Tariffs and the Organization of Trade in China*

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Abstract

This paper examines the impact of China's falling import tariffs on the organization of its exports between ordinary and processing trade. These trade forms differ in terms of tariff treatment and the ability of firms to sell on the domestic market. At the industry level, we find that falling input tariffs cause the share of ordinary trade in gross exports to increase, with both the intensive and extensive margins playing roles. The choice of trade form is tied to a lesser degree to the size of the domestic market, which processing firms cannot access. Consistent with the literature, we show that changes in the organization of trade linked to input tariff cuts caused the share of Chinese domestic content in gross exports to increase at the industry-province level.

Keywords: China, Processing Trade, Tariffs, Domestic Content.

JEL classification: F14, F15, F16

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1 Introduction

Between 1990 and 2009, China's share of world manufacturing exports grew from only 2 percent to 13 percent (Hanson, 2012). An important dimension of this impressive growth has been the prominent, albeit declining role of processing exports.[1] In 1999, processing exports represented 57.3 percent of China's total exports, but by 2006 this fell to 53.6 percent and in 2012 were only 34.8 percent.[2] The role of China's ordinary trade increased commensurately. Recent scholarship suggests that the composition of trade matters for China and its trading partners. Koopman, Wang, and Wei (KWW, 2012) and Kee and Tang (KT, 2016) find that ordinary exports embody more than twice as much domestic value added per USD as do processing exports. Furthermore, recent work by Jarreau and Poncet (2012), and Yu (2015) indicates that ordinary trade entails substantially more upgrading and has larger spillovers on the local economy than does processing.

In this paper we examine the causal determinants of this shift to ordinary trade. Ordinary and processing trade in China differ most prominently in terms of tariff treatment and the ability of firms to sell on the domestic market. Firms involved in processing trade enjoy the right to duty-free imports of intermediate goods and capital equipment that are used in export processing activity, but face restrictions in selling to the domestic market. For firms exporting through ordinary, it is the reverse. Beginning in the mid-1990s, China embarked on an ambitious program of tariff liberalization that saw average tariffs fall from over 40 percent in 1995 to less than 10 percent following their accession to the WTO (Branstetter and Lardy, 2008). Lower tariffs should have eroded some of the policy advantages processing exports enjoyed relative to ordinary trade. Changes in the size of the domestic market relative to export opportunities could have either reinforced this effect, or been offsetting.

Utilizing Chinese Customs data for the period between 2000 and 2006, we find strong

[1] Export processing zones and regimes have been a common development strategy existing in various forms in countries such as Mexico, Vietnam, Senegal, and Kenya. Radelet and Sachs (1997) and Radelet (1999) emphasize the importance of export processing zones in export-led development. See Madani (1999) for a review of export processing zones around the world.

[2] Estimates for 1999 and 2006 are taken from Koopman, Wang, and Wei (2012, pg. 184). For 2012, *The China Daily* reported that "processing trade imports and exports accounted for 34.8 percent of the total value of foreign trade, down 9.2 percentage points compared with 2011." http://usa.chinadaily.com.cn/epaper/2013-01/28/content_16180791.htm (retrieved September 22nd, 2016).

evidence that the recent shift from processing to ordinary trade is causally linked to falling input tariffs. Our estimates suggest that falling input tariffs explain slightly more than eighty percent of the observed average increase in the share of ordinary trade in exports at the industry-province level, with both existing and new exporters playing prominent roles in this adjustment.[3] We also link the organization of trade to the size of the domestic market. Up through 2006, more rapid growth of demand in overseas markets offset some of the benefits to organizing exports through ordinary trade tied to falling input tariffs.

We corroborate our key finding for exports through a similar analysis of the organization of imports. Unlike exports, where the impact of falling input tariffs on trade organization is pervasive across all types of goods, our results for imports only hold for capital goods and intermediate inputs, and not for consumption goods. This finding is consistent with a world in which firms can use imported capital and intermediate inputs to produce a variety of goods, and choose the organizational form that maximizes profits.

Last, we examine the link between falling tariffs, trade forms, and the share of domestic content embodied in gross exports. Following KT (2016), we define the *domestic value added ratio* as the value of domestic goods and services embodied in gross exports divided by the value of these exports. KWW (2012) and KT (2016) both document significantly higher domestic value-added ratios in ordinary trade compared to processing. Our results on the relationship between tariffs and trade form suggest possibly significant increases in the share of the value of gross exports earned by domestic agents through this link. There are a number of alternative channels through which lower tariffs may influence this share: within each trade form, tariffs may affect the use of imported intermediates relative to those domestically sourced; in addition, they may affect the respective roles of foreign and Chinese firms, who often differ in their use of imported intermediates. Thus, falling tariffs can be associated with either an increase or decrease in domestic value added ratios. Indeed, an important motivation at the outset of China's reforms for the high tariffs was to maintain high levels of domestic content.

To address this question, we draw on a sample of manufacturing firms that we can di-

[3]These findings complement other recent work emphasizing the contribution of entry to the dynamism in China's manufacturing sector (e.g Brandt, Van Biesebroeck, and Zhang, 2012 and Brandt, Van Biesebroeck, Wang, and Zhang, 2016).

rectly link to Chinese Customs data for the period between 2000 and 2006. For these firms, we document that the domestic value added ratio for ordinary exports is approximately 40 percentage points higher than it is for processing, consistent with earlier estimates by KWW (2012) and KT (2016). Through an analysis of the relationship between changes in input tariffs and changes in the domestic value added ratio for Chinese exports, we find that the fall in input tariffs led to an *increase* in the domestic value added ratio through a change in composition. However, once we control for the direct relationship between the share of ordinary trade and the domestic value added ratio, we no longer find a relationship between input tariffs and domestic value added ratios. This finding implies that the effect of input tariff cuts on the domestic value added ratio of exports operated substantially through the rising share of ordinary trade in China's exports.

To motivate our empirical work, we first sketch out a simple partial equilibrium model of firm organizational choice following Helpman, Melitz, and Yeaple (2004). Under processing trade, firms import intermediate inputs duty free but are restricted from selling on domestic markets. For these firms, the opportunity cost of processing trade is forgone domestic sales; for the marginal firm, the ability to source duty free is offset by restrictions on selling in the domestic market. As a result, lower input tariffs reduce firms' incentives to organize through processing trade. Moreover, lower input prices due to falling tariffs make it easier for new ordinary exporters to overcome the fixed costs of exporting, thereby resulting in the entry of new firms organizing through ordinary trade.

This paper is linked to two distinct literatures within international trade. First, it is related to a small but growing literature on the defining characteristics and causes of ordinary and processing trade in China. Feenstra and Hanson (2005) focus on the effect of incomplete contracts on the choice between domestic or foreign ownership within processing. Our paper is distinct from theirs in that we examine the causes of sorting between ordinary and processing trade. Yu (2015) examines the relative productivity of ordinary and processing firms, and how output tariff cuts affect this difference. Finally, Manova and Yu (2016) examine the influence of credit constraints and higher up-front costs on firm sorting between trade forms. We complement these papers by examining the role of input tariffs, as well as the importance of domestic market access. Second, our paper is linked to an extensive literature on fragmentation of the supply chain and production sharing in the context of China (e.g. Feenstra and Hanson, 2005) and the global trading system in general (Yi, 2003). Within this literature, we are most closely related to Kee and Tang (2016). They point out that, in sharp contrast to the rest of the world, domestic value-added ratios in China rose with global integration.[4] While they analyze the reasons for the changes occuring within each trade form, our analysis focuses on the effect of changes in organizational form on domestic content through the lens of the relationship between lower input tariffs, the organization of trade and domestic value added ratios.

Section 2 describes the institutional context and historical details. Section 3 sketches our simple partial equilibrium model. Section 4 discusses the data and our empirical framework. Section 5 presents our results, with robustness checks provided in Section 6. Section 7 discusses the effect of tariff reduction on the domestic content of China's exports. Section 8 concludes.

2 Stylized Facts/Context

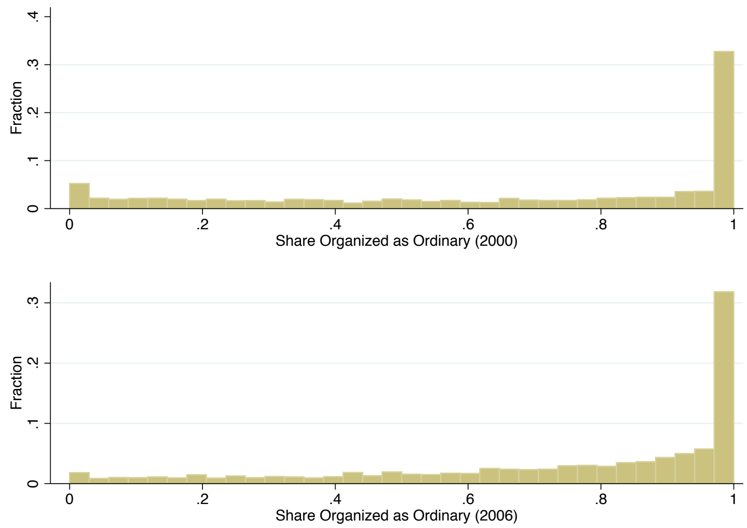
2.1 Ordinary and Processing Trade

The vast majority of Chinese exports occur through either ordinary or processing trade, which combined represent more than 95 percent of Chinese exports between 2000 and 2006.[5] Established in 1979, China's processing regime confers substantial benefits on export processors, most importantly, the right to import duty-free raw materials, components, and capital equipment used in processing activity, and preferential tax treatment (Naughton, 1996). Processing firms are not allowed to use these inputs in production for sales on the domestic market, and in fact must set up segregated production facilities to sell domestically (Interviews, 2005, 2006,

[4]See Johnson and Noguera (2016) for a review of global trends

[5]For a general discussion, see Naughton (1996). Within processing trade, there are two forms: import and assembly and pure assembly, of which the earlier represents more than 75 percent. Both forms can import duty free, but are restricted in terms of their ability to sell to the domestic market. Because of these similarities, we combine these two organizational forms into a single form that we refer to as 'processing'. Differences between the two, including the right to source domestically, ownership of imported intermediates, and taxation as a legal entity, are the focus of a small but growing literature. For a discussion of some of these differences, see Feenstra and Hanson (2005), Branstetter and Lardy (2008), and Fernandes and Tang (2012).

Figure 1: Share of Ordinary Trade (2000 & 2006)

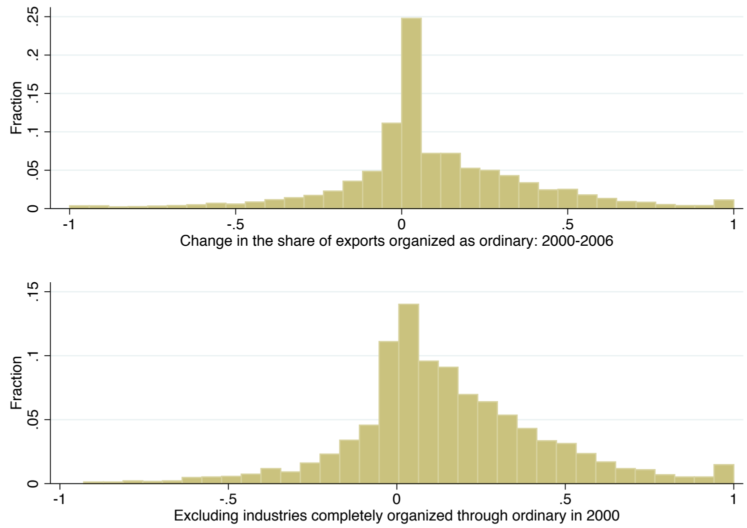


and 2007.)[6] In contrast, firms engaged in ordinary trade must pay duties on their imports, but are free to sell on the domestic market. Consequently, firms in industries in which the domestic market is large relative to export demand have an incentive to organize through ordinary trade. Exports in all organizational forms are subject to VAT rebates.

In the aggregate, ordinary trade comprised 42.1 percent of total exports in 2000 and 45.3 percent in 2006, an increase of 3.2 percentage points, or 7.6 percent. At the 6-digit HS industry, however, trade was organized predominantly through ordinary trade. In 2000, the unweighted average share of ordinary exports across industries was 67.6 percent and by 2006 rose to 75.1 percent, or an increase of 11 percent. The gap between the growth in ordinary's share at the aggregate and the industry level reflects the fact that the sectors experiencing the most rapid growth were heavily involved in processing. Figure 1 presents histograms of the share of exports organized through ordinary trade in HS industries in 2000 and 2006. Figure 2 shows the distribution of changes at the HS level between 2000 and 2006. The bottom panel of Figure 2 drops industries that in 2000 were already completely organized through ordinary trade. The large mass in the distribution to the right of the origin reflects the general shift

[6]Segregated facilities helped to reduce the 'leakage' of tariff-free intermediates into the local economy.

Figure 2: Change in the Share of Ordinary Trade (2000-2006)



towards ordinary trade over this period.

A majority of firms–73 percent in 2003–export through a single organizational form. At the six-digit HS product level, 94.8 percent of all firms in 2003 did the same. Consequently, while exporting through multiple organizational forms is more common at the firm level, only a small percentage of firms export *a given product* through multiple forms.[7] Over time, the prevalence of firms that export a given product through multiple forms also fell from 7.6 percent of all firms in 2000 to 5.2 percent in 2003, and 3.2 percent in 2006. Consequently, in our theoretical and empirical framework, we assume that each plant chooses a single form of trade for each product. Throughout this paper references to 'sector' or 'industry' are to 1996 HS six-digit codes unless otherwise indicated.

2.2 Tariffs

In China, tariffs began to come down in the early 1990s as part of a broad set of external reforms culminating in WTO accession. Statutory tariffs fell from an average of 43.2 percent in 1992

[7] We also observe that exports by firms exporting through multiple forms accounted for 68.8% of total exports in 2003. However, exports by firms exporting a given product through multiple organizational forms accounted for only 33.2 percent of total exports.

to 15.1 percent in 2001 and to 9.9 percent in 2007. This was accompanied by an equally sharp reduction in the dispersion in tariffs (Brandt et al., 2016). Viewed from the perspective of this fifteen-year period, these cuts and the compression in tariffs reflect policymakers' objective of lower and more uniform tariffs. Tariff cuts occurring after 2001 were negotiated in the late 1990s as part of China's WTO accession.[8] Once these tariff cuts were negotiated, they were locked in, severing the link between tariff cuts and contemporaneous economic changes. As a result, concerns about possibly endogenous behavior of tariffs are based on expectations of their effects rather than the effects themselves.

To address concerns about the possible endogeneity of tariff liberalization and lacking a solid IV strategy, we use long-differences to eliminate time-invariant industry-province factors. The robustness section also evaluates numerous threats to the exogeneity of tariff cuts including the initial structure of tariffs across industries, pre-existing trends in input tariffs and ordinary trade shares, as well as changes in other key variables.

2.3 Domestic Absorption

We define domestic absorption to be the value of total sales of firms manufacturing in China less exports plus imports. This is our measure of domestic market size. Although China is often viewed as an 'export-driven' economy, exports represent approximately 15 percent of gross manufacturing output, and domestic absorption exceeds exports in most industries. At the four-digit China Industrial Classification (CIC) level, domestic absorption for the median industry in 2004 was 8 times larger than exports, and was greater than exports in 87 percent of all industries. Over the period we examine, 2000-2006, external demand grew more rapidly than domestic absorption.

3 Theory

In this section, we sketch a simple partial equilibrium model in which entrepreneurs choose between organizing production into either ordinary or processing trade.[9] Input tariffs and

[8] Brandt et al. (2016) discuss the institutional context of this round of tariff liberalization in detail.

[9] We purposefully do not explore the full general equilibrium of the model. This requires a model that captures how falling tariffs affect both global sourcing decisions and product and factor market competition,

domestic demand affect the distribution of exports within an industry between ordinary and processing. The key trade-off that we highlight is that exporting through ordinary trade allows a product to be sold on the domestic market but at the cost that the firm incurs tariffs on imported intermediate inputs. Processing trade offers duty-free import of intermediate inputs but prohibits sale of the product on the domestic market.

3.1 Demand

There are two markets: China and the World. Consumers in each market possess identical and homothetic Cobb-Douglas preferences over an exogenously fixed number of industries indexed i. Within an industry, monopolistically competitive entrepreneurs each sell a single differentiated variety that can *either* be an ordinary *or* a processing good. We assume that the elasticity of substitution is the same across all varieties within an industry and equal to $\sigma > 1$.[10]

Entrepreneurs producing the ordinary good can sell it exclusively in the domestic (China) market (D) or to both domestic and overseas consumers (O). Entrepreneurs producing the processing good are legally prohibited from selling it domestically and can only sell it to world consumers (P). We refer to the choice of which good to produce and the market in which to sell it (D, O, or P) as the 'organization of production' and the choice of ordinary versus processing exports as the 'organization of trade.'

The price an entrepreneur receives for a good produced under organizational form j, (p_i^j), depends on their exogenous capability, (ϕ_f). Industry-specific demand shifters for domestic and World consumers are captured by D_i^C and D_i^W, respectively.[11] Thus, revenue demand functions from selling domestically (D), selling domestically and exporting through ordinary trade (O), and only exporting through processing (P), respectively, are given by:

$$r_i^D(\phi_f) = \left(D_i^C\right) \left[p_i^D(\phi_f)\right]^{1-\sigma}, \quad r_i^O(\phi_f) = \left(D_i^W + D_i^C\right) \left[p_i^O(\phi_f)\right]^{1-\sigma}, \quad r_i^P(\phi_f) = D_i^W \left[p_i^P(\phi_f)\right]^{1-\sigma}.$$

which is beyond the scope of this paper.

[10]We relax these assumptions in the online appendix and consider cases in which: 1. a single entrepreneur can produce both ordinary and processing goods within an industry; and 2. substitution possibilities between varieties within a single trade form are greater than between ordinary and processing varieties within the same industry.

[11]Specifically $D_i^W = (t_i\sigma/(\sigma-1))^{1-\sigma}\nu_i \left(P_i^W\right)^{\sigma-1} Y^W$ where t_i is any exogenous transport cost for exports to the World, ν_i is the share of world income spent in industry i, P_i^W is the world CES price index for industry i and Y^W is world income. A domestic analog holds for D_i^C.

3.2 Inputs, Technology, and Costs

We assume a two-tier production function. In the top tier, there are two factors that are combined via a Cobb-Douglas technology: labor L (with cost share α) and intermediate inputs M, (with a cost share $1-\alpha$).[12] Labor is paid a factor return w. In the lower tier, imported intermediate inputs M_M, and domestically supplied intermediate inputs M_D are combined into the composite M via a CES technology with an elasticity of substitution ψ.[13] Imported intermediates face an ad-valorem tariff set at the industry level τ_i unless used in the production of processing exports. For this section, we assume that input prices (which include transport costs), p_M and p_D, are exogenous. We discuss issues associated with pass-through of input tariff cuts into import prices (p_M) and into prices charged by domestic firms (p_D) below. In addition, firms face a fixed cost of production f_i^j that we allow to differ by organizational form and industry.

As suggested by KWW (2012) and KT (2016), the use of imported intermediate inputs can differ across industries and also across organizational forms within an industry. Assuming that variable and fixed costs have the same relative factor mix within an organizational form, total cost functions associated with the three organizational forms are given by:

$$TC_i^D \equiv c_i^D \left[\frac{q_f}{\phi_f} + f_i^D\right], \qquad TC_i^O \equiv c_i^O \left[\frac{q_f}{\phi_f} + f_i^O\right], \qquad TC_i^P \equiv c_i^P \left[\frac{q_f}{\phi_f} + f_i^P\right],$$

where q_f is output and

$$c_i^O = c_i^D \equiv w^\alpha \left[p_D^{1-\psi} + \gamma_i^O \left(\tau_i p_M\right)^{1-\psi}\right]^{\frac{1-\alpha}{1-\psi}} \qquad c_i^P \equiv w^\alpha \left[p_D^{1-\psi} + \gamma_i^P \left(p_M\right)^{1-\psi}\right]^{\frac{1-\alpha}{1-\psi}}. \tag{1}$$

The total cost functions for domestic and ordinary trade firms (TC_i^D and TC_i^O) are similar in that both include tariffs τ_i on their imported intermediate inputs; reflecting the preferential policies extended to processing activity, the total cost function for processing firms (TC_i^P) does not. If the unit input requirement of imported intermediate inputs is higher for processing than for ordinary (for reasons unrelated to input tariffs) then $\gamma_i^P > \gamma_i^O$.[14] Lemma 1 formalizes the

[12] In the empirical section, we allow for multiple primary inputs to enter into industries with different intensities. Their inclusion at this point does not illuminate the results that follow.

[13] KT (2016) find ψ to be greater than one in large cross-section of Chinese industries during this period.

[14] Formally, this is seen by using Shephard's lemma and setting $\tau_i = 1$.

notion that, other things equal, the input bundles associated with production for the domestic market and ordinary trade are more expensive in industries in which input tariffs are higher.

Lemma 1. *For a given p_M/p_D, both c_i^D/c_i^P and c_i^O/c_i^P are increasing in τ_i, other things equal.*

Proof. Simple inspection of the equations in (1) deliver the result. ∎

Profit functions for domestic, ordinary, and processing organization are as follows:

$$\pi_i^D = \frac{D_i^C}{\sigma}\left(c_i^D\right)^{1-\sigma}\phi_f^{\sigma-1} - c_i^D f_i^D, \tag{2}$$

$$\pi_i^O = \frac{D_i^C + D_i^W}{\sigma}\left(c_i^O\right)^{1-\sigma}\phi_f^{\sigma-1} - c_i^O f_i^O, \tag{3}$$

$$\pi_i^P = \frac{D_i^W}{\sigma}\left(c_i^P\right)^{1-\sigma}\phi_f^{\sigma-1} - c_i^P f_i^P. \tag{4}$$

Following the literature, we assume that the fixed cost of production for domestic sales is smaller than for exporting through either form (e.g. Bernard, Jensen, Redding, and Schott, 2007).

3.3 Sorting

Taking capabilities as given, entrepreneurs in industry i choose the organization of production that maximizes profit and earn $v_i(\phi_f) \equiv \max\left\{0, \pi_i^D(\phi_f), \pi_i^O(\phi_f), \pi_i^P(\phi_f)\right\}$.[15] Conditional on exporting, entrepreneurs sort into either ordinary or processing trade depending on whether $\pi_i^O(\phi_f) \lesseqgtr \pi_i^P(\phi_f)$.

We refer to the case in which there are strictly positive amounts of both ordinary and processing exports in an industry as a 'diversified equilibrium.' All exporters for whom $\pi_i^O(\phi_f) > \pi_i^P(\phi_f) > 0$ sort into ordinary trade, and all for whom $\pi_i^P(\phi_f) > \pi_i^O(\phi_f) > 0$ sort into processing. Any exporter for whom $\pi_i^O(\phi_f) = \pi_i^P(\phi_f) > 0$ is indifferent between organizational forms. Setting equation (3) equal to (4), the capability of this marginal exporter is equal to:

$$\left(\phi_f^P\right)^{\sigma-1} \equiv \frac{\sigma\left[c_i^P f_i^P - c_i^O f_i^O\right]}{D_i^W\left(c_i^P\right)^{1-\sigma} - \left(D_i^W + D_i^C\right)\left(c_i^O\right)^{(1-\sigma)}}. \tag{5}$$

[15]The first argument allows for costless exit.

This expression will be strictly positive as long as the two inequalities below are of the same direction:

$$\left(\frac{c_i^O}{c_i^P}\right)^{\sigma-1} \lesseqgtr 1+\frac{D_i^C}{D_i^W} \qquad \text{and} \qquad \frac{c_i^P f_i^P}{c_i^O f_i^O} \lesseqgtr 1. \tag{6}$$

When both inequalities are strictly greater than (>), the marginal profit with respect to capability and the fixed cost of exporting are greater for processing than for ordinary exports. If they are both strictly less than (<), then the marginal profit with respect to capability and the fixed cost of exporting are greater for ordinary trade than for processing.[16] The first case describes a setting in which the benefits of importing capital and intermediate inputs duty free compensate only the most capable entrepreneurs for the higher fixed costs of processing and the loss of access to domestic consumers. In the second case, only for the most capable entrepreneurs do the returns to accessing the domestic market compensate for the higher fixed cost of ordinary exports and loss of duty free intermediate inputs.[17]

If $\pi_i^O(\phi_f) > \pi_i^P(\phi_f)$ for all active exporters, then a 'specialized equilibrium' holds in which all exporters sort into ordinary exports. Under the opposite inequality, only processing is chosen for active exporters.[18] A specialized equilibrium with only ordinary trade will hold if ordinary trade is both high marginal profit and low fixed cost such that the first inequality of (6) is $<$ and the second is $>$. This can emerge if domestic market size is relatively large and/or input tariffs are relatively low.[19] A specialized equilibrium with only processing trade can emerge if the profit return to capability is higher for processing and the fixed cost is lower.[20]

Figure 3 presents a diversified equilibrium in which there is both a larger return to capability and greater fixed cost for processing. Consistent with this, the processing profit function cuts the ordinary profit function from below. $\left(\phi^{P,1}\right)^{\sigma-1}$ represents the capability at which an entrepreneur is indifferent between ordinary and processing. $\left(\phi^{O,1}\right)^{\sigma-1}$ is the capability at

[16]Both of these cases can be seen easily by examining the profit functions associated with each organizational form of production: equations (3) and (4).

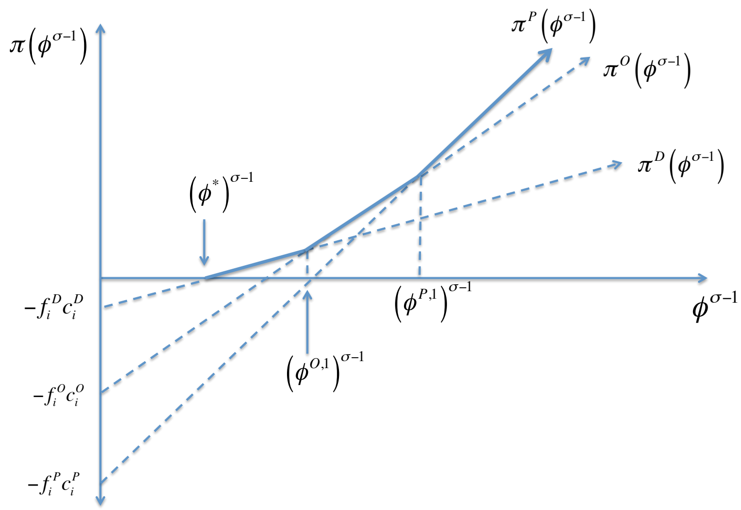
[17]If there are no differences in fixed costs, all exporters choose the organizational form with greater marginal profit.

[18]As in Melitz (2003), this requires that some firms choose to export.

[19]Technically, it can also hold if the inequalities in (6) are both $<$ but the profits of the marginal firm are negative.

[20]This is the case when firms produce for the domestic market and export through processing alone. In practice, these types of firms are rare: only 1.4% of firms produce for the domestic market and export through processing but not ordinary trade.

Figure 3: Higher Marginal Return to Processing Exports

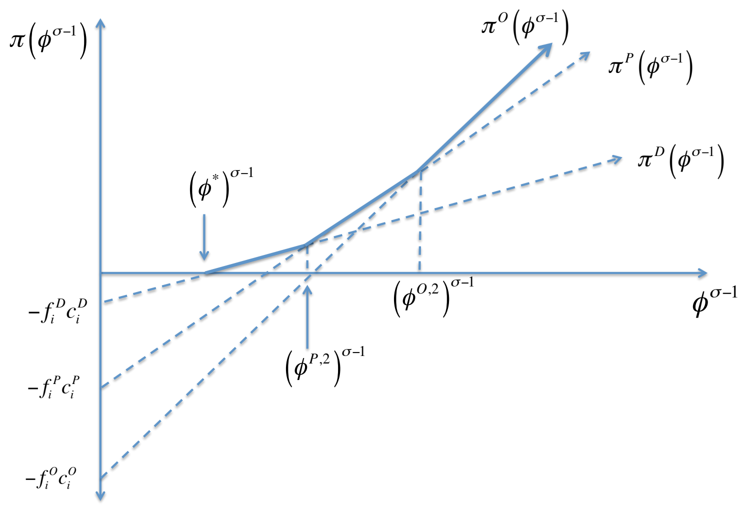


which entrepreneurs are indifferent between selling exclusively to the domestic economy and exporting through ordinary trade. Entrepreneurs with capability $\phi_f < \phi^*$ exit. The solid line depicts $v_i(\phi)$. In this case, the least capable entrepreneurs exit, the low intermediate capability entrepreneurs produce only for the domestic market, high intermediate capability entrepreneurs organize through ordinary trade, and the most capable entrepreneurs organize through processing.

Figure 4 presents a diversified equilibrium in which ordinary trade offers a higher return to capability, but at a greater fixed cost. $\left(\phi^{P,2}\right)^{\sigma-1}$ denotes the level of capability for which an entrepreneur is indifferent between domestic sales and processing trade, and $\left(\phi^{O,2}\right)^{\sigma-1}$ is the critical cut-off between export processing and ordinary trade. ϕ^* is unchanged between the two figures. In the second case, the least capable entrepreneurs exit, low intermediate capability entrepreneurs produce only for the domestic market, high intermediate capability entrepreneurs organize through processing, and the most capable entrepreneurs organize through ordinary trade.

We remain agnostic as to which ordering of the inequalities is most likely to hold at the industry level. As we show below, in both cases the key finding holds, namely, that relative trade shares respond to changes in input tariffs and differences in the size of the domestic

Figure 4: Higher Marginal Return to Ordinary Exports



relative to the foreign market across industries.[21] Either ordering can be rationalized, and is model-dependent.[22] For example, if R&D causes substantial fixed costs in processing or if intermediate input tariffs are high, then Figure 3 is empirically relevant. Alternatively, if capital investment or identifying export markets causes high fixed costs for ordinary trade, and if a high premium is also placed on the ability to access the domestic market, then Figure 4 should hold.

3.4 Specialized Equilibrium: Comparative Statics

If $\pi_i^P(\phi_f) > \pi_i^O(\phi_f)$ for all firms that choose to export, then all exporters organize through processing. Lower input tariffs can cause some firms to switch to ordinary trade, leading to a diversified equilibria as in Figure 3 or 4. This increases the share of ordinary exports from zero to some positive amount.[23] An increase in the size of the domestic market relative to foreign can have a similar effect. If $\pi_i^O(\phi_f) > \pi_i^P(\phi_f)$ for all exporters, then all exporters organize through ordinary trade, and lower input tariffs and/or a larger relative domestic market size

[21]All results continue to go through if selling domestically is high fixed cost/high marginal profit relative to processing as well.

[22]Recent research arguing that processing firms are less productive than firms engaged in ordinary trade suggests the ordering in Figure 4. See Yu (2015) and Manova and Yu (2016).

[23]If the change in input tariffs is large enough, the industry can shift from being completely organized through processing to being completely organized through ordinary trade.

cannot increase the share of ordinary exports any more. However, the *level* of ordinary exports will increase in this case. For this reason, the empirical section also examines the effect of falling input tariffs and relative market size on export levels.[24]

3.5 Diversified Equilibrium: Comparative Statics

To develop crisp predictions for the share of ordinary trade when ordinary and processing co-exist in an industry, we assume that productivity follows a Pareto distribution, with $\phi_{min,i}$ representing the minimum productivity draw in industry i, and $k > \sigma - 1$ the common shape parameter.[25] We define the (value) share of total exports that occur through ordinary trade in industry i as $S_{O,i} \equiv \frac{V_{O,i}}{V_{O,i}+V_{P,i}}$ where $V_{j,i}$ is the value of shipments in industry i through organizational form j. Proposition 1 lays out the relevant comparative static results for changes in input tariffs and relative market size (holding the other constant):

Proposition 1. *Suppose that* $0 < S_{O,i} < 1$. *If* τ_i *falls, holding* $\frac{D_i^C}{D_i^W}$ *fixed, then* $S_{O,i}$ *rises regardless of which organizational form is high return to capability/high fixed cost. If* $\frac{D_i^C}{D_i^W}$ *rises, holding* τ_i *fixed, then* $S_{O,i}$ *rises regardless of which organization of exporting is high return to capability/high fixed cost.*

Proof. See the online appendix. ∎

For the sorting depicted in Figure 3, lower input tariffs increase the marginal profit to ordinary exporting as marginal costs fall and profits rise for entrepreneurs that previously were not able to overcome the fixed cost of ordinary exports. Consequently, some entrepreneurs that previously only sold domestically now export the ordinary good as the minimum capability necessary for ordinary trade also falls $\left[\left(\phi^{O,1}\right)^{\sigma-1}\downarrow\right]$. In addition, some entrepreneurs that previously chose to organize through processing trade now switch into ordinary trade due to a falling cost advantage of processing trade. As a result, the minimum capability at which entrepreneurs organize through processing trade rises $\left[\left(\phi^{P,1}\right)^{\sigma-1}\uparrow\right]$. On the intensive margin, falling input tariffs lower input prices which are passed through into lower prices, causing export levels of incumbent ordinary exporters to rise while there is no change for processing

[24] The online appendix presents graphically the comparative statics discussed in this subsection.

[25] This restriction ensures industry revenue is finite.

exporters who are not subject to these tariffs. Consequently, the share of exports organized through ordinary trade increases on both the extensive and intensive margins.

For the sorting in Figure 4, lower input tariffs increase both the marginal return to exporting through ordinary trade and of selling domestically as marginal costs fall for entrepreneurs organizing through those two forms of production. Consequently, some entrepreneurs that previously chose to organize through processing trade now switch into ordinary trade due to a falling cost advantage of processing trade $\left[\left(\phi^{O,2}\right)^{\sigma-1}\downarrow\right]$ and some entrepreneurs that previously exported through processing choose to sell only on the domestic market $\left[\left(\phi^{P,2}\right)^{\sigma-1}\uparrow\right]$. Again, the level of ordinary exports increases for incumbent ordinary exporters due to lower input prices. Consequently, the share of exports organized through ordinary trade increases on both the extensive and intensive margins. In both cases, a larger domestic market relative to international demand also increases the attractiveness of organizing through ordinary trade, leading to an increase in the share of exports organized through ordinary trade.

3.6 Pass-Through

Our theoretical framework assumes that p_D and p_M are both exogenous and do not respond to changes in tariffs. This implies 100% pass-through of lower tariffs into the price that firms pay for imported inputs $(1+\tau)p_M$ and 0% pass-through into the price of domestically provided inputs p_D. We now briefly discuss departures from this assumption and discuss evidence regarding pass-through in China during this period.

Consider the case of complete pass-through of lower input tariffs into the price that firms pay for domestically provided inputs such that a one percent fall in input tariffs also causes p_D also to fall by one percent. If p_M is exogenous and fixed, the relative price of domestically provided inputs to foreign-provided inputs $(p_D/\left((1+\tau)p_M\right))$ does not change and firms that are subject to tariffs do not substitute between domestically provided and imported intermediates occurs. Ordinary firms' sales expand as the prices of *each* of their intermediate inputs fall because they benefit from both lower tariffs on imported goods and lower prices for domestically provided inputs. Average cost for firms engaged in processing trade also falls even though they do not pay tariffs on imported inputs. This is because the price of domestically provided inputs falls.[26] Average cost for processing declines by less than for ordinary exporters because they do not benefit from lower input tariffs on imported inputs. While total industry ordinary exports increase due to lower average costs, the change in total processing exports is ambiguous as some firms might reorganize into ordinary trade. The share of ordinary trade increases.

Pass-through into the prices of domestically provided inputs has been shown to be strong in China. Brandt et al. (2016) find that the pass-through of tariff cuts into the price of domestically provided intermediates is approximately 0.4 over a one-year window. Long-run pass-through is likely even larger. For import prices, Han et al. (2016) also find evidence of incomplete pass-through. They estimate that a one percent lower tariff results in an approximately 0.5 percent lower (tariff inclusive) price of imported goods.[27] The similarity in the two estimates suggests that the relative price of inputs from these two sources changes very little with tariff cuts, thereby mitigating any possible substitution effects between them.

4 Data

We use trade transaction data collected by the Customs Administration of China available for the years 2000-2006. These data provide firm-level information at the 8-digit HS level on the quantity and value of exports and imports, destination and source countries, whether goods are exported directly or through Hong Kong, organizational form (e.g. processing and ordinary trade), and ownership type (e.g. foreign- or Chinese-owned). To link data over time, we aggregate these data to the six-digit HS level.[28] We use the full sample of transactions data rather than the commonly used matched transactions-manufacturing sample [as in KT (2016) and Manova and Yu (2016)] because the latter omits small firms who tend to organize through ordinary trade.

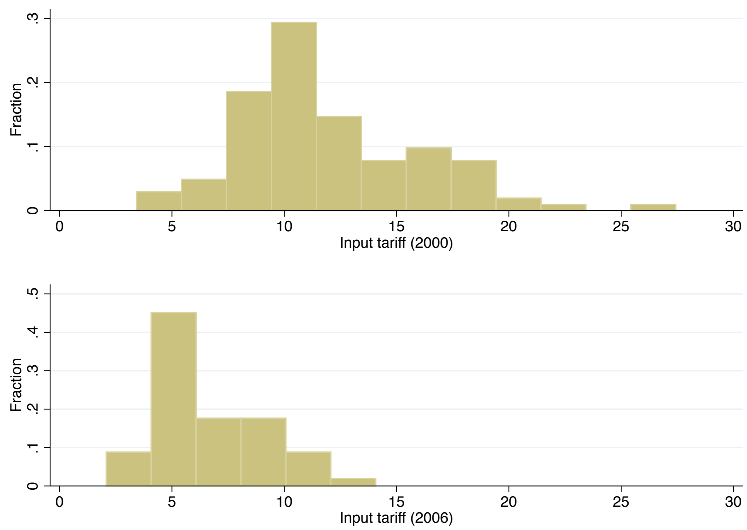
A key variable of interest in our analysis is input tariffs. Generally speaking, a firm's

[26]Processing firms do use domestically provided inputs. KT (2016) and KWW (2012) estimate that the domestic value added ratio for processing exports is between 0.4 and 0.5. Pass-through of lower tariffs into the price of domestically provided inputs can also cause substitution toward these inputs by processing firms consistent with the evidence presented in KT (2016).

[27]Han et al. (2016) Table 2, column 1.

[28]A change in HS codes in 2002 requires us to use a concordance linking pre- and post-2002 codes.

Figure 5: Input Tariffs ($\tau_{I,it}$): 2000 & 2006



input tariff is a weighted average of tariffs applied to goods imported by the firm. Following the literature (e.g. Brandt et al., 2016), we use input tariffs that are constructed by passing statutory tariffs through the Chinese input-output matrix.[29] The resulting tariffs therefore vary at the Chinese Input-Output (IO) classification level.[30] By construction, all variation in input tariffs over time comes from changes in the statutory tariffs and not from changes in the intensity with which these inputs are used. Figure 5 presents histograms of the calculated input tariffs in 2000 and 2006. We observe a clear fall and compression in input tariffs with the average input tariff calculated at the IO industry level falling from 11.43 percent to 6.49 percent between 2000 and 2006.

Domestic absorption for industry i, D_{it}^{D}, is total industry sales in the domestic (Chinese) market. By definition, it is equal to the sum of total sales of all firms in that industry producing in China minus exports plus imports. The manufacturing census data that are required to calculate this variable are only available for 1995, 2004, and 2008 at the Chinese Industrial Classification (CIC) level.[31] We interpolate to obtain annual values for 2000-2003 and 2005-2006. Appendix A describes this in detail. As required by theory, we divide domestic absorption

[29]We use the 2004 input-output matrix.
[30]There are 84 of these codes.
[31]There are 352 of these codes, each of which maps into approximately 6-8 HS codes.

Table 1: Summary Statistics

Variable	**Obs.**	**Mean**	**Median**	**Std. Dev.**	**Min**	**Max**
$S_{O,ip,2000}$	31,357	0.848	1	0.314	0	1
$S_{O,ip,2003}$	39,427	0.882	1	0.273	0	1
$S_{O,ip,2006}$	49,123	0.897	1	0.250	0	1
$\ln(S_i/U_i)$	56,239	-0.924	-0.871	0.310	-2.574	-0.427
$\ln(K_i/L_i)$	56,239	4.350	4.262	0.349	3.009	5.210
$\%Diff_i$	56,239	0.471	0.450	0.220	0.024	0.980
$D^D_{i,2000}/D^X_{i,2000}$	56,239	15.950	6.643	44.926	0.013	783.666
$D^D_{i,2003}/D^X_{i,2003}$	56,239	13.824	6.123	31.932	0.002	455.429
$D^D_{i,2006}/D^X_{i,2006}$	56,006	10.230	4.985	26.980	0.005	480.379
$\tau_{I,i,2000}$	56,239	10.825	10.124	3.462	3.431	26.852
$\tau_{I,i,2003}$	56,239	6.984	6.349	2.298	2.267	15.899
$\tau_{I,i,2006}$	56,239	6.160	5.859	1.714	2.135	13.369

by total exports (D^X_{it}) to obtain a normalized measure of domestic relative to foreign demand, D^D_{it}/D^X_{it}.[32] We refer to this as *relative market size* for the remainder of the paper.

We also consider the effect of several industry-level variables that reflect differences in factor requirements or the prices of intermediate inputs sourced domestically and internationally that might affect organizational choice. Specifically, we include measures of the skilled labor and capital intensity in each industry. To avoid any bias associated with the endogeneity of firm input choice, we use U.S. measures of skill (the ratio of non-production to production workers) and capital (ratio of equipment to labor) intensity from the NBER manufacturing data base.[33] We use the Chinese input-output matrix to capture both direct and indirect demand for skilled labor and capital-intensive intermediate inputs. We also include the proportion of intermediate inputs that are differentiated ($\%Diff_i$) from Nunn (2007).

Table 1 presents summary statistics for all variables used in our primary regressions where observations are indexed by industry i and province p. Ordinary trade is extremely common with the median industry-province observation organized exclusively through ordinary trade in all years.[34] In addition, the (average) share of ordinary trade is increasing on average over

[32]External market size is also constructed at the CIC level using a concordance from the HS to the CIC level. In cases where a given HS code maps into multiple CIC sectors, we allocate trade using CIC industry size as measured by output.

[33]These measures were originally published by the NBER at the SITC level. We then used a concordance to translate them to the HS 6-digit level.

[34]Ordinary trade is more common in Table 1 than described in section 2. This is partially due to the fact that processing is geographically concentrated, as a result of which the unweighted average share in ordinary at the industry-location level is higher than it is at the industry level.

time.[35] As illustrated in Figure 5, input tariffs fell by an average of 4.7 percentage points. Although the domestic market was larger than exports in each year, it grew less rapidly; as a result, relative domestic market size declined over time.

4.1 Estimation Details

Our primary outcome of interest is the value share of exports organized through ordinary trade:

$$S_{O,ipt} \equiv \frac{V_{O,ipt}}{V_{O,ipt} + V_{P,ipt}}, \tag{7}$$

where $V_{O,ipt}$ and $V_{P,ipt}$ are export values organized through ordinary and processing trade, respectively, for industry i in province p in year t. We examine the organization of trade at this level for four reasons. First, in contrast to the firm-level, industry-level analysis allows us to quantify the extensive margin's contribution to total changes. Second, ordinary trade firms are generally small. For this reason, average changes in ordinary trade at the firm level often differ from changes at the industry level. Third, geographic heterogeneity may play an important role in determining firms' choice of organizational form (Defever and Riaño, 2012). In the Chinese context, special economic zones are prominent. And fourth, we conduct our analysis at the six-digit HS level, as opposed to the four-digit CIC, to examine more finely the product-level extensive margin.

In the cross section, we estimate equation (8) for each of the years $t \in \{2000, 2003, 2006\}$

$$\ln(S_{O,ipt}) = \beta_{I,t} \ln(\tau_{I,it}) + \beta'_{X,t} \mathbf{X}_{it} + \Phi_{pt} + \epsilon_{ipt} \tag{8}$$

where $\tau_{I,it}$ is the input tariff, $\mathbf{X}_{it}$ is a vector of explanatory variables, and Φ_{pt} is a province fixed effect for that cross-section. We use provincial fixed effects to control for factors such as the presence of special economic zones that might make some geographic locations more likely to be organized into ordinary or processing trade. Finally, ϵ_{ipt} is an error term that is clustered at the IO-industry level to account for the fact that multiple HS industries may map into a single IO industry at which the input tariff is defined, and that other control variables

[35] The number of observations on trade shares is less than that on tariffs and industry characteristics because exports in some observations are zero.

are only defined at the industry level and not the industry-province level.

In the cross-section, we use Tobit estimators that are censored from above at $\ln(1) = 0$. We discuss censoring from below in section 6. Our dependent variable is undefined if there are no exports, and so our panel is unbalanced. Finally, because exporting activity by a different number of firms underlie each observation, heteroskedasticity might compromise the consistency of our estimates. For this reason, we weight each observation by the number of firms in the industry-province cell.

In order to eliminate any time-invariant industry-province effects that might be correlated with input tariffs, we also estimate the relationship by taking first differences of equation (8) between 2000 and 2006. Our estimating equation is then given by equation (9):

$$\Delta \ln(S_{O,ipt}) = \beta_{\Delta I} \Delta \ln(\tau_{I,it}) + \beta_X' \mathbf{X}_i + \Phi_p + \epsilon_{\Delta,ipt} \tag{9}$$

where standard errors are clustered at the IO level and variables are defined analogous to equation (8).[36] Input tariff reductions between 2000 and 2006 are defined as negative. The coefficients β_X' now capture differential trends in the share of ordinary exports correlated with industry observables, and Φ_p absorbs province-specific trends. Section 6 examines and rules out reasons why additional industry-specific trends might be correlated with changes in input tariffs.

5 Results

Columns (1)-(6) of Table 2 present Tobit estimation results of equation (8), while columns (7) and (8) are linear estimates for equation (9). Columns (7) and (8), which eliminate time-invariant industry-province factors, are our preferred specifications but we present cross-sectional results for comparison.

In the individual cross-sections for 2000, 2003 and 2006, the coefficient on input tariffs is consistently negative and declining slightly. The results suggest that sectors with the lowest (highest) input tariffs have the highest (lowest) share of ordinary trade. Consistent with our

[36] Results are robust to two-way clustering at the IO-province level as described by Cameron, Gelbach, and Miller (2008).

model, there is also a robust positive correlation in each year between relative market size and the role of ordinary trade in exports.

The time-series effects of tariffs are similar. Column (8) suggests that a 1 log point cut in input tariffs increases the average share of ordinary trade by 0.81 log points, *ceteris paribus*. With weighting, the average increase in the share of ordinary trade for a given industry-province pair is 0.54 log points. With input tariffs falling on average by 0.56 log points [ln(10.83) − ln(6.16)] between 2000 and 2006, this implies that 83% of the average change in the share of ordinary trade is consistent with falling input tariffs.[37] The effect of relative market size is positive and significant as suggested by theory, and only slightly smaller than in the cross-section. Table 1 shows that the ratio of domestic absorption to external market size was actually *falling* during this period, which partially offset the effect of falling input tariffs on trade form.

5.1 Levels

Table 3 explores the growth rates of export levels that underlie our results for shares. We do this for two reasons. First, our model predicts that the *level* of ordinary trade within an industry-province pair should rise as input tariffs fall. If there is no pass-through, we might expect processing exports to decline due to reorganization, although some degree of pass-through into the price of domestically provided intermediate inputs might provide a countervailing force as discussed in section 3.6. Second, the large number of observations that are organized exclusively through ordinary trade precludes an increase in the share of ordinary trade but does allow for increased levels in response to lower input tariffs.

We start by estimating the following regression where $\Delta \ln(V_{ipt})$ is the log change in export value between 2000 and 2006 in the industry-province pair ip:

[37] This large contribution is not due to our weighting scheme. The unweighted average change is 0.10 log points. The weighted average of 0.54 log points reflects the fact that industry-province pairs with more firms increased their share of ordinary trade more than those with fewer firms. Estimating equation (9) without weights delivers a coefficient on input tariffs of 0.24 [$p = 0.07$] suggesting an even larger contribution of falling tariffs to the increase in the ordinary share of trade (1.35=0.24*0.56/0.10) suggesting mitigating effects from other factors. The change in relative market size can be one such mitigating factor.

Table 2: Baseline Estimation

	Dep. Var: $\ln(S_{O,ipt})$						Dep. Var: $\Delta\ln(S_{O,ipt})$	
	2000	2000	2003	2003	2006	2006	2000-2006	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln(\tau_{I,it})$	-1.67***	-1.01**	-0.82***	-0.63**	-0.49**	-0.53**		
	(0.53)	(0.45)	(0.32)	(0.30)	(0.25)	(0.23)		
$\Delta\ln(\tau_{I,it})$							-0.90***	-0.81**
							(0.26)	(0.31)
$\ln(D^D_{it}/D^X_{it})$		0.22**		0.18**		0.11*		
		(0.10)		(0.09)		(0.06)		
$\Delta\ln(D^D_{it}/D^X_{it})$								0.068**
								(0.03)
$\%Diff_i$		-1.33**		-1.36***		-1.02***		-0.14
		(0.62)		(0.51)		(0.36)		(0.12)
$\ln(S_i/U_i)$		-0.55		-0.63		-0.72***		0.029
		(0.59)		(0.39)		(0.26)		(0.15)
$\ln(K_i/L_i)$		0.18		0.043		0.14		-0.076
		(0.69)		(0.48)		(0.30)		(0.15)
Obs.	30,434	30,434	38,927	38,927	47,406	47,199	26,927	26,839
Non-Cens.	7,613	7,613	9,303	9,303	11,468	11,442	.	.
R-Cens.	22,821	22,821	29,624	29,624	35,938	35,757	.	.

Columns (1)-(6) are one-sided Tobits with an (upper) censoring value of $ln(1) = 0$. Columns (7) and (8) are WLS. Dependent variables are at the top of each column. Standard errors in parentheses are clustered at the IO level. All regressions include province fixed effects. $p < 0.01$: $^{***}, 0.01. \leq p < 0.05 :^{**}, 0.05 \leq p < 0.10 :^{*}$. Regressions weighted by the number of firms for each ip observation.

Table 3: Growth of Total, Ordinary, and Processing Exports

	Dep. Var. $\Delta\ln(V_{j,ipt})$			Dep. Var. $\%\Delta V_{j,ipt}$		
	Total	Ord.	Proc.	Total	Ord.	Proc.
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\ln(\tau_{I,it})$	-0.11	-0.91*	0.13	-0.075	-0.34**	0.057
	(0.27)	(0.50)	(0.28)	(0.13)	(0.16)	(0.18)
$\Delta\ln(D^X_{it})$	1.13***	0.93***	0.90***	0.54***	0.28***	0.62***
	(0.07)	(0.09)	(0.05)	(0.05)	(0.04)	(0.04)
$\Delta\ln(D^D_{it}/D^X_{it})$	-0.038	-0.061	-0.078	0.030	-0.0057	-0.0069
	(0.03)	(0.05)	(0.06)	(0.02)	(0.02)	(0.03)
$\%Diff_i$	-0.20*	-0.29	0.083	-0.023	-0.014	-0.11
	(0.12)	(0.21)	(0.28)	(0.06)	(0.07)	(0.20)
$\ln(S_i/U_i)$	0.14	0.16	0.76***	0.0053	0.014	0.40***
	(0.09)	(0.20)	(0.15)	(0.05)	(0.07)	(0.11)
$\ln(K_i/L_i)$	0.020	0.040	-0.13	0.020	0.076	-0.11
	(0.07)	(0.15)	(0.12)	(0.04)	(0.07)	(0.07)
Obs.	27,655	26,839	6,483	47,436	47,079	11,666
Non-Cens.	.	.	.	27,655	26,839	6,483
R-Cens.	.	.	.	19,781	20,240	5,183

Columns (1)-(3) are WLS and columns (4)-(6) are two-sided Tobits with censoring values of -2 and 2. Dependent variables given at the top of each column. Standard errors in parentheses are clustered at the IO level. All regressions include province fixed effects. $p < 0.01 :^{***}, 0.01 \leq p < 0.05 :^{**}, 0.05 \leq p < 0.10 :^{*}$. Regressions weighted by the number of firms for each ip observation.

$$\Delta \ln(V_{ipt}) = \beta_{\Delta I} \Delta \ln(\tau_{I,it}) + \beta'_X \mathbf{X}_i + \Phi_p + \epsilon_{\Delta',ipt}. \quad (10)$$

We then run similar regressions where the dependent variables are ordinary exports and processing exports, $\Delta \ln(V_{O,ipt})$ and $\Delta \ln(V_{P,ipt})$, respectively. One difference between this estimating equation and the one for shares [equation (9)] is the need to control for changes in total demand at the industry level that are differenced out when looking at shares. To do this we follow an IV strategy in which we include the increase in Chinese exports to the world [$\Delta \ln \left(D^X_{it}\right)$] and then instrument for it using the change in world trade (excluding China).[38] Columns (1)-(3) of Table 3 present these results.

We also estimate these relationships using as the dependent variable a proportional change calculated from a midpoint average:

$$\%\Delta V_{ipt} = \frac{V_{ip,2006} - V_{ip,2000}}{0.5 * [V_{ip,2006} + V_{ip,2000}]}$$

that is bound between [-2,2] by design and is estimated using a two-sided Tobit with censoring at these values.[39] This transformation has the advantage of accommodating values of zero in 2000 or 2006 (but not both) and is common in the job creation and destruction literature [see Levinsohn (1999) and Haltiwanger, Jarmin, and Mir (2013)]. These results appear in columns (4)-(6). Columns (1) and (4) show no statistically significant relationship between changes in input tariffs and total exports although the point estimate is negative. As expected however, falling input tariffs increase ordinary exports [columns (2) and (5)]. The effects on processing exports [columns (3) and (6)] are not significantly different from zero.

5.2 Imports and Heterogeneous Effects

Our theory suggests that falling input tariffs should also increase the share of *imports* organized through ordinary trade. We examine this relationship in Table 4, where the dependent variable is the (log) share of imports organized through ordinary trade, $\ln(S^M_{O,ipt})$. For comparability, we use the output tariff calculated at the same level as the input tariff that we use in Table 2.

[38] This is calculated at the HS six-digit level. The instrument is strong well above conventional levels.

[39] Dependent variables for ordinary and processing in columns (5) and (6) are defined analogously.

The relationship between lower output tariffs and the change in the share of imports coming through ordinary trade [column (8)] is positive, but only marginally significant [$p = 0.12$].

To explore this result further, Table 5 examines whether there are heterogeneous effects of lower input tariffs by type of good. Using the United Nations Broad Economic Classification (BEC) system, we classify goods into three basic categories: consumption goods, capital goods, and intermediate inputs. In our regressions, we include a set of interactions terms involving indicators for these categories and our tariff measures. The omitted category in all regressions is consumption goods. Because processing trade most prominently involves the imports of intermediate inputs and capital goods for further assembly and re-export, we expect our results to be strongest for these two types of goods and do not expect them to hold for imports of final consumption goods. Since processing trade involves the use of imported intermediates in the manufacture and exporting of all types of goods, we have no strong prior about how our results might differ by the type of exported good.

Columns (1) and (4) of Table 5 replicate column (8) of Tables 2 and 4, respectively. Columns (2) and (5) add indicator variables for capital goods and intermediate inputs, $BEC_{K,i}$ and $BEC_{INT,i}$. Columns (3) and (6) include the interaction terms. Column (3) is consistent with our prior that the effect of lower input tariffs does not depend on the type of good that is being produced for export. Furthermore, column (6) suggests that input tariffs influence the choice between importing through ordinary or processing in the case of intermediate and capital goods, but have no effect on consumption goods.

5.3 Decomposition

There are a number of alternative margins through which the increase in ordinary trade may have occurred. We start by decomposing the total effect into the contributions of domestic and foreign firms. Both play a prominent role in China's exports. In 2000, 53% (47%) of total exports was through foreign (domestic) firms. Of total exports by foreign firms, 13% was through ordinary trade in 2000, while 59% of total exports by domestic firms was through ordinary. Our concern here is that other policy changes implemented concurrently with the

Table 4: Imports

	Dep. Var: $\ln\left(S^M_{O,ipt}\right)$						Dep. Var: $\Delta\ln\left(S^M_{O,ipt}\right)$	
	2000	2000	2003	2003	2006	2006	2000-2006	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln\left(\tau_{O,it}\right)$	-1.50*	-0.98**	-0.86	0.063	-0.034	0.44		
	(0.77)	(0.49)	(0.62)	(0.49)	(0.35)	(0.40)		
$\Delta\ln\left(\tau_{O,it}\right)$							-0.20	-0.35
							(0.30)	(0.22)
$\ln\left(D^D_{it}/D^X_{it}\right)$		0.20**		0.21**		0.18*		
		(0.09)		(0.10)		(0.10)		
$\Delta\ln\left(D^D_{it}/D^X_{it}\right)$								0.10
								(0.09)
$\%Diff_i$		3.77***		3.25***		2.38***		-1.26***
		(0.99)		(0.79)		(0.63)		(0.37)
$\ln\left(S_i/U_i\right)$		2.53***		1.96***		1.33**		-1.50***
		(0.65)		(0.74)		(0.60)		(0.35)
$\ln\left(K_i/L_i\right)$		0.48		0.37		0.31		-0.067
		(0.44)		(0.43)		(0.35)		(0.28)
Obs.	26,947	26,947	33,980	33,980	36,279	36,082	22,271	22,164
Non-Cens.	11,810	11,810	14,846	14,846	16,808	16,791	.	.
R-Cens.	15,137	15,137	19,134	19,134	19,471	19,291	.	.

Columns (1)-(6) are one-sided Tobits with an (upper) censoring value of $ln(1) = 0$. Columns (7) and (8) are WLS. Dependent variables are at the top of each column. Standard errors in parentheses are clustered at the IO level. All regressions include province fixed effects. $p < 0.01$:***, $0.01. \leq p < 0.05$:**, $0.05 \leq p < 0.10$:*. Regressions weighted by the number of firms for each ip observation.

Table 5: Heterogeneous Effects

Panel A: Exports				Panel B: Imports			
Dep. Var: $\Delta\ln(S_{O,ipt})$				Dep. Var: $\Delta\ln(S^M_{O,ipt})$			
	(1)	(2)	(3)		(4)	(5)	(6)
$\Delta\ln\left(\tau_{I,it}\right)$	-0.81**	-0.83***	-1.12**	$\Delta\ln\left(\tau_{O,it}\right)$	-0.35	-0.33	0.24
	(0.31)	(0.29)	(0.51)		(0.22)	(0.23)	(0.27)
$BEC_{K,i} * \Delta\ln\left(\tau_{I,it}\right)$			-0.26	$BEC_{K,i} * \Delta\ln\left(\tau_{O,it}\right)$			-0.54*
			(1.27)				(0.33)
$BEC_{INT,i} * \Delta\ln\left(\tau_{I,it}\right)$			0.46	$BEC_{INT,i} * \Delta\ln\left(\tau_{O,it}\right)$			-0.65*
			(0.54)				(0.38)
$\Delta\ln\left(D^D_{it}/D^X_{it}\right)$	0.068**	0.086**	0.087**	$\Delta\ln\left(D^D_{it}/D^X_{it}\right)$	0.10	0.091	0.090
	(0.03)	(0.04)	(0.04)		(0.09)	(0.09)	(0.09)
$BEC_{K,i}$		0.047	-0.084	$BEC_{K,i}$		-0.16	-0.46*
		(0.10)	(0.71)			(0.19)	(0.25)
$BEC_{INT,i}$		0.080	0.34	$BEC_{INT,i}$		0.038	-0.32
		(0.07)	(0.29)			(0.17)	(0.28)
$\%Diff_i$	-0.14	-0.080	-0.12	$\%Diff_i$	-1.26***	-1.08***	-1.10***
	(0.12)	(0.15)	(0.17)		(0.37)	(0.36)	(0.36)
$\ln\left(S_i/U_i\right)$	0.029	0.0053	0.018	$\ln\left(S_i/U_i\right)$	-1.50***	-1.46***	-1.48***
	(0.15)	(0.13)	(0.13)		(0.35)	(0.37)	(0.37)
$\ln\left(K_i/L_i\right)$	-0.076	-0.073	-0.079	$\ln\left(K_i/L_i\right)$	-0.067	-0.094	-0.086
	(0.15)	(0.14)	(0.14)		(0.28)	(0.29)	(0.29)
Obs.	26,839	26,806	26,806	Obs.	22,164	22,164	22,164

All regressions are WLS. Dependent variables given at the top of each column. Standard errors in parentheses are clustered at the IO level. All regressions include province fixed effects. $p < 0.01$:***, $0.01 \leq p < 0.05$:** , $0.05 \leq p < 0.10$:*. Regressions weighted by the number of firms for each ip observation.

Table 6: Decomposition

	Total	Domestic	Foreign	Domestic Incumbent	Foreign Incumbent	Domestic New	Foreign New	Domestic Exit	Foreign Exit
	$\%\Delta S_{O,ipt}$	$DOM_{O,ipt}$	$FOR_{O,ipt}$	$DOM^I_{O,ipt}$	$FOR^I_{O,ipt}$	$DOM^N_{O,ipt}$	$FOR^N_{O,ipt}$	$DOM^E_{O,ipt}$	$FOR^E_{O,ipt}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta \ln \left(\tau_{I,it}\right)$	-0.61**	-0.45*	-0.15	-0.075	-0.080	-0.19	-0.12	-0.18*	0.040*
	(0.24)	(0.23)	(0.12)	(0.10)	(0.05)	(0.18)	(0.08)	(0.10)	(0.02)
$\Delta \ln \left(D^D_{it}/D^X_{it}\right)$	0.056**	0.051***	0.0053	-0.00072	0.0069	0.011	-0.0097	0.041***	0.0081**
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
$\%Diff_i$	-0.053	-0.063	0.013	-0.061	-0.036	-0.091	0.046	0.089	0.0030
	(0.10)	(0.10)	(0.04)	(0.04)	(0.03)	(0.06)	(0.04)	(0.07)	(0.01)
$\ln\left(S_i/U_i\right)$	-0.11	-0.17**	0.064	0.0021	-0.00085	-0.12***	0.064	-0.055	0.0011
	(0.12)	(0.08)	(0.05)	(0.04)	(0.02)	(0.04)	(0.04)	(0.06)	(0.01)
$\ln\left(K_i/L_i\right)$	0.021	0.071	-0.052	-0.041*	-0.0036	0.053	-0.026	0.059	-0.023***
	(0.12)	(0.08)	(0.05)	(0.02)	(0.02)	(0.04)	(0.04)	(0.05)	(0.01)
Obs.	27,597	27,597	27,597	27,597	27,597	27,597	27,597	27,597	27,597
L-Cens.	95	73	18	1	8	0	0	72	9
Non-Cens.	26,839	27,265	27,509	27,589	27,575	27,364	27,550	27,525	27,588
R-Cens.	663	259	70	7	14	233	47	0	0

All regressions are two-sided Tobits with censoring values of -2 and 2. Dependent variables given at the top of each column. Standard errors in parentheses are clustered at the IO level. All regressions include province fixed effects. $p < 0.01$:***, $0.01 \leq p < 0.05$:**, $0.05 \leq p < 0.10$:*. Regressions weighted by the number of firms for each ip observation.

tariff cuts might have encouraged greater entry by Chinese-owned firms, in which case the correlation between tariffs and ordinary trade shares would be spurious. One specific policy is the universal extension of direct trading rights in 2004 to domestically-owned firms, rights which foreign-owned firms already possessed (see Bai, Krishna, and Ma, 2015). Second, because of potential differences between domestic and foreign firms in the use of imported intermediates within each trade form, the effect of tariffs on their choices may matter for the overall relationship between tariffs and domestic value added ratios.

Because the change in the log of a sum of components cannot be decomposed exactly, we use the proportional change in the share of ordinary trade $\%\Delta S_{O,ipt} \equiv \frac{S_{O,ip,2006}-S_{O,ip,2000}}{0.5*[S_{O,ip,2006}+S_{O,ip,2000}]}$, and decompose it into components due to changes in domestic and foreign firms:[40]

$$\%\Delta S_{O,ipt} = DOM_{O,ipt} + FOR_{O,ipt}.$$

[40]Formally, start by defining $V^D_{O,ipt}$ as ordinary exports by domestic firms, and V_{ipt} as total exports. Then, we can define $DOM_{O,ipt} \equiv \frac{\frac{V^D_{O,ip,2006}}{V_{ip,2006}} - \frac{V^D_{O,ip,2000}}{V_{ip,2000}}}{0.5*\left[S_{O,ip,2006}+S_{O,ip,2000}\right]}$ as the contribution of domestic firms to the total proportional increase in the share of ordinary trade. An analogous expression holds for the contribution of foreign firms $FOR_{O,ipt}$ with the sum of the two equaling the total proportional change, $\%\Delta S_{O,ipt}$. Appendix B describes this in more detail.

Under the properties of linear regression, the marginal effects of lower input tariffs for these two components sum to the total effect.[41] Column (1) of Table 6 presents the effect of lower input tariffs on the total change in the share of ordinary trade, $\%\Delta S_{O,ipt}$. Columns (2) and (3) decompose this into the contributions of domestic and foreign firms, $DOM_{O,ipt}$ and $FOR_{O,ipt}$.

Domestic firms account for the largest share of the total change (75%), highlighting their importance in the expansion of ordinary trade. The contribution from foreign firms is non-negligible (25% of the total), however it is not statistically significant. This can be either because foreign firms were not increasing their share of ordinary trade or their small overall share of ordinary trade makes their contribution difficult to pick up. If the former, we are concerned that our results reflect reforms benefitting domestically-owned firms rather than the effect of input tariffs. Consequently, in Appendix C we examine the percentage increase in the share of ordinary exports in domestic and foreign firms separately. For both subsamples, we find large, positive and significant effects of falling input tariffs on the share of ordinary trade. Thus, while both domestic and foreign firms increased their "within" share of ordinary trade, the *contribution* of domestic firms to the total change was much larger.

Next, we further decompose the total effect into components due to incumbents (I), new firms (N), and exiting firms (E), allowing each of these to be further divided into domestic and foreign firm components:[42]

$$\%\Delta S_{O,ipt} = \underbrace{DOM^{I}_{O,ipt} + FOR^{I}_{O,ipt}}_{incumbents} + \underbrace{DOM^{N}_{O,ipt} + FOR^{N}_{O,ipt}}_{new\ firms} + \underbrace{DOM^{E}_{O,ipt} + FOR^{E}_{O,ipt}}_{exiting\ firms}.$$

Incumbent firms [columns (4) and (5)] are those that sell the same product in 2000 and 2006. New firms [columns (6) and (7)] are those that start exporting a product between 2000 and 2006.[43] Exiting firms [columns (8) and (9)] are those that stop exporting a product between 2000 and 2006. Again, the sum of the marginal effects of the change in tariffs for these components [columns (4)-(9)] equals the total effect [column (1)].

[41] Although Tobit is a non-linear estimator, the small number of censored values when looking at proportional changes leads it to closely resemble linear regression.

[42] These terms are derived analogously as in footnote 40. See Appendix B for more details of this decomposition.

[43] In this group, we include firms that exported another product in 2000 and added the relevant product after 2000. These are not quantitatively important.

On the intensive margin, we find similar point estimates for both domestic and foreign incumbent firms. Falling input tariffs also cause the share of ordinary trade to increase due to entry of new domestic and foreign exporters, with domestic firms playing a slightly stronger role. Finally, we find that falling input tariffs increased ordinary trade shares due to less exit by domestic firms but lower ordinary trade due to increased exit by foreign firms, however the net effect of the two is to increase the share of ordinary trade.

The strong role for new exporters in increasing the share of ordinary trade (columns 6 and 7) is consistent with the ordering in Figure 3 as lower input tariffs allow intermediate capability firms who had previously only sold domestically to overcome the fixed costs of exporting and enter into ordinary trade. However, the role for exit (columns 8 and 9) is consistent with intermediate capability firms leaving processing to sell on the domestic market alone as the preferential treatment associated with processing trade diminishes.[44] Therefore, our results suggest that the data fall somewhere in between Figure 3 in which processing trade is high return to capability/high fixed cost relative to ordinary trade and Figure 4 in which the opposite is true.

6 Robustness

We now examine the robustness of our results to a potential number of concerns including functional form, the sample of observations we use, and endogeneity issues that pose threats to our identification strategy.

6.1 Functional Forms

We re-estimate equation (8) using two alternative specifications. Results appear in Appendix D. With $S_{O,ipt}$ as the dependent variable, we use two-sided Tobits that allow for censoring at $S_{O,ipt} = 0$ and $S_{O,ipt} = 1$. Comparable estimates are provided for equation (9), where the

[44]Tables 2 and 3 are consistent with either ordering. With no pass-through of lower input tariffs into prices charged by domestic intermediate input providers, both orderings predict an increase in the level of ordinary trade and a fall in processing trade as processing exporters sort into ordinary trade. With some pass-through of lower input tariffs into prices charged by domestic intermediate input providers, the prediction for processing exporters becomes ambiguous as they have access to lower prices charged by domestic providers of intermediate inputs and pass some of these lower prices onto consumers abroad.

Table 7: Robustness

	No Trading Co.	Interior in 2000	$\tau_{I,i,2000}$	Trend $\tau_{I,it}$	$\Delta\tau_{I,it}^{alt}$	China Skill	Trend $S_{O,ipt}$	IV	Value Weights	Finance
	$\Delta\ln(S_{O,ipt}^{NT})$	$\Delta\ln(S_{O,ipt})$	$\Delta\ln(S_{O,ipt})$	$\Delta\ln(S_{O,ipt})$	$\Delta\ln(S_{O,ipt})$	$\Delta\ln(S_{O,ipt})$	$\Delta\ln(S_{O,ipt}^{03-06})$	$\Delta\ln(S_{O,ipt})$	$\Delta\ln(S_{O,ipt})$	$\Delta\ln(S_{O,ipt})$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\Delta\ln\left(\tau_{I,it}\right)$	-0.95**	-0.78**	-0.76***	-0.77***		-0.80***		-0.82**	-2.27***	-0.78**
	(0.39)	(0.39)	(0.26)	(0.28)		(0.27)		(0.34)	(0.79)	(0.33)
$\ln\left(\tau_{I,i,2000}\right)$			0.040							
			(0.14)							
$\Delta\ln\left(D_{it}^{D}/D_{it}^{X}\right)$	0.080*	0.039	0.064*	0.065**	0.10***	0.059	0.051**	0.059	0.23	0.063*
	(0.04)	(0.04)	(0.04)	(0.03)	(0.02)	(0.04)	(0.02)	(0.05)	(0.14)	(0.04)
$\%Diff_i$	-0.18	-0.43**	-0.15	-0.11	-0.085	-0.11	-0.037	-0.13	-0.044	-0.20
	(0.16)	(0.16)	(0.12)	(0.12)	(0.12)	(0.12)	(0.07)	(0.12)	(0.48)	(0.16)
$\ln\left(S_i/U_i\right)$	-0.0085	0.26	0.044	0.026	0.019		0.099	0.018	-0.23	0.0097
	(0.18)	(0.19)	(0.15)	(0.15)	(0.09)		(0.08)	(0.17)	(0.36)	(0.14)
$\ln\left(K_i/L_i\right)$	-0.14	-0.23	-0.079	-0.058	-0.12	-0.031	-0.028	-0.068	0.28	-0.075
	(0.17)	(0.16)	(0.14)	(0.15)	(0.09)	(0.13)	(0.07)	(0.17)	(0.33)	(0.15)
$\Delta\ln\left(\tau_{I,it}^{96-99}\right)$				-0.58						
				(0.35)						
$\Delta\ln\left(\tau_{I,it}^{alt}\right)$					-0.44***					
					(0.10)					
$\ln(S_i/U_i)_{ch}$						-0.037				
						(0.09)				
$\Delta\ln\left(\tau_{I,it}^{short}\right)$							-0.53*			
							(0.28)			
$\Delta\ln\left(S_{O,ipt}^{00-02}\right)$							-0.072***			
							(0.02)			
$exfin_i$										-0.16
										(0.18)
$invent_i$										-1.06
										(1.45)
$tang_i$										-0.51
										(0.61)
RD_i										0.51
										(0.85)
Obs.	17,124	7,471	26,839	26,839	26,709	26,839	23,516	26,839	26,839	26,839

All columns are WLS. Dependent variables are at the top of each column. Standard errors in parentheses are clustered at the IO level except for column (5) in which standard errors are clustered at the HS six-digit level. All regressions include province fixed effects. $p < 0.01 :^{***}, 0.01 \leq p < 0.05 :^{**}, 0.05 \leq p < 0.10 :^{*}$. Regressions weighted by the number of firms for each ip observation except column (9) which is weighted the value of exports for each ip observation.

dependent variable is the proportional increase in ordinary trade $\%\Delta S_{O,ipt} = \frac{S_{O,ip,2006} - S_{O,ip,2000}}{0.5*[S_{O,ip,2006} + S_{O,ip,2000}]}$, which is bound in the interval [-2,2]. Results are robust to this specification. Our results are also robust to using first differences that are bound in the interval [-1,1].

6.2 Subsamples

Over the period we examine, a significant (29% in 2000), albeit declining portion of China's trade was carried out through trading companies. Although we observe both ordinary and processing exports through trading companies, a potential concern is that for trade intermediated by trading companies, the mechanisms outlined in section 3 may be muted by other factors. Thus, as is common in the literature (e.g. Manova and Yu, 2016), column (1) of Table 7 excludes all firms identified to be trading firms.[45] Results are slightly stronger than our baseline specification.

Column (2) examines a subsample for which there was a strictly positive amount of *both* ordinary and processing exports in 2000. This allows us to examine the effect of input tariff cuts on industry-locations that were not at corners, and had potentially more room for choice between ordinary and processing. It also drops all province-industry observations that were already at 100 percent ordinary trade in 2000 and thus could not increase their share of ordinary trade.

6.3 Additional Tariff Measures

Column (3) includes the initial input tariff level in 2000. This serves two purposes. First, it controls for pre-WTO levels of protection in an industry. Second, it controls for the possibility that sectors may have had different trajectories based on their initial tariff level. We are also concerned that pre-existing trends may be endogenously correlated with our tariff measures, thus biasing our results. In column (4), we include the change in input tariffs from 1996 to 1999 to help absorb any unobserved heterogeneity.

One common criticism of input tariffs constructed using input-output tables is that they do not distinguish imported from domestically provided intermediate inputs. By relying on the

[45]This is done by looking for the Chinese characters for "trading company" in a firm's name.

input tariffs constructed by using the IO matrix, our measures are also rather coarse. Column (5) uses an input tariff constructed from firm product-level import data in a manner analogous to Yu (2015).[46] Our results are robust to this measure.[47]

6.4 Additional Endogeneity Concerns

Column (6) considers the possibility that US measures of skill intensity may be inaccurate measures of the skill requirements of Chinese firms. Consequently, we replace our measure of skill intensity from the NBER with a measure from the Chinese census. Results are unchanged. Column (7) examines pre-existing trends in trade shares. Our concern is that pre-existing trends may be endogenously correlated with our tariff measures, thus biasing our results. We do not have data on the pre-2000 trends for the share of ordinary trade. However, in column (7), we run regressions for the change in the share of ordinary trade from 2003 to 2006 using input tariff cuts over the same period, and include as additional controls the change in ordinary's share from 2000 to 2002. Finally, column (8) addresses the fact that domestic absorption is an endogenously determined outcome because of its normalization by total exports. We instrument for this using a variable whose denominator contains total world exports (excluding China) to the world.[48] Column (9) weights the observations by total shipments in the industry-province pair instead of by the number of firms. While the point estimate is much larger, the qualitative result is unchanged.

Finally, column (10) considers the variables related to financial constraints examined by Manova and Yu (2016). Specifically, we include: (i) reliance on external financing ($exfin_i$); (ii) the ratio of inventory to sales ($invent_i$) which is commonly thought to reflect liquidity needs, (iii) the ratio of tangible to total assets ($tang_i$); and (iv) R&D expenditures as a proportion of total sales (RD_i). All variables are from Kroszner et al. (2007). Our results are robust to their inclusion.[49]

[46] The online appendix describes the construction of this alternate input tariff in detail.

[47] While the point estimate is smaller in absolute value, the average change in this measure is larger leading to similar contributions.

[48] The instrument is strong with a first stage F-statistic of 242 when the data are collapsed to the CIC level.

[49] Although they are insignificant in the results presented here, $invent_i$ and $tang_i$ are of the expected sign and are significant in the cross section.

7 Implications for Domestic Factor Demand

KWW (2012) and KT (2016) argue that ordinary exports embody a larger share of Chinese value added than do processing exports. Both papers estimate that the share of domestic value added in Chinese exports ('domestic value added ratio') is 40-50 percentage points higher for ordinary than processing trade.[50] Consequently, our results imply that falling input tariffs might influence the domestic value added ratio of an industry's exports by affecting the relative mix of ordinary and processing trade. However, lower levels of protection might have offsetting influences that could *reduce* the share of value paid to domestically provided goods and services. In particular, reductions in the level of protection that lower the relative price of imported intermediate inputs might lead firms and industries to substitute away from domestic factors. In addition, the composition of exports between domestic and foreign firms might also be altered, inducing changes in overall domestic content depending on differences in domestic value added ratios between these two types of firms. This section rigorously assesses this potentially ambiguous effect.

7.1 Calculating Domestic Value Added Ratios

Following KT (2016), we start by calculating the domestic value added ratio (DVAR) for the exports of each industry. This represents the share of gross export revenue accruing to domestically provided goods and services. To do so, we link the Customs data for 2000-2006 to firm-level data that are a product of annual surveys by the National Bureau of Statistics (NBS).[51] Appendix E discusses the construction of this variable in detail.[52] A DVAR value of one implies that all export revenue accrues to domestic agents, while a value of zero implies that all export revenue goes to foreign agents.[53] These calculations are at the four-digit Chinese

[50]KWW (2012) estimate that between 2002 and 2007 the domestic content of ordinary trade was 86.8 percent of total value compared to 37.3 percent for processing. Using firm-level data, KT (2016) obtain estimates of 88 and 42 percent, respectively.

[51]This results in a subsample that covers 32 percent of the aggregate export value used in section 5 in 2000 and 37 percent in 2006. Table A1 in the online appendix re-estimates the baseline results of Table 2 using this subsample and finds that they continue to hold.

[52]Following KT, we drop trading firms from this analysis but similar regression results hold with their inclusion.

[53]Because we are only calculating this for exports, we are not double-counting domestic content as long exports are not re-imported for further processing.

Table 8: Average Industry Domestic Value Added Ratios ($DVAR$)

Year	Total	Ord.	Proc.	Ord. (Dom.)	Proc. (Dom.)	Ord. (For.)	Proc. (For.)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
2000	0.679	0.944	0.503	0.968	0.529	0.928	0.496
	(329)	(324)	(284)	(260)	(119)	(299)	(277)
2006	0.792	0.954	0.593	0.969	0.595	0.941	0.595
	(352)	(351)	(332)	(341)	(253)	(347)	(321)

Note: Numbers in parentheses are CIC industry counts.

Industrial Classification (CIC) level (as opposed to the HS level) because each firm in the NBS data is assigned to a single CIC industry. After aggregating up to the industry level, Table 8 presents average domestic value added ratios across industries.

Column (1) of Table 8 shows that across CIC industries domestic value added ratios increased (on average) from 67.9 to 79.2 percent between 2000 and 2006, an 11.3 percentage point or 16.6 percent change. This parallels the increase in ordinary trade over the same time span. Columns (2) and (3) provide the same estimates where DVAR is calculated for ordinary and processing shipments separately. Consistent with KWW (2012) and KT (2016), domestic content is approximately 30-40 percentage points higher for ordinary trade than for processing in both 2000 and 2006. Columns (4) and (5) calculate the industry average of DVAR for exports by domestic firms. Columns (6) and (7) present statistics for exports by foreign firms. Results are similar for the subsamples comprised of these two types of firms.

Table 8 also shows that the domestic value added ratio increased very little for ordinary shipments between 2000 and 2006. This is true on average [column (2)], for exports by domestic firms [column (4)], and for exports by foreign firms [column (6)]. However, as also found by KT (2016), the average domestic value added ratio actually increased within processing. This is true on average [column (3)] for exports by domestic firms [column (5)], and exports by foreign firms [column (7)].[54] These data confirm that there are potentially large effects from compositional shifts out of processing and into ordinary trade.

[54]KT (2016) argue that this is at least partially due to lower input tariffs that increased upstream competitiveness. Relatedly, Yu (2015) finds strong productivity enhancing effects of output tariff cuts on firms engaged in ordinary trade who can provide intermediate inputs to other Chinese firms.

Table 9: Input Tariffs and Domestic Value Added Ratios

	Dep. Var. $\Delta\ln(DVAR_{ipt})$		Dep. Var. $\Delta DVAR_{ipt}$		Dep. Var. $\%\Delta DVAR_{ipt}$	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\ln\left(\tau_{I,it}\right)$	-0.51**	-0.28	-0.25**	-0.19*	-0.48**	-0.33
	(0.24)	(0.27)	(0.10)	(0.11)	(0.20)	(0.20)
$\Delta\ln(S_{O,ipt})$		0.17***		0.058***		0.12***
		(0.03)		(0.01)		(0.02)
$\ln\left(S_i/U_i\right)$	-0.24	-0.19	-0.19**	-0.18**	-0.24	-0.22
	(0.19)	(0.19)	(0.08)	(0.08)	(0.16)	(0.15)
$\ln\left(K_i/L_i\right)$	0.37**	0.14	0.13*	0.053	0.28**	0.11
	(0.17)	(0.15)	(0.07)	(0.06)	(0.14)	(0.11)
$\%Diff_i$	0.23	-0.048	0.16	0.081	0.26	0.094
	(0.26)	(0.27)	(0.11)	(0.10)	(0.21)	(0.20)
$\Delta\ln\left(D_{it}^D/D_{it}^X\right)$	-0.015	-0.0038	0.018	0.023	0.0047	0.017
	(0.06)	(0.05)	(0.03)	(0.02)	(0.05)	(0.04)
Obs.	1,596	1,535	1,633	1,549	1,633	1,549
L-Cens.	.	.	1	1	2	1
Non-Cens.	.	.	1631	1548	1596	1535
R-Cens.	.	.	1	0	35	13

Columns (1)-(2) are WLS. Columns (3)-(6) are two-sided Tobits with censoring values of -1 and 1 in columns (3) and (4), and -2 and 2 in columns (5) and (6). Dependent variables given at the top of each column. Standard errors in parentheses are clustered at the IO level. All regressions include province fixed effects $p < 0.01 :^{***}, 0.01 \leq p < 0.05 :^{**}, 0.05 \leq p < 0.10 :^{*}$. Regressions weighted by the number of firms for each ip observation.

7.2 Industry Level Evidence

We now explicitly examine the link between lower input tariffs and domestic value added ratios. Analogous to section 5, we conduct our analysis at the CIC industry-province level so as to allow for geographic heterogeneity. With slight abuse of notation, CIC industries are indexed i and provinces are indexed p. Our starting point is equation (11), where the dependent variable is the log difference of the domestic value added ratios:

$$\Delta\ln(DVAR_{ipt}) = \beta_1\Delta\ln(\tau_{I,it}) + \beta_X'\mathbf{X}_i + \Phi_p + \mu_{ipt}. \tag{11}$$

Industry-level input tariffs are the same as before, while the vector $\mathbf{X}_i$ contains the same control variables as in section 5. We continue to cluster the standard errors at the IO industry level and weight observations as before. Equation (12) includes the (log) change in the share of ordinary trade as an additional control:

$$\Delta\ln(DVAR_{ipt}) = \beta_1\Delta\ln(\tau_{I,it}) + \beta_2\Delta\ln(S_{O,ipt}) + \beta_X'\mathbf{X}_i + \Phi_p + \mu_{ipt}. \tag{12}$$

If the effect of input tariff cuts on DVAR is coming through the organization of trade, we expect any effect of $\Delta \ln(\tau_{I,it})$ in equation (11), to be mitigated or eliminated entirely when the share of ordinary trade is included directly in equation (12).

Column (1) of Table 9 presents results from estimating equation (11) and column (2) adds the share of ordinary trade to estimate equation (12). Columns (3) and (4) present Tobit results when the dependent variable is in first differences ($\Delta DVAR_{ipt}$). Columns (5) and (6) present results using proportional changes [$\%\Delta DVAR_{ipt}$].[55]

Column (1) finds that a 1 log point cut in input tariffs causes a 0.51 log point increase in the domestic value added ratio, consistent with the results in section 5 and a higher measured DVAR in ordinary relative to processing trade. The inclusion of the share of ordinary trade [column (2)] reduces the point estimate on input tariffs by about half and increases the standard error so that the effect is no longer statistically significant. There is, however, a very strong and significant relationship between the (log) change in the share of ordinary trade and the change in the DVAR as suggested by the data in Table 8. Columns (3)-(6) show that this qualitative result is unchanged under alternative functional form assumptions although input tariffs maintain a marginal significance in column (4).

While it is tempting to argue that lower input tariffs increased total demand for domestic factors of production, this does not follow from our analysis for two reasons. First, our empirical strategy that compares first differences only identifies relative effects and not aggregate effects. Second, the analysis only examines the domestic value added ratio of exports and not total production.

Interestingly, while imprecisely estimated, the point estimate on input tariffs remains negative in columns (2), (4), and (6), which directly control for the change in the share of ordinary trade. One might expect substitution effects to appear in our results as a positive coefficient on input tariffs after controlling for the share of ordinary trade. Specifically, there might be both between and within effects, where the between effect is the reallocation of production from processing to ordinary trade, which implies an increase in DVAR, and the within effect is that producers in the ordinary trade regime should decrease their DVAR. Once we control

[55]Where $\%\Delta DVAR_{ipt} \equiv \frac{DVAR_{ip,2006} - DVAR_{ip,2000}}{0.5 * [DVAR_{ip,2006} + DVAR_{ip,2000}]}$

for the between effect, we might expect the within effect to appear in our results. However, the point estimate on input tariffs remains negative even after controlling for the organization of trade.

This behavior can be explained by patterns of pass-through and productivity upgrading in China. Brandt et al. (2016) find relatively high degrees of pass-through from tariffs into prices charged by domestic agents. Also, as documented by Han et al. (2016) foreign (e.g. US) firms capture some of the tariff cuts into higher prices. Such high degrees of pass-through into the price of domestically provided inputs, combined with the partial capture of tariff cuts by foreign firms mitigates possible substitution effects as discussed in section 3.6. Yu (2015) also finds that reductions in output tariffs have substantial positive effects on the productivity of Chinese firms. If productivity upgrading for Chinese firms causes the relative price of domestic inputs to fall for processing firms (who do not directly benefit from falling tariffs), this is consistent with rising domestic value added ratios for processing firms documented in Table 8 and KT (2016).

8 Conclusion

This paper finds that a majority of the average change from processing to ordinary exports for China between 2000 and 2006 can be explained by reductions in input tariffs with both the intensive and extensive margins playing roles. In the cross-section, a larger domestic market vis-à-vis export opportunities promoted the organization of ordinary exports. Over the period we examine however, the relative value of accessing the domestic market actually declined as world export markets grew more quickly than domestic absorption in China, which offset some of the effect of falling tariffs on trade form. A reversal in this behavior due to the Great Trade Collapse following the Great Recession in 2008 may explain the more recent sharp decline in the role of processing.

Our finding that lower levels of protection for intermediate inputs did not cause domestic value added ratios to fall might seem counter-intuitive. However, lower input tariffs in China promoted the entry of new exporters who were more likely to export through ordinary trade with higher domestic content. Falling input tariffs also encouraged incumbent firms to increase their share of exports organized through ordinary trade, leading to higher shares of domestic value added in gross exports through changes in export composition.

Assembly-intensive processing trade has played a strategic role in industrial upgrading and export-led development for many countries (Radelet and Sachs, 1997 and Radelet, 1999). It is a potentially important source of foreign exchange and foreign technology and know-how when domestic markets are protected. However, processing trade also entails relatively lower demand for domestic factors of production as documented here and elsewhere. Empirical assessment of these trade-offs is an important area of research with regard to China and to development policy in general. The reduced form mechanisms identified in this paper along with those in other papers such as Yu (2015) and Manova and Yu (2016) can serve as the foundations for more structural work that can provide full general equilibrium welfare assessments of processing trade.

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A Domestic Absorption Calculation

For years $t \in \{1995, 2004, 2008\}$, we calculate domestic absorption as follows where Q_{it} is the value of production, M_{it} is the value of imports into China, and X_{it} is the value of exports from China in CIC industry i:

$$D_{it}^{D} \equiv Q_{it} + M_{it} - X_{it}.$$

Q_{it} is available at the CIC level but is only available for census years. We use UN COMTRADE trade data for the years 1995, 2004, and 2008 in the calculation above. These trade data are collected at the HS level and then aggregated to the CIC level. In cases where a given six-digit HS code maps into multiple CIC codes, shares are allocated based on the output size of the CIC industries. We then calculate the average growth rate of this variable for two windows 1995-2004 and 2004-2008 where $T_{t'-t}$ is the number of years in each window between years t' and t:

$$g_{i,1995-2004} = \frac{\ln\left(D_{i,2004}^{D}\right) - \ln\left(D_{i,1995}^{D}\right)}{T_{2004-1995}} \qquad g_{i,2004-2008} = \frac{\ln\left(D_{i,2008}^{D}\right) - \ln\left(D_{i,2004}^{D}\right)}{T_{2008-2004}}.$$

We then impute the interim years according to the following formula

$$D_{i,2000}^{D} \equiv D_{i,1995}^{D} * (1 + g_{i,1995-2004})^{5}$$

$$D_{i,2003}^{D} \equiv D_{i,1995}^{D} * (1 + g_{i,1995-2004})^{8}$$

$$D_{i,2006}^{D} \equiv D_{i,2004}^{D} * (1 + g_{i,2004-2008})^{2}$$

The ratio of domestic absorption to external demand is the ratio of $D_{i,t}^{D}$ to Chinese exports at the CIC level for the years 2000, 2003, and 2006. Log differences are the difference between the (log) 2006 and 2000 values.

B Decomposition Details

Start by defining the proportional change in the share of ordinary trade as

$$\%\Delta S_{O,ipt} = \frac{S_{O,ip,2006} - S_{O,ip,2000}}{0.5 * [S_{O,ip,2006} + S_{O,ip,2000}]} = \frac{\frac{V_{O,ip,2006}}{V_{ip,2006}} - \frac{V_{O,ip,2000}}{V_{ip,2000}}}{0.5 * [S_{O,ip,2006} + S_{O,ip,2000}]}.$$

Decomposing this into export values accruing to domestic and foreign firms, we obtain

$$\%\Delta S_{O,ipt} = \underbrace{\frac{\frac{V^D_{O,ip,2006}}{V_{ip,2006}} - \frac{V^D_{O,ip,2000}}{V_{ip,2000}}}{0.5 * [S_{O,ip,2006} + S_{O,ip,2000}]}}_{DOM_{O,ipt}} + \underbrace{\frac{\frac{V^F_{O,ip,2006}}{V_{ip,2006}} - \frac{V^F_{O,ip,2000}}{V_{ip,2000}}}{0.5 * [S_{O,ip,2006} + S_{O,ip,2000}]}}_{FOR_{O,ipt}}.$$

The first term provides us with the dependent variable in column (2) of Table 6 and the second provides us with the dependent variable in column (3) of Table 6. To decompose further into the incumbent, new firm, and exiting firm margins, define $V^{D,k}_{O,ip,2006}$ as ordinary exports by domestic firms in group $k \in \{I, N, E\}$ (as described in the text), we obtain

$$\%\Delta S_{O,ipt} = \sum_k \frac{\frac{V^{D,k}_{O,ip,2006}}{V_{ip,2006}} - \frac{V^{D,k}_{O,ip,2000}}{V_{ip,2000}}}{0.5 * [S_{O,ip,2006} + S_{O,ip,2000}]} + \sum_k \frac{\frac{V^{F,k}_{O,ip,2006}}{V_{ip,2006}} - \frac{V^{F,k}_{O,ip,2000}}{V_{ip,2000}}}{0.5 * [S_{O,ip,2006} + S_{O,ip,2000}]}.$$

Therefore we obtain

$$\%\Delta S_{O,ipt} = DOM^I_{O,ipt} + DOM^N_{O,ipt} + DOM^E_{O,ipt} + FOR^I_{O,ipt} + FOR^N_{O,ipt} + FOR^E_{O,ipt}$$

where, setting 2006 values to zero for exiting firms and 2000 values to zero for new firms, we obtain the following values for the decomposition for domestic and foreign incumbent, new, and exiting firms (respectively):

$$DOM^I_{O,ipt} = \frac{\frac{V^{D,I}_{O,ip,2006}}{V_{ip,2006}} - \frac{V^{D,I}_{O,ip,2000}}{V_{ip,2000}}}{0.5 * [S_{O,ip,2006} + S_{O,ip,2000}]} \qquad FOR^I_{O,ipt} = \frac{\frac{V^{F,I}_{O,ip,2006}}{V_{ip,2006}} - \frac{V^{F,I}_{O,ip,2000}}{V_{ip,2000}}}{0.5 * [S_{O,ip,2006} + S_{O,ip,2000}]}$$

$$DOM^N_{O,ipt} = \frac{\frac{V^{D,N}_{O,ip,2006}}{V_{ip,2006}}}{0.5 * [S_{O,ip,2006} + S_{O,ip,2000}]} \qquad FOR^N_{O,ipt} = \frac{\frac{V^{F,N}_{O,ip,2006}}{V_{ip,2006}}}{0.5 * [S_{O,ip,2006} + S_{O,ip,2000}]}$$

$$DOM^E_{O,ipt} = -\frac{\frac{V^{D,E}_{O,ip,2000}}{V_{ip,2000}}}{0.5 * [S_{O,ip,2006} + S_{O,ip,2000}]} \qquad FOR^E_{O,ipt} = -\frac{\frac{V^{F,E}_{O,ip,2000}}{V_{ip,2000}}}{0.5 * [S_{O,ip,2006} + S_{O,ip,2000}]}$$

C Baseline Estimation for Domestic and Foreign Firms

This section examines our baseline results by looking at subsamples of domestic and foreign firms. This section is not a formal decomposition of the overall effect (as found in the main body of the text). Rather, it is a "within" exercise that examines whether the forces identified in Table 2 hold within subsamples of each type of firm. To do this, start by defining the share of ordinary exports by domestic firms as

Table 10: Domestic Firms Subsample

	Dep. Var: $\ln\left(S^D_{O,ipt}\right)$						Dep. Var: $\Delta\ln\left(S^D_{O,ipt}\right)$	
	2000	2000	2003	2003	2006	2006	2000-2006	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln\left(\tau_{I,it}\right)$	-2.41*	-1.37*	-1.44*	-1.06*	-0.91	-0.85**		
	(1.35)	(0.82)	(0.87)	(0.58)	(0.56)	(0.42)		
$\Delta\ln\left(\tau_{I,it}\right)$							-0.95***	-0.74***
							(0.22)	(0.24)
$\ln\left(D^D_{it}/D^X_{it}\right)$		0.31		0.25		0.12		
		(0.22)		(0.20)		(0.11)		
$\Delta\ln\left(D^D_{it}/D^X_{it}\right)$								0.065*
								(0.03)
$\%Diff_i$		-1.07		-1.19		-0.89		-0.050
		(0.86)		(0.79)		(0.56)		(0.12)
$\ln\left(S_i/U_i\right)$		0.080		-0.17		-0.30		0.15
		(0.94)		(0.56)		(0.27)		(0.12)
$\ln\left(K_i/L_i\right)$		-0.011		-0.19		-0.038		-0.15
		(0.72)		(0.53)		(0.29)		(0.10)
Obs.	28,815	28,815	37,411	37,411	45,807	45,607	25,281	25,202
Non-Cens.	4,256	4,256	4,921	4,921	6,008	5,998	.	.
R-Cens.	24,559	24,559	32,490	32,490	39,799	39,609	.	.

Columns (1)-(6) are one-sided Tobits with an (upper) censoring value of $ln(1) = 0$. Columns (7)-(8) are WLS. Dependent variables are at the top of each column. Standard errors in parentheses are clustered at the IO level. All regressions include province fixed effects. $p < 0.01$:***, $0.01. \leq p < 0.05$:**, $0.05 \leq p < 0.10$:*. Regressions weighted by the number of firms for each ip observation.

$$S^D_{O,ipt} = \frac{V^D_{O,ipt}}{V^D_{ipt}}$$

where V^D_{ipt} is total exports by domestic firms in the triplet ipt and $V^D_{O,ipt}$ is exports through ordinary trade for the same triplet. An analogous expression holds for the share of ordinary exports by foreign firms $S^F_{O,ipt}$. Tables 10 and 11 present results for these subsamples. Notice that these are not formal decompositions but rather "within" samples that allow us to examine the mechanisms at play for these two types of firms separately.

D Alternative Functional Forms

First, we redefine our dependent variable in the cross-section as $S_{O,ipt}$ and in the time series as $\%\Delta S_{O,ipt} = \frac{S_{O,ip,2006} - S_{O,ip,2000}}{0.5*\left[S_{O,ip,2006} + S_{O,ip,2000}\right]}$. For the cross-sectional results, the dependent variable is bound in the interval [0,1] and we therefore use a two-sided Tobit with a lower censoring value of 0 and an upper censoring value of 1. Results in the cross-section appear in column (1)-(6) of Table 12. Columns (7) and (8) present proportional changes where the left censoring is at $\%\Delta S_{O,ipt} = -2$ and the upper censoring is at $\%\Delta S_{O,ipt} = 2$. Qualitative results are unchanged from our main specification. Columns (9) and (10) estimate equation (9) when the dependent variable is defined in first differences $[\Delta S_{O,ipt} = S_{O,ip,2006} - S_{O,ip,2000}]$ such that the dependent

Table 11: Foreign Firms Subsample

	Dep. Var: $\ln\left(S^F_{O,ipt}\right)$						Dep. Var: $\Delta\ln\left(S^F_{O,ipt}\right)$	
	2000	2000	2003	2003	2006	2006	2000-2006	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln\left(\tau_{I,it}\right)$	-2.15***	-1.45***	-1.06***	-0.86**	-0.78**	-0.87***		
	(0.39)	(0.53)	(0.33)	(0.34)	(0.31)	(0.28)		
$\Delta\ln\left(\tau_{I,it}\right)$							-2.08***	-1.79***
							(0.68)	(0.68)
$\ln\left(D^D_{it}/D^X_{it}\right)$		0.29***		0.26***		0.20***		
		(0.09)		(0.08)		(0.07)		
$\Delta\ln\left(D^D_{it}/D^X_{it}\right)$								0.11**
								(0.05)
$\%Diff_i$		-1.94***		-2.05***		-1.48***		0.28
		(0.70)		(0.56)		(0.45)		(0.30)
$\ln\left(S_i/U_i\right)$		-1.60**		-1.24***		-1.08***		-0.066
		(0.69)		(0.48)		(0.37)		(0.35)
$\ln\left(K_i/L_i\right)$		0.58		0.22		0.13		0.060
		(0.88)		(0.60)		(0.40)		(0.33)
Obs.	10,798	10,798	15,751	15,751	21,731	21,647	9,327	9,301
Non-Cens.	5,027	5,027	6,785	6,785	8,800	8,782	.	.
R-Cens.	5,771	5,771	8,966	8,966	12,931	12,865	.	.

Columns (1)-(6) are one-sided Tobits with an (upper) censoring value of $ln(1) = 0$. Columns (7)-(8) are WLS. Dependent variables are at the top of each column. Standard errors in parentheses are clustered at the IO level. All regressions include province fixed effects. $p < 0.01 :^{***}, 0.01. \leq p < 0.05 :^{**}, 0.05 \leq p < 0.10 :^{*}$. Regressions weighted by the number of firms for each ip observation.

variable is bound between -1 and 1.[56] Results are qualitatively similar across specifications.

[56]Because our baseline results are in proportional changes and the columns (9) and (10) are in first differences, their coefficients are not strictly comparable.

Table 12: Alternative Functional Forms

	Dep. Var: $S_{O,ipt}$						Dep. Var: $\%\Delta\left(S_{O,ipt}\right)$		Dep. Var: $\Delta\left(S_{O,ipt}\right)$	
	2000	2000	2003	2003	2006	2006	2000-2006		2000-2006	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\ln\left(\tau_{I,it}\right)$	-0.61***	-0.36***	-0.37***	-0.27***	-0.29***	-0.29***				
	(0.15)	(0.13)	(0.11)	(0.10)	(0.10)	(0.09)				
$\Delta\ln\left(\tau_{I,it}\right)$							-0.66***	-0.61**		
							(0.21)	(0.24)		
$\Delta\tau_{IO,i}$									-0.015*	-0.0096**
									(0.01)	(0.00)
$\ln\left(D_{it}^{D}/D_{it}^{X}\right)$		0.066**		0.066**		0.045**				
		(0.03)		(0.03)		(0.02)				
$\Delta\ln\left(D_{it}^{D}/D_{it}^{X}\right)$								0.056**		0.00099
								(0.02)		(0.01)
$\%Diff_i$		-0.46***		-0.48***		-0.39***		-0.053		-0.0018
		(0.18)		(0.17)		(0.13)		(0.10)		(0.05)
$\ln\left(S_i/U_i\right)$		0.053		-0.11		-0.22**		-0.11		-0.18***
		(0.17)		(0.13)		(0.10)		(0.12)		(0.04)
$\ln\left(K_i/L_i\right)$		-0.063		-0.050		0.014		0.021		0.059**
		(0.21)		(0.17)		(0.13)		(0.12)		(0.02)
Obs.	31,276	31,276	39,427	39,427	47,772	47,564	27,687	27,597	27,746	27,655
L-Cens.	842	842	500	500	366	365	95	95	60	60
Non-Cens.	7,611	7,611	9,289	9,289	11,408	11,382	26,927	26,839	27,416	27,325
R-Cens.	22,823	22,823	29,638	29,638	35,998	35,817	665	663	270	270

All regressions are two-sided Tobits with censoring values of 0 and 1 in columns (1)-(6), -2 and 2 in columns (7) and (8), and -1 and 1 in columnbs (9) and (10). Dependent variables given at the top of each column. Standard errors in parentheses are clustered at the IO level. All regressions include province fixed effects. $p < 0.01 :^{***}$, $0.01 \leq .\ p < 0.05 :^{**}, 0.05 \leq p < 0.10 :^{*}$. Regressions weighted by the number of firms for each ip observation.

E Construction of Domestic Content Ratios

Start with the accounting identity for a firm f operating in industry i:

$$X_{fi} = \pi_{fi} + w_{fi}L_{fi} + r_{fi}K_{fi} + M_{fi}^D + M_{fi}^I$$

where X_{fi} is the value of exports, π_{fi} is profits from these exports, $w_{fi}L_{fi}$ is total payments to labor in production of these exports, $r_{fi}K_{fi}$ is total payments to capital for these exports, M_{fi}^D is total payments to domestically-provided intermediate inputs for these exports, and M_{fi}^I is total payments to imported intermediate inputs for these exports [KT (2016), equation (1)]. Then decompose imported intermediate inputs into two mutually exclusive and exhaustive components: foreign value added (q_{fi}^F) and domestic value added (through indirect channels) (δ_{fi}^D). Similarly, decompose domestically-provided intermediate inputs into domestic value added (q_{fi}^D) and foreign value added (through indirect channels) (δ_{fi}^F) (see their pg. 7). Then define domestic value added, DVA_{fi}, as

$$DVA_{fi} \equiv \pi_{fi} + w_{fi}L_{fi} + r_{fi}K_{fi} + \delta_{fi}^D + q_{fi}^D.$$

Define X_{fi}^P and X_{fi}^O as the value of processing and ordinary exports (respectively) for firm f in industry i, and M_{fi}^P and M_{fi}^O as analogous expressions for the value of imports. For a processing firm, KT show that domestic value added corresponds to:

$$DVA_{fi}^P = X_{fi}^P - M_{fi}^P + (\delta_{fi}^D - \delta_{fi}^F).$$

Following KT, we set $\delta_{fi}^D = 0$, and then use average values of δ_{fi}^F from their Table Appendix Table A7. This allows us to calculate domestic value added for a processing exporter DVA_{fi}^P.

For an ordinary exporter, the calculation is slightly more complicated because one cannot tell how total imports of intermediate inputs are allocated between production of exports and domestically sold output. Following KT, we use a proportionality assumption where the ratio of intermediate inputs used for ordinary exports to total intermediate inputs is assumed to be equal the ratio of ordinary exports to overall production for the firm. Arithmetically, where Y_{fi}^D is domestic sales, M_{fi} is total imports, and $Y_{fi} = Y_{fi}^D + X_{fi}$ is total output, this assumption allows us to write domestic value added embodied in the exports of an ordinary exporter:

$$DVA_{fi}^O = X_{fi}^O - M_{fi}^O + (\delta_{fi}^D - \delta_{fi}^F)$$

where

$$M_{fi}^O = M_{fi}\left[1 - \frac{Y_{fi}^D}{Y_{fi}}\right].$$

Industry domestic value added in exports is then equal to the sum of domestic value added in ordinary exports and processing exports across all firms in an industry i:

$$DVA_i = \sum_{f\in\mathcal{S}_i; j\in\{O,P\}} DVA_{fi}^j.$$

where $\mathcal{S}_i$ is the set of all firms in industry i. The ratio of domestic value added in exports to gross exports is then equal to this value divided by total exports:

$$DVAR_i = \frac{\sum_{f \in \mathcal{S}_i; j \in \{O,P\}} DVA^j_{fi}}{\sum_{f \in \mathcal{S}_i; i \in \{O,P\}} X^j_{fi}}.$$