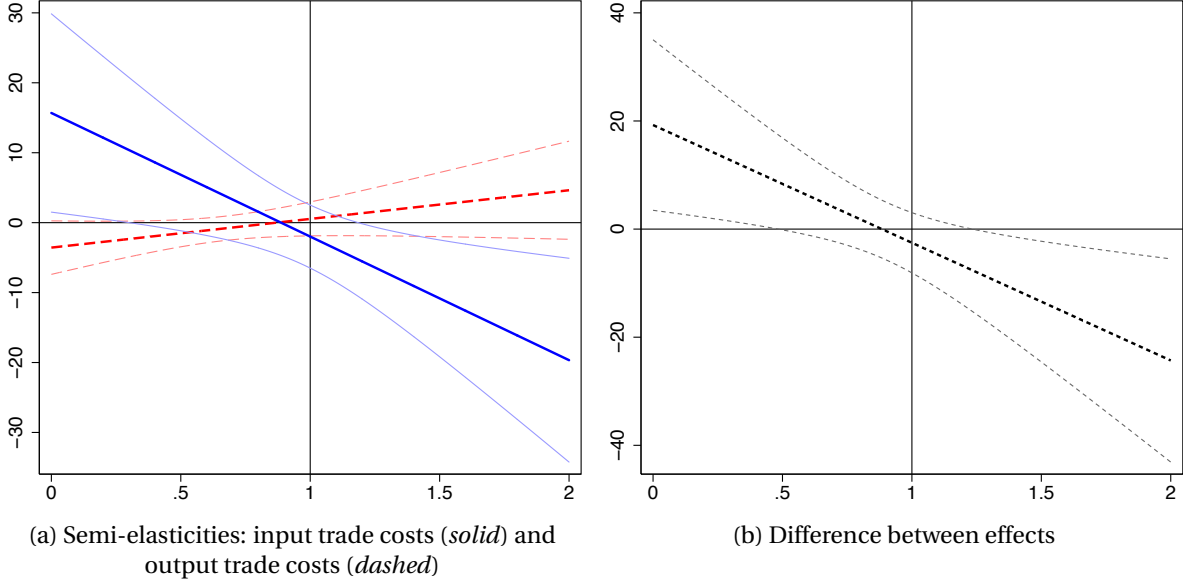
(a) Semi-elasticities: input trade costs (*solid*) and output trade costs (*dashed*)

(b) Difference between effects

Figure 7: The effects of trade costs on the number of establishments, with 95% confidence bands — Industry comparative-advantage ranking on the x-axis (median=1)

10% level, one in the expansions regression and one in the net-extensive-margin regression. However, based on the signs and relative magnitudes, we can describe a general pattern of their contribution in the net employment growth results.[29] In accordance with the previous empirical results, the coefficients have the expected signs. For industries with severe comparative disadvantage, a decline in input trade costs is associated with lower rates of job creation ($\hat{\beta}_I^e > 0$ and $\hat{\beta}_I^b > 0$), and higher rates of job destruction ($\hat{\beta}_I^c < 0$ and $\hat{\beta}_I^d < 0$). Nevertheless, the response of the job destruction rates is by far smaller, and therefore, the net effects at the intensive and extensive margins are mostly determined by expansions and births, respectively. Thus, these results indicate that after a decline in input trade costs, the decrease in employment in industries with comparative disadvantage occurs through less job creation rather than through more job destruction. With respect to the contribution of each margin of employment to the net employment response to input trade costs, the regression results do not show any remarkable difference between them ($\hat{\beta}_I^{e-c}$ is similar to $\hat{\beta}_I^{b-d}$, and $\hat{\rho}_{I1}^{e-c} + \hat{\rho}_{I2}^{e-c}$ is close to $\hat{\rho}_{I1}^{b-d} + \hat{\rho}_{I2}^{b-d}$).

The net intensive-margin results at the establishment level in section 6.2.1 show that high-productivity firms have net expansions after a decline in input trade costs, giving support to the existence of a strong productivity effect. In the model, the productivity effect could dominate the market-access and job-relocation effects in the differentiated-good industry, and hence the net effect at the intensive margin is ambiguous. Empirically, based on the only statistically significant coefficient on input trade costs in the expansions regression, $\hat{\beta}_I^e$, we do not find evidence of a dominating productivity effect in industries with comparative

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[29]Note that the coefficients of the regression of net employment growth are equal to the sum of the coefficients of the net intensive-margin regression and the net extensive-margin regression. The difference between the coefficients from the expansions regression and the contractions regression gives the coefficients for the net intensive-margin regression. The same is true for the births, deaths, and net extensive-margin regressions.

disadvantage.[30]

In the probability-of-death regressions in section 6.2.2, we find an increase in the death probability of low-productivity firms after a decline in input trade costs. The industry-level regression for the number of establishments shows that in comparative disadvantage industries, there are indeed establishments that die and are not replaced—the number of establishments in these industries falls. However, the small and statistically insignificant effect in the industry-level death rate suggests that the employment destroyed by the dying establishments is minimal—*i.e.* the establishments that die are very small and do not have an important effect on industry-level total employment.

For the semi-elasticities with respect to output trade costs, note that the estimated coefficients in the net-employment-growth regression are smaller in magnitude than the input-trade-costs coefficients, but also, they have opposite signs. The output-trade-costs results are driven mainly—in sign, magnitude, and significance—by the expansions regression, whose estimated coefficients on output trade costs are highly significant. The results imply that after a decline in output trade costs, there is net employment creation in industries with comparative disadvantage. This result is the opposite of the theoretical result of Bernard, Redding, and Schott (2007), who find that trade liberalization causes net job destruction in disadvantaged industries, and net job creation in advantaged industries. In their model, both types of industries have simultaneous job creation and destruction after a decline in output trade costs: job destruction from low-productivity firms that are dying or contracting, and job expansions from new and existing high-productivity exporting firms. The job-destruction effect dominates in comparative-disadvantage industries, and the opposite happens in comparative-advantage industries. In section 6.2 we find empirical support for the firm-level predictions of Bernard, Redding, and Schott: after a decline in output trade costs, there are net job expansions in high-productivity establishments, net job contractions in low-productivity establishments, and a higher probability of death in low-productivity establishments. At the industry level, however, the empirical results suggest that the job-creation effect from high-productivity establishments dominates in comparative-disadvantage industries.

Although a formal explanation of the previous result is out of the scope of this paper, we provide a possible explanation. In Figure 5a, note that a decrease in output trade costs is related to statistically significant job expansions even for firms just above the median (*i.e.* about 50% of establishments have a statistically significant increase in their job-expansion rate). Taking into account the effect on the establishment-level job-contraction rate, the net effect in Figure 5c shows statistically significant net job expansions for establishments with a relative productivity ranking of 1.24 or higher (about 38% of establishments). These proportions are very high to be explained solely by exporting firms—according to Bernard, Jensen, Redding, and Schott (2007), only 18% of U.S. manufacturing firms were exporting in 2002. Hence, there must be other channels of job expansion through which (exporting and non-exporting) medium- and high-productivity establishments respond after a decline in output trade costs.

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[30]The signs and magnitudes of the input-trade-cost interaction terms in the expansions regression suggest that the productivity effect becomes stronger in comparative advantage industries. However, that result lacks statistical significance.

As output trade costs are related to trade in final goods, one of these channels might be related to firm-level reactions to increases in competition in the final-goods market. In an industry with a comparative disadvantage, the competitive pressures from new foreign firms (after a decline in trade barriers) are higher than in comparative-advantage industries. Medium- and high-productivity firms—independently of their exporting status—could react by aggresively expanding their operations in order to protect their market share, creating another channel for job expansions after a decline in output trade costs. In a similar spirit, Lawrence (2000) finds that international competition increased productivity in unskilled-labor-intensive industries in the U.S. manufacturing sector and suggests that this productivity growth is biased in favor of unskilled workers.[31]

The regressions include the same industry-level controls that we used in the estimation at the establishment level, plus the log change in the ratio of non-production (NP) workers, and without the log change in industry employment. As the employment net growth and the log change in employment are basically the same variable, the use of the lagged log change would introduce a lagged dependent variable bias in the job-flow regressions. Therefore, we use instead the second lag of the log industry-level employment, which helps us to control for possible trends in employment growth rates. For the other explanatory variables, only the log changes in the prices of shipments and materials are significant in three or more regressions. The estimated coefficients indicate that the employment growth rate increases in industries with increasing prices and decreases (along with the number of establishments) in industries with increasing prices of materials.

The industry-level estimation is less efficient than the establishment-level estimation. The robustness checks in Appendix B support our industry-level results, though they have very limited statistical significance. A lesson from the job-flow literature is that aggregate employment changes hide substantial movements in gross job flows. But also, as obtained here and pointed out by Levinsohn (1999), even industry-level gross job flows hide relevant and efficient firm-level information that is obscured as we aggregate the data.

7   Conclusions

Input trade has changed the international trade landscape. As such, its effects on labor markets have been subject to intense academic and public debate. In this paper, we contribute to this debate by showing how declines in input trade costs affect job flows at the firm and industry levels. Our analysis followed both theoretical and empirical routes.

Our heterogeneous-firm model makes sharp predictions for the effects of input trade costs on job flows. In particular, we identify three basic effects of input trade costs that are absent in a standard Melitz's model of trade in final goods: a market-access effect, a job re-

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[31]Lawrence argues that productivity growth in industries competing with developing countries is biased in favor of unskilled workers, as U.S. firms try to emulate production processes from countries that do not use skill-intensive technologies. He mentions that "we would not expect technological changes in developed countries such as the United States to use more capital- or skill-intensive production methods when experiencing competition from developing countries."

location effect, and a productivity effect. After a decline in input trade costs, the first two effects generate firm-level job destruction, while the productivity effect can generate job expansions for importing firms. In the end, the model predicts deaths and contractions for low-productivity firms, an ambiguous effect for (high-productivity) importing firms, a decline in the industry's number of firms, and overall net job destruction.

Using the universe of establishments in California's manufacturing industry from 1992 to 2004, we find evidence consistent with the firm-level reduced-form predictions of the model. On the other hand, we find empirical support for the industry-level predictions only in industries with comparative disadvantage. That is, our empirical evidence shows that industry comparative advantage matters for the industry-level effects of input trade cost on job flows. For simplicity, our model does not consider industry-level heterogeneity. However, it can be extended in the direction of the Heckscher-Ohlin model with heterogeneous firms of Bernard, Redding, and Schott (2007).

After controlling for output trade costs in our empirical analysis, we find that the effects of input trade costs are more important. First, they matter more for establishment-level decisions on expansions and contractions for most levels of firms' relative productivity. Second, they have a larger impact than output trade costs in the probability-of-death regressions, though the difference is not statistically significant. Third, input and output trade costs have opposite effects in the industry-level analysis, but the effects of input trade costs are stronger. In comparison with the channels identified in heterogeneous-firm models of trade in final goods, our empirical results suggest a higher relevance for job flows of the input-trade-costs channels identified in our model.

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