Input-Trade Liberalization, Export Prices and Quality Upgrading

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Abstract

This paper explores the impact of input-trade liberalization on imported input and exported product prices. Using Chinese transaction data for 2000-2006, we capture causal effects between exogenous input tariff reductions and within firm changes in HS6 traded product prices. Identification is based on a quasi-natural experiment where some firms are exempt from paying tariffs and stand as a control group. Both imported input and export prices rise. The effect on export prices is specific to firms sourcing inputs from developed economies and exporting output to high-income countries. Results are consistent with a scenario within which firms exploit the input tariff cuts to access high-quality inputs in order to quality-upgrade their exports.

Keywords: Firm heterogeneity, imported inputs, trade liberatization, export prices, quality upgrade, mark-up, firm-level data.

JEL Classification: F10, F12, F13

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1 Introduction

Firms exporting high-quality (price) products have high revenue, access a large number of destination markets and pay high wages (e.g., Verhoogen 2008, Crozet, Head and Mayer 2012, Manova and Zhang 2012). Recent theoretical works show that producing these high-quality products require high-quality inputs (i.e., Kugler and Verhoogen 2012, Hallak and Sivadasan -forthcoming). While upgrading exports quality may help firms enter profitable developed countries market, accessing high-quality inputs may be too costly for producers, especially in developping countries. We argue that firms may take advantage of input-trade liberalization to upgrade the quality of their imported inputs in order to upgrade the quality of their exported products.

This paper is the first provide empirical evidence on the link between input-trade liberalization and the quality of traded products. We capture a causal effect between exogenous input tariff reductions and changes in imported inputs and exported product prices by exploring the evolution of prices within firms at the HS6 (harmonized system) product level in a period of trade liberalization. We first show that following a decrease in input tariffs, firms import more varieties of inputs - if the input originates from the most advanced economies. As input tariffs fall, firms also pay a higher price for their imported inputs at the HS6 level. This effect is two times higher for firms sourcing their inputs from high-income countries. We interpret these findings as the firms upgrade of their imported inputs quality in a period of trade liberalization. This result could also be explained by a lack of competition among suppliers of foreign inputs taking advantage of the tariff cuts to increase their prices or by an exogenous increase in the price of commodities. We show that our findings are not driven by these alternative explanations.

The input-trade liberalization also results in an increase of firms HS6 exported product prices. Such impact of input tariffs reduction on export prices is specific to inputs imported from the most advanced economies and to products that are exported to the highest income countries. Our results suggest that the increase in firms exported product prices reflects an improvement in product quality. The alternative explanation of higher markups is difficult to reconcile with the increase in imported input prices and the facts that only imports from advanced countries and exports towards high-income countries are relevant to explain the increase in export prices. Schott (2004), Hallak and Schott (2011) and Khandelwal (2010) actually find that export quality is correlated with the destination country income level. We also verify that our results are not driven by demand shocks nor increased marginal costs and provide evidence that we have indeed identified a quality upgrading effect. Our findings are in line with a scenario according to which trade liberalization allows firms to upgrade their

inputs at low cost in order to quality upgrade their exported products.

We rely on an original methodology which allows us to identify causal links between cuts in input tariffs and trade prices. We take advantage of a detailed and unique database of Chinese firms' trade data for the 2000-2006 period that includes two essential features for our analysis. First, it covers the Chinese accession to the WTO in 2001 which led to an important decrease in tariffs. Second, it characterizes trade transaction according to a dual regime where some firms are exempt from paying tariffs. Chinese trade transactions are recorded according to their trade regimes: firms importing under the "ordinary" regime pay tariffs, whereas firms importing under the "processing" regime have been exempted from paying tariffs for over 30 years. In order to obtain the processing status, firms must export all the output produced with imported inputs. This dual trade regime is crucial to our approach as it allows us to rely on a quasi-natural experiment where firms not subject to tariffs stand as the control group thereby alleviating concerns related to potential endogeneity issues.[1]

Our identification strategy exploits both the variation in input tariffs and the existence of a control group composed of processing firms that export the same variety (product-destination pair) in the same year as ordinary firms. With imported inputs prices as variable of interest, we rely on the variation of input tariffs across HS6 products and time. In order to capture the impact of input-trade liberalization on exported product prices, we construct firm level input tariffs. Firm specific input tariffs are calculated as a weighted average of the tariffs paid by the firm on the inputs it actually uses, with a constant weighting over time. These tariff measures reflect the firm's input mix and capture the HS6 input tariff variations. Moreover, they are free of composition and reverse causality problems related to the change of weights over time.

An important concern is the potential endogeneity between tariffs change and the imports or exports of firms. We address this issue in several ways. We first show that the input tariffs reduction is exogenous to the firms expected imports/exports patterns and political lobbying. We are also concerned with the quality of our control group. We ensure that for each ordinary firm there is at least one processig firm exporting the same HS6 product to the same destination in the same year. Importantly, we show that the firms' processing status is exogenous to the level of input tariffs. Firm-product fixed effects included in the estimation help control for differences between ordinary and processing firms; they do not however capture time-varying features, other than input tariffs, that affect ordinary and processing firms differently. We thus perform several robustness checks. We include in the estimation a time trend by trade status

[1]The literature so far has shown a positive correlation across firms between input and output prices (Kugler and Verhoogen, 2012, Manova and Zhang 2012, Hallak and Sivadasan - forthcoming), these cross-section analyses do not however assess causality.

in order to capture status specific paths or shocks over the sampled period (i.e., we interact firms' type -ordinary or processing- with a time dummy). Moreover, we run the estimation on firms of similar size or excluding foreign firms (highly represented in processing) or non-private firms (highly represented in ordinary) as well as specific sectors such as textile or electronics.

We also ensure that changes in export prices are not associated with demand shocks nor increased marginal costs. We provide evidence that we have indeed identified a quality upgrading effect relying on the methodology developed by Khandelwal (2010) and Khandelwal, Schott and Wei (forthcoming). Finally, we carried out several robustness tests that show that our estimates are not driven either by the measure of input tariff nor our sample. All our findings are robust to alternative explanations and sensitivity tests that could explain the increase in export prices within firm-product across destinations and over time.

In addition to the literature on the determinants of export price variation in cross-section, i.e., within-product across firms or within product-firm across markets (see Bastos and Silva 2010, Gorg, Halpern and Murakovy 2010, Kugler and Verhoogen 2012, Martin 2012, Manova and Zhang 2012 and Harrigan, Ma and Shlychkov 2012), this paper also contributes to the literature on trade liberalization and firm-performance. Most of the literature focuses on productivity and investigates the effect of a decrease in tariffs on firms' total factor productivity (TFP) (e.g., Pavnick 2002, Schor 2004, Fernandes 2007, Amiti and Konings 2007, Topalova and Khandelwal 2010, Brandt et al. 2012). These papers find that there is a positive impact from cuts in output tariffs on productivity (the pro-competitive effect) and an even stronger impact from a decrease in input tariffs (the imported inputs channel). Other studies relate imported inputs and firms' TFP but do not consider trade liberalization (e.g., Kasahara and Rodrigue 2008, Halpern, Koren and Szeidl 2009). Bas (2012), Goldberg, Khandelwal, Pavnick and Topalova (2011), and Bas and Strauss-Kahn (2012) explore the impact of trade liberalization on the other attributes of the firms. They show that trade liberalization entails a large increase in firms product and export scopes. None of these papers however examine the role of trade liberalization on firms' imported inputs and export prices and investigate quality upgrading in a period of trade liberalization. Few papers empirically study the relationship between trade, prices and markups. Those that do focus on the pro-competitive effect (i.e., Fernandes and Paunov, 2011, Amiti and Khandelwal - forthcoming) or examine output prices and markups (i.e., De Loecker et al. 2012). We differ from these works by focusing on the role of input tariff reduction on export prices (i.e, the imported input channel) and by identifying a causal link between input trade liberalization and traded product prices.

The paper is organized as follows: Section 2 discusses the literature and provides a theoretical motivation for our work; Section 3 presents the Chinese trade liberalization and dual

trade regime, explores the data and discusses the empirical strategy; Section 4 reports our main results regarding the impact of inputs trade liberalization on firms' imported inputs and exported product prices; Section 5 proposes alternative explanations to the quality upgrading pattern and discusses our findings; Section 6 presents several robustness checks. Section 7 concludes.

2 Theoretical motivation

Our analysis of export price variations relies on the idea that consumers value quality. Firms compete on quality as well as on price on export markets. Furthermore, since quality is expensive to produce, a rise in export price may be associated with an increase in demand: consumers are willing to pay a premium for higher quality goods. Linder's (1961) early work already noted the role of quality as a determinant of the direction of trade arguing that richer countries spend a larger share of their income on high-quality goods. Recent empirical work corroborates this idea. On the supply side, Schott (2004) and Hummels and Klenow (2005) show that export prices are correlated with exporters income per capita. Hallak and Schott (2011) as well as Khandelwal (2010) - in influential papers distinguishing price and quality - confirm this link between export quality and level of development. On the demand side, Hallak (2006) finds that demand for quality is related to importers' income per capita: richer countries import relatively more from countries producing high-quality goods.

Recent firm-level empirical studies find that firms that export are bigger and charge higher prices (e.g., Hallak and Sivadasan -forthcoming-, Kugler and Verhoogen 2012, Crozet, Head and Mayer 2012, Manova and Zhang 2012, Iacovone and Javorcik 2010) and evidence a positive relationship between export prices and distance to destination (Baldwin and Harrigan 2011). While standard models of heterogeneous firms (henceforth HFs) a la Melitz (2003) and Bernard et al. (2003) cannot describe this patterns, a new and growing literature explores the role of product quality in explaining these observed features (Baldwin and Harrigan 2011, Hallak and Sivadasan -forthcoming-, Crozet, Head and Mayer 2012, Johnson 2012, Verhoogen 2008, Kugler and Verhoogen 2012).[2] In these models quality is costly to produce and consumers are willing to pay a higher price for high-quality varieties.

Most models assume a representative consumer who maximizes a CES utility function: $U = \left(\int_{i \epsilon \Omega} (x_i q_i)^{\frac{\sigma-1}{\sigma}} d_i \right)^{\frac{\sigma}{\sigma-1}}$ where x_i and q_i denotes the quantity consumed and the quality of a typical variety i, $\sigma > 1$ is the elasticity of substitution across varieties and Ω is the set of all varieties available in the market. These preferences yield demand for a specific variety which

[2] HF models predict that more productive firms charge lower prices, and consequently, have higher revenues and profits to afford the fixed export cost and self-select into export market.

depends on the differentiated goods price but also on its quality: $x_i = p_i^{-\sigma} q_i^{\sigma-1} P^{\sigma-1} E$ where p_i is the price of the variety i and P and E correspond to the aggregate quality-adjusted price index and expenditure in the export market. Quality thus acts as a demand shifter; it can be understood as any product attribute that is valued by the consumer. On the production side, the models used differ in the way they introduce product quality differentiation but they all share the common feature that producing high-quality goods is costly with marginal costs increasing in the level of quality of the final good.

Although the profit maximizing output price increases with the level of product quality, high-price, high-quality firms generate high profit than their lower capability counterparts. This occurs because the increase in utility resulting from the consumption of higher quality products more than compensates for the higher production costs. As exporting firms incur a fixed cost, these models provide a convincing framework to explain why exporters produce higher quality goods and charge higher output prices (e.g., Verhoogen 2008, Kugler and Verhoogen 2012) as well as why export prices are higher in more distant (Baldwin and Harrigan, 2011) and more difficult to enter (Jonhson, 2012) destination markets.

Kluger and Verhoogen's (2012) paper is of particular interest for our analysis as they model the link between the quality of intermediate inputs and the quality of final goods. The authors derive two functional forms for quality in a model where output quality is endogenous and firms optimize their quality choice. In the first case, they assume that firm capability and input quality are complements in the production of output quality. In the second case, output quality depends on input quality and also implies a fixed cost for quality investment. In the intermediate input sector, producing higher quality inputs is more costly in terms of labor. Consequently, for the final goods producers, the quality of intermediate inputs and the price of that input are positively correlated. In both variants of their model, in equilibrium, higher capability firms use high-quality inputs to produce high-quality outputs. Higher-quality inputs have a higher price, which raises marginal costs. If the scope for quality differentiation is large (a long quality ladder in Khandelwal's terms), Kugler and Verhoogen's (2012) model predicts a positive relationship between output price, input prices and plant size. Recent working papers theoretically examine the impact of trade liberalization on exported product quality. Fan and Li (2013) endogeneize firms' choice of the number and quality of imported inputs in period of tariffs reduction and find that firms increase both the number and quality of inputs, leading to an increase in export quality.[3] Similarly, in a theoretical North-South model of heterogeneous firms and quality upgrading, Demir (2012) extends the framework of Kugler and Verhoogen

[3]Fan and Li (2013) test their model using Chinese data. They however rely on cross-section analysis and do not explore the causal link between input tariffs reduction and imported inputs and exported product prices in their analysis - something which we do in the present paper.

(2012) and shows the mechanisms through which input-trade liberalization leads to export quality upgrading of firms located in the South.

We refer to this recent literature product quality at the firm level to guide our empirical analysis of the impact of input-trade liberalization on traded good prices. The Chinese tariff cuts reduce the cost of imported intermediate goods. Chinese firms may use this opportunity to buy higher-quality (higher-priced) inputs in order to upgrade the quality of their final goods. They then become more competitive (quality wise) on export markets, which may be particularly relevant in high income destination countries.[4]

3 Data and empirical strategy

3.1 China trade liberalization

The period under study, 2000-2006, corresponds both to a drastic increase in Chinese foreign trade (e.g., the yearly export growth increased by 50% over the period) and to a significant episode of trade liberalization. Following China's accession to the World Trade Organization (WTO) in December 2001, the authorities undertook a series of important commitments to open and liberalize the economy and to offer a more predictable environment for trade and foreign investment. The government gradually reduced tariffs, non-tariff measures, licenses and quotas. Between 2001 and 2006, applied Chinese tariffs declined on average by 7 percentage points with a wide variation in tariff changes across manufacturing industries (Table A1 in the Appendix reports the reduction in tariffs for aggregated sectors).

Importantly, as mentioned by Brandt et al. (2012), the large disparity in sectoral tariffs in the early years diminished over the period as high tariffs converged to a more uniform (low) level after accession to the WTO. Figure A1 in the Appendix reflects this convergence in tariffs. The share of HS6 products facing tariffs above 20% declines from 32.7% in 2000 to 12.5% in 2006. In contrast, the share of HS6 products with tariffs below 5% increased from 6.8% in 2000 to 16.7% in 2006. We make use of this sectoral discrepancy in tariff reductions to capture the impact of trade liberalization on import and export prices.

China's trade policy is characterized by a dual system which distinguishes two main trade regimes depending on the type of goods traded (Feenstra, 1998, Branstetter and Lardy, 2006). Traded goods are reported as "ordinary goods" or "processing goods". Ordinary goods are made up of imports of goods that are sold domestically or exported, whereas processing goods consist of imports of intermediate goods that are processed and sold on the export market

[4] As mentioned by Fajgelbaum, Grossman and Helpman (2011), low quality firms in developing countries may find it difficult to access the profitable developed countries markets.

only.[5] Since 1979, firms importing products under the processing trade regime have been exempt from paying tariffs. This legal framework provided incentives to produce for the export markets. On the contrary, until recently, ordinary goods were subject to high levels of nominal tariffs. This dual system is key to our analysis as the impact of the WTO accession differs for ordinary and processing importers. Indeed, the tariff reduction affects only ordinary goods, whereas processing goods are traded freely.

3.2 Data

Our dataset is a panel of Chinese manufacturing firms for the 2000-2006 period. We rely on transaction data from the Chinese Customs Trade Statistics (CCTS) database which is compiled by the General Administration of Customs of China. This database includes monthly firm level imports and exports at the 8-digit HS product-level. Trade data are reported free on board (f.o.b.) in US dollars. We collapse the data to yearly frequency, aggregate product data at the 6-digit HS level and deflate them using 2-digit HS level deflators from Upward, Wang and Zheng (2010).[6] The database also records the country of origin of imports as well as the destination of exports and contains firm specific information such as name, address or custom regimes. Transactions are classified according to 18 different custom regimes which vary in their tariffs levels. This information is essential for our work. We rely on three regimes: "ordinary trade", "processing and assembly trade" and "processing with imported materials trade". Imports under the processing trade regime concern raw material, parts and components but exclude capital goods and equipments. This regime is also separated from the "warehousing trade" and "entrepot trade" regimes. Transactions registered under the processing trade regime correspond to imported inputs that are used in the production of goods for export markets. In contrast with those in ordinary trade, imports under processing trade regimes are not subject to tariffs.[7] Ordinary and processing trade encompasses 76% (96%) of total manufacturing imports (exports) on average over the period.

We restrict our sample to firms importing intermediate inputs through either the ordinary or the processing trade regime.[8] Imports under processing trade regime are necessarily intermediate inputs as they are used for the purpose of processing exports. Imports under ordinary

[5] As mentioned in Manova and Yu (2012), a processing firm must show proofs of a contractual agreement with a foreign buyer to whom it will export the good in order to obtain the exemption on input tariffs.

[6] Such modifications are necessary in order to match transaction data with tariffs. Within HS6 codes, HS8 products may be measured in different units (e.g., kilogrammes or meters). In order to avoid adding "apples with oranges", we drop HS8 products that differ in measurement from the rest of the HS6 category. It represents less than 0.77% of the sample. Finally, as the HS classification changed over time, we convert older classifications (i.e., HS1-1996 and HS2-2002) into HS0-1988/1992 classification using WITS conversion tables.

[7] For more information on these custom regimes refer to Table A2 in the Appendix.

[8] We exclude from the estimated sample HS6 products higher than 980,000 corresponding to services and wholesalers and HS6 products lower than 100,630 corresponding to animal products and vegetables commodities.

trade however include both intermediate and final goods. In order to identify the intermediate inputs, we use the Broad Economic Categories (BEC) classification from the United Nations that classifies HS6 products into final, intermediate and capital goods. These intermediate goods correspond to 70% of all imports (under the ordinary trade regime) on average over the period. We classify firms that import all their inputs for the year under the ordinary trade regime as ordinary importers. Similarly, firms importing all their inputs under processing trade regimes are defined as processing importers. By relying on these restrictive definitions, we exclude firms buying foreign inputs under both trade regimes. Most firms (94% of the total firms importing inputs) however import intermediate goods under one trade regime only.[9]

Our identification strategy relies on a quasi-natural experiment that exploits differences in firm-product export prices over time and across destinations associated with changes in input tariffs over time and across firms, using processing firms that are not subject to tariffs as a control group. To ensure that processing firms are an appropriate control group we rely on processing firms with similar characteristics to ordinary firms in terms of export patterns - We require that, for each ordinary firm and year, there is at least one processing firm that exports the same HS6 product to the same destination. We thus exclude from the estimated sample observations for ordinary firms for which there is no control group (i.e., no counterpart processing firm exporting the same variety to the same market).

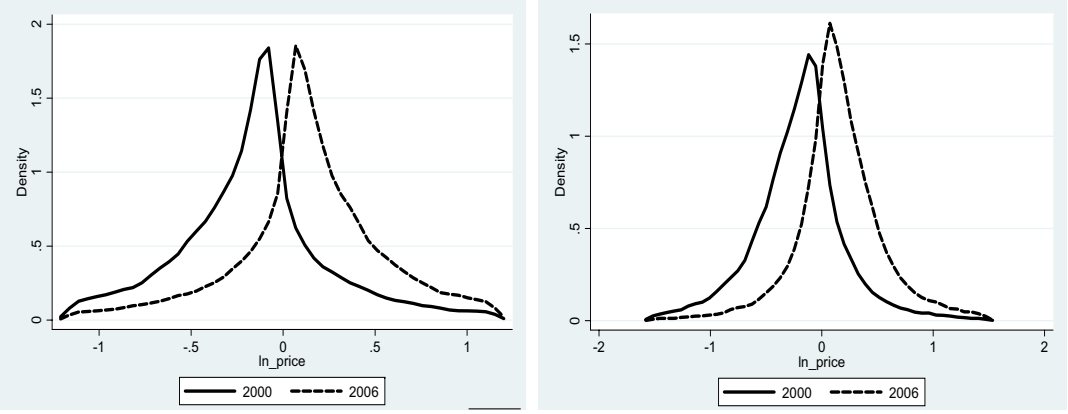
Our estimated sample is an unbalanced panel of firms that export HS6-level products and are either ordinary importers of intermediate inputs or processing importers of intermediate inputs for the entire period. The sample increases from 18,493 firms in 2000 to 36,013 in 2006. On average, we have 10,517 ordinary firms and 15,289 processing firms per year. Our estimated sample corresponds to 60% of the full sample of firms that export and import. Most of the difference in sample size is a consequence of our matching procedure which requires that for each treated firm (ordinary) there is at least one control firm (processing) at the product-destination-year level. Our estimated sample presents an appropriate representativeness of the full sample in term of sectoral decomposition (see Table A3 in the Appendix for descriptive statistics). We begin by exploring the effects of tariff reductions at the HS6 product level on firm-product imported input prices. For this, we have an estimated sample of firms importing up to 3,107 products from 156 countries of origin corresponding to 2,286,393 observations at the firm-product-country of origin level over the sample period. Firms export up to 2,511 products across 178 destinations. With regards to the main specifications - using export prices as dependent variable - we work with an unbalanced panel of 3,208,484 firms-HS6-product-country of destination and year observations. Despite the unbalanced nature of our panel, the

[9]We exclude firms that switch from ordinary to processing status over time (these firms correspond to less than 4% of the firms in the sample).

number of ordinary and processing firms present in our estimation sample is similar. Indeed, we study changes in import and export prices for 38,234 unique ordinary firms and 39,091 unique processing firms present over the period.

To provide a first illustration of the change in export and import prices over the trade liberalization period, we present the distribution of prices in 2000 and 2006 in Figure 1. We include only firm-product pairs present in both years in order to capture the evolution of prices within firm-product. We regress prices on firm-product fixed effects and plot the residual.[10] The left panel of Figure 1 shows the distribution of import prices while the right panel of Figure 1 represents the distribution of export prices. Both graphs reveal a right shift in the distribution indicating an increase in imported input prices and export prices over the period. This paper explores whether these post trade liberalization increase in imported input and export prices are related, and whether these observed patterns can be interpreted as an upgrade in quality.

Figure 1: Distribution of import and export prices in 2000 and 2006



Source: Author's calculation.

3.3 Empirical strategy

3.3.1 Trade liberalization and imported input prices

China's accession to the WTO in December 2001 provides an interesting framework of unilateral trade liberalization. The specificity of the Chinese dual trade regime - where ordinary firms are directly affected by trade reform while processing firms are not - represents a unique natural experiment within which to investigate the impact of trade policy. We exploit the change in import tariff combined with the characteristics of the dual trade system in order to test the effects of the liberalization of inputs trade on imported input prices.

[10] In Figure 1 outliers at the top and bottom 1st percentiles are excluded from the database. Alternative trimming and no trimming at all provide similar results which are available upon request.

The main estimation strategy is similar to a difference-in-difference approach where ordinary importers are the treated group and processing importers are the control group.[11] Thanks to the control group, we are able to account for (sectoral or regional) policies that affect ordinary and processing importer similarly. We thus introduce into the analysis a dummy variable which takes the value of one when the firm trades under the ordinary regime. We first focus on the impact of input-trade liberalization on the (f.o.b.) price of the firm's imported inputs. The dummy variable is interacted with the tariff of the imported input at the HS6 product level. We use the Most Favorite Nation (henceforth MFN) applied tariffs set by China to the rest of the world. Chinese MFN tariffs at the HS6 level come from the WITS (World Bank) database for the 2000-2006 period. We consider the following specification:

$$P_{ikct}^{IM} = \beta_1 Ordinary_i * \tau_{k,t-1} + \beta_2 Ordinary_i + \beta_3 \tau_{k,t-1} + \beta_4 X_{i,t-1} + \beta_5 Z_{c,t-1} + \alpha_{ik} + \alpha_t + \alpha_c + \eta_{ikct} \quad (1)$$

where P_{ikct}^{IM} corresponds to the log of the import price (unit value) for input k for firm i from country c at time t and τ_{kt-1} is the tariff on input k at time $t-1$ for firms that import this HS6 level product. $Ordinary_i$ is a dummy variable indicating whether firm i is an ordinary or a processing importer, it takes a value of one if the firm is ordinary and zero otherwise. X_{it-1} control for firm i size defined by quartiles of size distribution based on the number of imported varieties with the first quartile (Q1) representing the smallest firms and the fourth quartile (Q4) the omitted category. Z_{ct-1} controls for origin country variables such as real exchange rate (RER) or GDP. α_{ik}, α_t, and α_c are firm-product, time and origin-country fixed effects and η_{ikct} an i.i.d. component. Note that the dummy variable $Ordinary_i$ does not vary within firms over time.[12] Because of its colinearity with firm-product fixed effect, it will drop from the estimation. We cluster standard error at the firm-product level.

3.3.2 Trade liberalization and export prices

Next, we investigate the impact of input-trade liberalization on the firm export prices. The dummy for ordinary is interacted with the input tariff of the firm. Firm level input tariffs are computed as a weighted average of tariffs on the inputs used by the firm, where the weights are constant over the period: $\tau_{it} = \sum_k \alpha_k \tau_{kt}$, where τ_{kt} is the output tariff of HS6-product k in t and k is used in the production of the final output of firm i. We rely on a constant weight α_k computed as the average weight of a specific HS6 product import value over the

[11] This is not a traditional difference-in-difference estimation as the treatment (i.e., the decrease in input tariffs) affect the treated group over time.

[12] Recall that the estimated sample is composed by firms that import all their inputs through either the ordinary or the processing trade regime for the entire period.

period. There are two main advantages of using an average constant weight to compute firm level input tariffs. First, this measure is free of potential reverse causality concerns between changes in firm-product export prices and variations in the imported input mix over time. Second, our measure of firm level input tariff avoids potential biased estimates stemming from changes in the composition of the input mix over time due to input tariff reductions.[13] The firm level input tariffs have decreased substantially over the period with a wide discrepancy across firms: The average input tariff decreased by about 6 percentage points (reaching up to 39 percentage points for some firms), a 43% drop, between 2000 and 2006 with most of the tariff cuts occurring between 2002 and 2004.[14] We focus on the following specification:

$$P_{ikct}^{EX} = \delta_1 Ordinary_i * \tau_{i,t-1} + \delta_2 Ordinary_i + \delta_3 \tau_{i,t-1} + \delta_4 X_{i,t-1} + \delta_5 Z_{c,t-1} + \alpha_{ik} + \alpha_t + \alpha_c + \eta_{ikct} \quad (2)$$

where P_{ikct}^{EX} is the log of export price (unit value) of firm i for product k in country c at time t and τ_{it-1} is the input tariff faced by firm i at time $t-1$. $Ordinary_i$ is the dummy variable indicating the firm i importer status, X_{it-1} control for firm i size and Z_{ct-1} controls for real exchange rate (RER) or GDP at destination. α_{ik}, α_t, and α_c are firm-product, time and destination/origin-country fixed effects and η_{ikct} an i.i.d. component.[15] In specification (2), $\tau_{i,t-1}$ is a firm level variable which is zero for processing firms (these firms do not pay the tariff). It is thus prefectly colinear with the interaction term between $Ordinary_i$ and firm-level tariffs, and will drop from the estimation.

By including firm-product level fixed effects, we capture the impact of input-trade liberalization on within firm-products prices over time and across destinations. We therefore identify causality effects between input tariffs cut and imported input and exported product prices. As firm-product is our most important dimension, we cluster standard errors at the firm-product level.[16] Note that all our results are robust to clustering at the firm-year level as well as to multi-way clustering with standard errors clustered at the firm, HS6 product and country level following the methodology described by Cameron, Gelbach and Miller (2011). Our baseline results using these alternatives clustering are presented in Section 6.

[13] Section 6.1 discusses drawbacks and advantages of our measure of firm level input tariffs more extensively.

[14] The average input tariff decreased by 16.2% between 2002 and 2003, and by 19.8% between 2003 and 2004.

[15] As shown by Manova and Zhang (2012), Martin (2012), Harrigan, Ma and Shlychkov (2012) among others, there are substantial variations in firm-product export prices across destination markets. A cut in input tariffs may impact firm-product prices differently across destinations. We therefore decided not to limit our within firm-product-destination estimation and let firm-product export prices vary across export markets.

[16] Data limitations (no information on the allocation of inputs for multi-products firms) unabled us to compute firm-product input tariffs. Firm-product standard errors might however be correlated over time across destinations (origins). We thus cluster standard errors at the firm-product level.

3.4 Endogeneity of trade policy

Previous studies (e.g., Schor, 2004, Goldberg et al, 2010, Topalova and Khandelwal, 2011) used Input-Output (IO) tables in order to compute the input tariff measure. Such tariffs are constructed using aggregate data (IO) tables are not usually more disaggregated than the HS3 level) and generate industry-level input tariffs which are then matched to the firm's sector of activity. As in Bas and Strauss-Kahn (2012), we exploit the disaggregated nature of our database by constructing an index of input tariffs which rely on output tariffs and import data at the HS6 level. Since the tariffs are generated from the firm's effective use of a specific imported input, we obtain a more precise measure of input tariffs computed at the firm level. We rely on weighted average tariffs across the firm's HS6 imported inputs - with the weights being constant for the entire period in order to address issues related to changes in the firm imported input mix. All our results are robust to the use of constant inital weights and IO tariffs.[17]

In order to address issues of endogeneity between changes in exports prices and trade policy, we must verify that tariffs were set independently of industries' expected exports and lobbying activities. If policy makers lower tariffs based on sectoral trade performance, we could run into serious causality issues. Higher tariff reduction could indeed be granted for sectors with the best performance on export markets and/or sectors which require large amount of imported inputs. Several arguments however alleviate this concern of the endogeneity of trade policy.

According to Branstetter and Lardy (2008), the Chinese authorities' decision to join the WTO was mainly motivated by the domestic reform agenda and willingness to become a market economy. WTO tariff reductions are thus unlikely to be related to lobby pressures of less-efficient industries looking for lasting protections. Similarly, Brandt et al. (2012) argue that the convergence in tariffs over the period is more likely to reflect a willingness to reach low tariffs in all sectors rather than a selective allocation of tariff reduction in response to sector performances or lobbying activities.

As a further test of the exogeneity of input tariffs, we follow Topalova and Khandelwal (2011) and examine the correlation of tariff changes with initial industry performance. Tariff cuts after 2001 are fixed in the accession agreement; we therefore use data for 2000 in order to capture initial sectoral performances. We regress changes in input tariffs on a number of industry characteristics computed as the size-weighted average of firms' characteristics for the first year. The firm-level data for 2000 comes from the Chinese Industry Statistical Database from HuaMei Information (HMI), provided by the National Bureau of Statistics of China (NBSC).[18]

[17] Section 6.1 reports the results obtained with these alternative measures of input tariffs.

[18] The NBSC collects yearly data from all state-owned firms as well as from firms with other ownership types and annual sales above 5 million RMB. The database includes about 163,000 firms for 2000 and accounts for

In order to compile our database, we rely on firm's name and address which are reported both in the (CCTS) custom-transaction and the (NBSC) firm-level databases. Industry characteristics include: value added, use of intermediate inputs, investment, a value-added based Herfindhal index measuring industry concentration, exports and imports as well as the share of processing and of state-owned firms. Table 1 shows no statistical correlation between input tariffs and industry characteristics pre-WTO accession. This result suggests little discretion in trade policy across sectors which is consistent with an exogenous input tariff reduction.

Table 1: **Exogenous tariff changes to initial industry characteristics**

	Change in tariffs	Observations	R-squared
Value added (2000)	0.0022	378	0.251
	(0.003)		
Intermediate inputs (2000)	-0.0016	388	0.247
	(0.003)		
Investment (2000)	-0.0005	241	0.279
	(0.002)		
Herfindhal index (2000)	-0.0001	389	0.251
	(0.001)		
Exports (2000)	-0.0004	389	0.251
	(0.001)		
Imports (2000)	-0.0000	389	0.250
	(0.001)		
Share processing (2000)	-0.0030	389	0.251
	(0.008)		
Share state-owned (2000)	-0.0013	389	0.251
	(0.009)		

Notes: The table presents the results of regressing changes in input tariffs between 2000 and 2006 at the 4-digit industry level on 4-digit industry characteristics in the initial year (2000). Value added (2000), intermediate inputs (2000), investment(2000), exports (2000) and imports (2000) are computed as the average of all firms producing in the same 4-digit industry. Herfindhal (2000) measure concentration in value added. All these variables are expressed in logarithmic form. Share processing (2000) and share state-owned (2000) correspond to the share of processing (resp. state-owned) firms at the 4-digit industry level. All estimations include 2-digit industry fixed effects. Robust standard errors in parentheses.

3.5 Processing firms as controls

We ensure that our control group is similar to our treated group in term of export patterns by requiring that each ordinary firm has at least one corresponding processing firm at the product-destination-year level. In Section 6.2, we show that our results do not depend on intrinsic differences between ordinary and processing firms in term of size, sector/product characteristics and firm-ownership. One endogeneity concern however remains.

Using processing firms as a control group for ordinary firms indeed raises the crucial question of endogeneity in the trade status of firms. Endogeneity is present if firms decide to function as processing firms (i.e., pure exporters) in sectors where input tariffs are high. Indeed, if input tariffs are excessive, a firm may find it profitable not to serve the domestic market in order to benefit from the duty-free processing trade status.[19] Such hypothesis how-

95% of total industrial output value.

[19]Note that tariffs reached up to 90% for products belonging to HS4 sector 8703 (Motors cars and other

ever requires that firms have the ability to chose their status freely at low cost, which seems unlikely in China over the period considered.

The processing trade status was first implemented to develop export oriented sectors through foreign invested entreprises (FIEs) importing (freely) capital equipment, managerial know-how and technology. Chinese firms were only granted the right to obtain the processing trade status in the 90s. Although the processing trade status was first authorized in specific free-trade zones, Yu and Tian (2012) state that by 2010 only 22% of China's processing imports was actually located in these zones. The distribution of processing trade certificates remains regulated by the authorities and requires several administrative steps. It may imply stopping the production for several month in order to go through customs auditing. The Chinese government also imposes directions for the allocation of the processing trade status. For example, in 2006, as part of the 11th Five-Year program, the Chinese government - aiming to upgrade the product structure of processing trade - changed its trade policy; it placed high energy consumption, high pollution, high resource consumption and low value-added products into prohibited and restricted categories under the status. According to the Hong Kong Trade Development Council (2012), processing factories handling products newly reclassified within the prohibited categories practically lost their licenses to continue producing.[20] Note that within firms at the product level, we observe very few changes in status: 5% switched from the ordinary to the processing status over the period and 7% did the reverse. This reflects an important stability in firms' trade status over time.[21] We thus believe that Chinese firms lack information and freedom to make choices on their trade status in response to the level of tariffs.

Moreover, while processing firms benefit from duty-free trade, they are not allowed to sale their products within China. This is a stringent constraint. In effect, at least until the late 90s, the domestic market stayed highly protected, creating what Feenstra (2008) called an example of "one country, two systems"; the export-promotion and import-substitution regimes co-existed. Doing business within China implied much less competitive pressure than accessing foreign markets. The incentive of Chinese firms to become processing exporters in order to benefit from the input duty-free is thus not obvious. In fact the proportion of ordinary firms remained high in most sectors. For example, in electrical machinery, which is one of the largest

vehicles principally designed for the transport of persons), or 57.5% for products of HS4 sector 4001 (Natural Rubber) or even 45% for products of HS4 sector 6908 (Glazed Ceramic and Tiles) in 2000). Several agricultural products (especially cereals and oils and fats have tariffs between 90% and 120%).

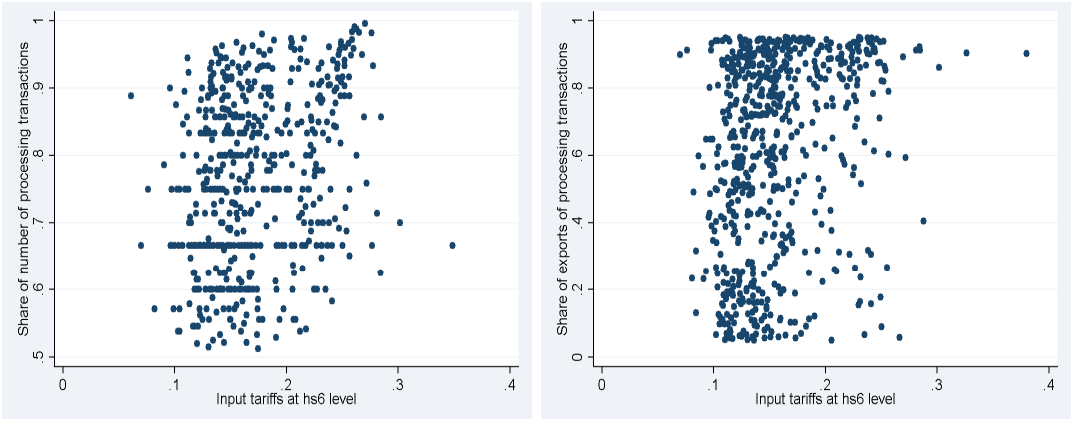
[20] These government restrictions on the distribution of processing trade certificates illustrate the regulatory power of authority as well as the constraints faced by individual firms wishing to change their status. As the change occurred late 2006, it does not affect our data which cover the 2000-2006 period.

[21] Note that 4% of firms switched status for at least one of their products over the period. In these cases, we no longer considered them a "pure" ordinary or processing firm and dropped them from our database.

processing sectors and has attracted a lot of foreign firms benefiting from the inputs duty-free, the share of processing firms is only of 44% (note that the corresponding share in value is much larger reaching 87%).

The average share of exports value under processing trade is slightly higher than 50% and has been quite stable since the mid-90s (see Yu and Tian 2012). Importantly, the share of processing exporters varies widely across sectors and does not depend on the sector's input tariff level. The left panel of Figure 2 shows the relative number of processing firms by HS6 sectors and the corresponding average HS6 input tariff level. As many firms are multiproduct, a firm's sector is defined according to its main HS6 export sector (i.e., highest HS6 export value). Input tariffs are calculated as explained in Section 3.3.2. Each firm is thus associated with a specific input tariff and a main HS6 export product. The HS6 input tariff level in the figures corresponds to the average input tariffs of all firms exporting the same HS6 product. In the right panel, we present the share of HS6 processing exports in value instead of number of firms. Both figures clearly show no obvious positive correlation between the share of processing exports (in number or value) and the level of input tariffs. In order to account for the multiproduct aspect of the firms, we also computed similar shares defining a firm's main export sector at the HS4 and HS3 levels. The figures obtained are similar to the ones presented here.

Figure 2: Share of hs6 processing export in term of the hs6 tariffs, 2000.



Source: Author's calculation using unweighted average tariff rates from WITS.

Due to the level of regulation in the attribution of processing trade certificates, the relative advantage of producing for the non-competitive home market and the absence of correlation between the choice of trade status and the input tariffs at the sector level, we are quite confident that the choice of being a processing importer-exporter is not endogenous to the tariffs level. Section 5.1.1 adresses the potential issue of specific shocks affecting ordinary and processing firms differently over the period (e.g., different policies across firms statuses leading to different

evolution of import and export prices for ordinary or processing firms), while Section 6.2 deals with potential intrinsic differences between ordinary and processing firms by controlling for size, sectors and ownership in addition to product and destination across the treated and control groups.

4 The impact of input-trade liberalization on imported input and export prices

4.1 Imported inputs and trade liberalization

Theoretical models show that firms upgrade the quality of their final goods and exported products by raising the quality of their intermediate goods. In order to do so, firms increase the number of varieties they import, thus reaching a better complementarity of inputs (Ethier 1982), and they import higher quality inputs from the most advanced economies (Kluger and Verhoogen 2012 and Demir 2012).

We are interested in the impact of input-trade liberalization on imported input and exported product prices. Following an input tariffs cut, the price of intermediate goods (excluding the tariff) may increase if firms upgrade the quality of their inputs. We first investigate how ordinary firms modified their imports of intermediate goods following China accession to the WTO. As explained above, we exploit the uniqueness of our database by performing a quasi-natural experiment where ordinary firms stand as the treated group and processing firms as the control group. As a first insight on the effect of the reduction of input tariffs on firms' imports, we regress the log of the firm's number of imported varieties (defined as a product-origin country pair) on firm-level input tariffs interacted with the firm's type dummy.

Table 2 shows that the reduction in tariff is associated with an increase in the number of varieties imported. Interestingly, the decrease in input tariffs has no effect on the number of varieties imported from developing countries (LDC) whereas it increases the number of varieties imported from developed countries (DC).[22] These results are in line with a story where exporters take advantage of the cut in tariffs to reach a better complementarity of high-quality inputs.[23]

Table 3 explores the impact of input-trade liberalization on imported input prices accounting for the product-origin country dimension of the data (i.e., whereas Table 2 is at the firm level, Table 3 is at the firm-product-origin level). We follow the empirical strategy exposed in

[22]Developing countries correspond to non high-income countries, defined by the World Bank as countries with 2007 per-capita GNIs under $11,456 computed in U.S. dollars using the Atlas conversion factor.

[23]Recall that we are working with MNF tariffs. This rules out the possibility that the tariffs cut be higher for DC than LDC countries.

Table 2: **Input tariffs and imported input varieties**

	N imported varieties (1)	N imported varieties DC (2)	N imported varieties LDC (3)
Tariff(t-1)× ordinary	-0.558***	-0.742***	-0.193
	(0.100)	(0.107)	(0.206)
Firm fixed effects	yes	yes	yes
Year fixed effects	yes	yes	yes
Observations	176,601	167,009	67,911
R-squared	0.868	0.858	0.846

Notes: Table 2 presents the results of the following equation: $numb_{it} = \beta_1 Ordinary_i * \tau_{i,t-1} + \beta_2 \tau_{i,t-1} + \alpha_i + \alpha_t + \eta_{it}$ where $numb_{it}$ correspond to the log of the number of imported varieties. As our dependent variables are at the firm level, $\tau_{i,t-1}$ corresponds to the firm-level input tariff. It is thus prefectly colinear with the interaction term $Ordinary_i * \tau_{k,t-1}$ and is dropped from the estimation. Standard errors are clustered at the firm level. *** indicates significance at the level of 1%.

Section 3.3.1 and run equation (1) with the logarithm of import prices at the firm-product-country-time level as dependent variable. We control for HS6 level tariffs as well as firms' size, origin countries' GDP and real exchange rates. As shown in previous studies (e.g., Manova and Zhang, 2012, Harrigan and Ma, 2012, Berman, Martin and Mayer, 2012), these variables are significant determinants of import and export prices. Origin country fixed effects control for distance and general supply conditions.

The coefficient on input tariffs for ordinary firms is negative and highly significant: A decline in input tariffs is associated with an increase in within firm HS6 (f.o.b.) imported inputs prices over time and across countries of origin. Relying on column (2), a 10 percentage point fall in input tariffs raises imported input prices by 18.5% relative to processing firms. Next we distinguish firms by the level of income of the inputs sourcing country. We include an interaction term between HS6 input tariffs, firms' ordinary type and an importer dummy accounting for the main sourcing country of their inputs (DC/LDC).[24] Importantly, as shown in column (3) and (4), the effect of input tariffs on imported input prices is almost twice as large if the inputs come from developed rather than from developing countries. In a recent paper, De Loecker et al. (2012) found that a decrease in input tariffs tends to lower the marginal cost. Their findings do not conflict with ours as imported input prices from the Chinese customs database do not include the import tax. The marginal cost may not reflect the higher prices of upgraded imported inputs as the extra cost may be offset by the fall in tariffs.

[24]This dummy variable takes a value of one if the firm imports more than 50% of their inputs from developed economies and zero otherwise.

Table 3: **Input tariffs and firms' import prices**

Dependent variable: Import prices (f.o.b.) of firm i for product k from country c in year t								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
							Excluding raw materials	
Tariff(t-1)× ordinary	-1.572***	-1.848***			-1.849***		-1.892***	
	(0.143)	(0.142)			(0.142)		(0.149)	
Tariff(t-1)× ordinary DC			-1.766***	-2.071***		-2.072***		-2.108***
			(0.143)	(0.144)		(0.144)		(0.150)
Tariff(t-1)× ordinary LDC			-0.875***	-1.362***		-1.363***		-1.367***
			(0.191)	(0.189)		(0.189)		(0.212)
Tariff(t-1)		1.490***		1.521***	1.490***	1.520***	1.626***	1.662***
		(0.067)		(0.067)	(0.067)	(0.067)	(0.072)	(0.072)
Herfindahl supplier					0.017	0.015		
					(0.013)	(0.013)		
RER(t-1)		-0.212***		-0.186***	-0.213***	-0.186***	-0.218***	-0.191***
		(0.019)		(0.019)	(0.019)	(0.019)	(0.020)	(0.020)
GDP(t-1)		-0.091***		-0.048***	-0.092***	-0.049***	-0.089***	-0.045**
		(0.017)		(0.017)	(0.017)	(0.017)	(0.018)	(0.017)
Size Q1		-0.016*		-0.016*	-0.013	-0.013	-0.016*	-0.016
		(0.010)		(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Size Q2		-0.012		-0.011	-0.009	-0.009	-0.011	-0.011
		(0.009)		(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Size Q3		0.001		0.001	0.002	0.002	0.001	0.002
		(0.007)		(0.007)	(0.007)	(0.007)	(0.008)	(0.008)
Firm-hs6 product fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Origin country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Observations	2,286,393	2,286,393	2,286,393	2,286,393	2,286,393	2,286,393	2,187,309	2,187,309
R-squared	0.932	0.932	0.932	0.932	0.932	0.932	0.932	0.932

Notes: The number of observations is substantially lower than for export transactions presented in the following tables. This is a consequence of our focus on intermediate goods and of a smaller number of trading partners on the import side. In columns (3), (4), (6) and (8) we include not reported dummy variables for importers from DC and LDC. Standard errors are clustered at the firm-product level. ***, **, * indicate significance at the level of 1, 5 and 10% respectively.

As expected, bigger firms have higher imported inputs prices and a depreciation of the real exchange rate results in a large increase in these prices - a 10% depreciation induces an average increase of 21%.[25] In the presence of origin-country fixed effects, the GDP variable captures GDP growth over time. It is thus non-surprising that imported inputs from countries with the highest GDP growth (i.e., developping countries) show the lower increase in imported input prices.

A lack of competition among HS6 level foreign input producers may favor an increase in imported input prices unrelated to the firm endogenous choice of inputs quality. In order to test for this alternative explanation of the increase in imported input prices, we introduce a measure of concentration reflecting the market power of input suppliers. We built a HS6 level Herfindahl index capturing the concentration of input suppliers according to their country of origin (i.e., the sum of squared market shares of imports by countries of origin). Columns (5) and (6) of Table 3 shows that the introduction of this variable does not modify our main results. As for our supplier concentration index, it appears positively but has no significantly impact.

Finally, one may argue that the change in imported input prices is caused by a surge in raw material and energy prices over the 2000-2006 period. This increase in input price is partially captured by the year fixed effects, but as usage of raw material and energy may vary per sector, we test the robustness of our results through the exclusion of raw material and energy from the firm's input mix.[26] The exclusion of raw material and energy does not alter our main findings - the coefficient for input tariffs is almost unchanged (see Columns (7) and (8) of Table 3).

The increase in input prices may also reflect a pass through effect as exporters to China take advantage of the Chinese unilateral trade liberalization to increase their (f.o.b.) prices. This pass-through effect should be stronger in sectors where suppliers have a high market power. The inclusion of supplier concentration index does not however modify our main results. Furthermore, this alternative explanation does not rationalize the increase in the number of imported inputs from developed economies revealed in Table 2 and the fact that imported input prices increase more for intermediate good originates from the most advanced economies.

To sum up, our results show that firms facing a decrease in inputs tariffs buy more varieties of inputs from developed countries and pay a higher price for theses inputs, suggesting a within firm-product quality upgrading of imported inputs.

[25] Most Chinese trade is invoiced in U.S. dollars (see Manova and Zhang, 2012), we thus include the exchange rate of foreign currency for US dollars. A depreciation here means that the exchange rate decreases.

[26] We exclude all products with HS6 codes below 300,000.

4.2 Export prices and trade liberalization

We are interested in the evolution of exported product quality (price) following trade liberalization. The literature so far shows a correlation between high-quality (price) output and high-quality (price) inputs but it does not explore the causal role of decreasing input tariffs on both imported inputs and exported products quality upgrading.[27] In order to capture the effect of input-trade liberalization on within firm-product export prices, we include firm-product, destination and year fixed effects in our estimation. We thus explore how within firm variations in product unit values (across countries and over time) relate to within firm reductions of input tariffs. Relative to the previous literature, this specification allows us to test the effect of input-trade liberalization on within firm-product export prices while using a control group (i.e., processing firms) for which variations in export prices are independent of the fall in input tariffs. We thus interpret our estimates as a causal effect of a reduction in input tariffs on within firm-product export prices.

A change in export prices following a trade liberalization episode may reflect either a variation in quality, as firms take advantage of the tariffs cut to upgrade input quality thereby improving the quality of exported products, or a change in the markup, as firms increase their markup by a limited pass-through of cost reduction to consumers.[28] An increase in the markup following a decrease in input costs (e.g., input tariffs cut) is however unlikely to raise export prices above the pre-trade liberalization level because of fierce competition on export markets. We thus argue that an increase in (f.o.b.) export prices would be unlikely to reflect an increase in the markup.[29]

Table 4 presents the results. We run equation (2) with firm-product-destination-time export prices as dependent variable. Columns (1) and (2) show estimates of the impact of the tariff cut on export prices by interacting firm-level input tariffs with the firm import status (i.e., ordinary or processing). Columns (3) and (4) specify whether the imports originated from developed or developing countries. Finally, columns (5) and (6) consider only the subsample of product exported to high income countries whereas columns (7) and (8) focus on exported products toward low income countries. As for the estimation of imported input prices, we

[27] Recent papers focus on the determinants of within product (or within product-destination) variations in export prices across firms or within firm-product variations across destinations in a cross-section analysis (e.g., Bastos and Silva, 2010, for Portugal, Gorg, Halpern and Murakovy, 2010, for Hungary, Martin, 2012, for France, Manova and Zhang, 2012, for China, Harrigan, Ma and Shlychkov, 2012, for US and Kugler and Verhoogen, 2011, for Colombia). Note that Kugler and Verhoogen (2011) use a panel of Colombian firms to show that bigger firms set higher output prices and pay higher input prices within product-year pairs. In their study, they compare prices across firms selling the same product in the same year.

[28] De Loecker et al. (2012), propose a new methodology based on the estimation of a translog production function in order to retrieve measures of firms' markups, marginal costs and productivity. We cannot replicate their strategy as we do not have data for domestic production and output prices at the product level.

[29] In section 5.2.1, we present alternative measures of quality at the firm-product level following the methodology of Khandelwal, Schott and Wei (forthcoming) that relies on an estimation of the demand function.

control for firm size, the GDP of destination countries and real exchange rates. Destination fixed effects provide control for distance and general demand conditions.[30]

The input tariff reduction has a positive and significant impact on ordinary importers' export prices. Relying on column (2) of Table 4, a 10 percentage point fall in input tariffs increases export prices by 1.2%. This is small effect of trade liberalization on export prices. This result is however in line with the findings of De Loecker and al. (2012). Their work focuses on within firm-product variation of output prices over time and they find a small impact (i.e., coefficient of -0.111) of the output tariff reduction on domestic Indian prices.

Note that, the role of input tariffs in explaining the difference in export prices across firms (instead of within firm-product, i.e., with no causal effects) provides much bigger estimates. In Table A4 in the Appendix, we estimate export prices variation across firms including product-destination-year fixed effects. The coefficient is -0.849, suggesting that ordinary firms with lower input tariffs charge higher export prices. The difference in magnitude with our casual estimation results from the fact that our analysis of the within firm-product effect of trade liberalization does not capture variations across firms nor variations of export prices related to entry of new, more expensive products on the export market (i.e., a product selection effect).

The impact of the input tariff reduction on export prices is specific to inputs imported from developed economies. it has no significant effect if the imports come from less developed countries (see column (4)). Furthermore, in line with Hallak and Schott (2011) or Khandelwal (2010), we find a link between export quality and countries' level of development. As shown in columns (5) and (7), the quality upgrading effect is specific to products that are exported to high income countries.

Bigger firms have higher export prices and a depreciation in the real exchange rate results in an increase in export prices: a 10% depreciation induces an average increase in export prices of 0.67%. Chinese exporters take advantage of their currency depreciation to increase their export prices (i.e, partial pass-through effect). Berman, Martin and Mayer (2012) find a similar elasticity of 0.8% using French data. Note that the effect of exchange rate depreciation on import prices was much larger as the currency depreciation is directly reflected in higher imported inputs prices (see Table 3).[31]

[30]The decrease in Chinese output tariffs raises the competitive pressure on domestic producers but has no direct effect on competition abroad (i.e., it should not directly affect export prices). Competition in foreign markets becomes fiercer for Chinese firms if foreign countries were to modify their trade and competition policy; Note that it would affect Chinese ordinary and processing firms similarly. In Section 5.1.2, we verify that our results are robust against the inclusion of export markets output tariffs in the estimation, thus controlling for product competition in the destination country.

[31]The input tariff cut impacts imported input prices and export prices quite differently. As shown in Table 3 and Table 4, the magnitude of the effect (size of coefficients) is indeed much bigger for imports than exports. This could at least partly be due to a pass-through effect on the import side.

Table 4: **Input tariffs and firms' export prices**

Dependent variable: Export prices (f.o.b.) of firm i for product k in country c and year t								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
					Exporters DC		Exporters LDC	
Tariff(t-1) × ordinary	-0.104***	-0.121***			-0.145***		-0.122	
	(0.030)	(0.030)			(0.036)		(0.076)	
Tariff(t-1) × ordinary DC			-0.129***	-0.144***		-0.169***		-0.147
			(0.031)	(0.032)		(0.038)		(0.079)
Tariff(t-1) × ordinary LDC			0.005	-0.014		-0.019		-0.143
			(0.092)	(0.092)		(0.116)		(0.231)
RER(t-1)		-0.067***		-0.067***	-0.044***	-0.045***	-0.012	-0.012
		(0.007)		(0.007)	(0.013)	(0.013)	(0.010)	(0.010)
GDP(t-1)		0.003		0.003	-0.096***	-0.096***	-0.002	-0.002
		(0.013)		(0.013)	(0.018)	(0.018)	(0.034)	(0.034)
Size Q1		-0.018***		-0.015***	-0.023***	-0.021***	-0.027**	-0.029**
		(0.005)		(0.005)	(0.006)	(0.006)	(0.012)	(0.012)
Size Q2		-0.017***		-0.018***	-0.022***	-0.021***	-0.030***	-0.032***
		(0.004)		(0.004)	(0.005)	(0.005)	(0.010)	(0.010)
Size Q3		0.001		0.001	-0.002	-0.002	-0.005	-0.007
		(0.003)		(0.003)	(0.004)	(0.004)	(0.008)	(0.008)
Firm-hs6 product fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Deatination country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Observations	3,208,497	3,208,497	3,208,497	3,208,497	1,965,068	1,965,068	561,207	561,207
R-squared	0.915	0.915	0.915	0.915	0.916	0.916	0.939	0.939

Notes: Recall that $\tau_{i,t-1}$ is a firm level variable which is prefectly colinear with the interaction term $Ordinary_i * \tau_{k,t-1}$ and therefore drops from the estimation. In columns (3), (4), (6) and (8) we include not reported dummy variables for importers from DC and LDC. Standard errors are clustered at the firm-product level. ***, **, * indicate significance at the level of 1, 5 and 10% respectively.

Overall, our results are in line with a story where ordinary firms take advantage of trade liberalization to upgrade their imported inputs in order to improve the quality of their exports. The alternative explanation that firms exploit reduced imported input cost to increase their markups is difficult to reconcile with the fact that (i) the price of imported inputs increase and (ii) only the fall of input tariffs from developed economies is relevant to explaining export prices growth.

5 Alternative explanations and discussion

There are several potential explanations for the increase in export prices over the 2000-2006 period, with the Chinese trade liberalization and its effect on imported input prices being one of them. In this section, we discuss and examine alternative explanations. We first clarify our strategies to control for these alternative factors. We then discuss influential elements ensuring that we are effectively capturing a quality upgrading effect.

5.1 Alternative explanations

5.1.1 Controlling for shocks specific to ordinary or processing firms

Processing and ordinary firms differ on several dimensions. Processing firms are often owned by foreigners (84% of foreign-owned firms import through processing trade regime), they have higher credit constraints (Manova and Yu, 2012) and lower productivity (Yu and Tian, 2012) than ordinary firms. These differences across firms groups are captured by the firm-product fixed effects that control for unobservable characteristics affecting firms and products that do not vary over time. However, specific exogenous shocks affecting differently ordinary and processing firms may explain the change in export prices over the period and consequently bias our results. Furthermore, comparing firms from ordinary and processing trade regime that export the same HS6 product to the same destination in the same year does not insure that firms would have followed the same export pattern over time in the absence of input tariff reductions. Time-varying factors other than tariffs may have a different impact on ordinary and processing export prices (for example if the Chinese government enforced the quality upgrade of state-owned firms which are highly represented in ordinary - 80% of state-owned firms import intermediates through the ordinary trade regime - or if processing firms benefit from specific export advantages other than being duty free).[32]

This section presents an additional sensitivity test showing that our results are robust to

[32]Processing firms may also be too different from ordinary firms in term of size or objectives to represent a good control group. In section 6.2, we alleviate these concerns by restricting our sample to the biggest firms, excluding multinationals firms or specific sectors and considering only private firms.

time-varying shocks affecting differently ordinary and processing firms over time. We include a time-trend for ordinary firm in our specifications (i.e., an interaction term between time dummy and firms status). Columns (1) and (2) of Table 5 present these results. While the interaction terms between ordinary status and year dummies are negative and statistically significant, our coefficients of interest on the interaction term between input tariffs and ordinary status remain robust and stable under this specification. Controlling for status specific time shocks does not alter our findings on the impact of input-trade liberalization on export prices.

5.1.2 Demand shocks

An increase in export prices may result from greater demand for a specific HS6-product unrelated to product quality. The export prices of firms rise because they increase their markups and/or because producing more output raises the demand for imported inputs which may entail higher input prices. If this increase in demand occurs in HS6-products whose production requires inputs facing the highest tariffs cut, our estimation becomes spurious. Similarly, export prices may be affected by product-destination specific variables that influence competition in export markets. For example, output tariffs and non-tariff barriers in the destination country may have a substantial impact on export prices. We control for such exogenous shocks in demand and competition at destination by introducing product-destination-year fixed effects in the estimation. Note that these product-destination-year fixed effects also control for sector-year variations such as inflation trend. Results are presented in Table 5 columns (3) and (4). Pass-through effects are also of particular interest. They would occur if firms increase their markups in response to a reduction in output tariffs in the export market. We thus introduce the output tariff at destination at the HS6-product level in the estimation (columns (5) and (6) of Table 5). Our results remain robust and stable with the inclusion of product-destination-year fixed effects and output tariffs in destination countries.[33] Unsurprisingly, the coefficient on export markets output tariffs is negative and significant. Chinese exporters take advantage of the decrease in the tariffs on foreign markets to increase their (f.o.b.) export prices (partial pass-through effect).

[33]The sample size is reduced in columns (5) and (6) since output tariffs in destination markets at the HS6 level are not available for all destination countries of our database.

Table 5: **Controlling for exogenous demand, competition and cost shocks**

Dependent variable: Export prices (f.o.b.) of firm i for product k in country c and year t								
	Trends in trade regime		Demand shocks		Tariff(kc,t-1) hs6-destination		Wages sector	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log Wages(s,t-1)							0.010**	0.010**
							(0.004)	(0.004)
Tariff(t-1)× ordinary	-0.094***		-0.075***		-0.109***		-0.131***	
	(0.031)		(0.030)		(0.032)		(0.030)	
Tariff(t-1)× ordinary DC		-0.117***		-0.095***		-0.140***		-0.156***
		(0.032)		(0.032)		(0.034)		(0.032)
Tariff(t-1)× ordinary LDC		0.018		0.013		0.044		-0.009
		(0.092)		(0.093)		(0.097)		(0.088)
Tariff(kc,t-1) at hs6-destination					-0.042**	-0.041**		
					(0.018)	(0.018)		
Ordinary × 2001	-0.067***	-0.067***						
	(0.008)	(0.008)						
Ordinary × 2002	-0.068***	-0.068***						
	(0.009)	(0.009)						
Ordinary× 2003	-0.081***	-0.081***						
	(0.010)	(0.010)						
Ordinary× 2004	-0.054***	-0.055***						
	(0.011)	(0.011)						
Ordinary× 2005	-0.021*	-0.022**						
	(0.011)	(0.011)						
Ordinary× 2006	-0.064***	-0.064***						
	(0.012)	(0.012)						
RER(t-1)	-0.066***	-0.066***	-0.009	-0.013	-0.080***	-0.080***	-0.068***	-0.068***
	(0.007)	(0.007)	(0.355)	(0.355)	(0.008)	(0.008)	(0.007)	(0.007)
GDP(t-1)	0.003	0.003	0.275	0.266	-0.030	-0.030	0.038***	0.038***
	(0.013)	(0.013)	(0.490)	(0.490)	(0.019)	(0.019)	(0.014)	(0.014)
Size Q1	-0.019***	-0.017***	-0.009*	-0.008	-0.013**	-0.012**	-0.019***	-0.017***
	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Size Q2	-0.019***	-0.019***	-0.011***	-0.011***	-0.015***	-0.015***	-0.019***	-0.020***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)	(0.004)
Size Q3	0.000	0.000	0.003	0.003	0.004	0.004	0.002	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)
Firm-hs6 fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Destination fixed effects	Yes	Yes			Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes			Yes	Yes	Yes	Yes
Hs6-destination-year fixed effects			Yes	Yes				
Observations	3,208,497	3,208,497	3,208,497	3,208,497	2,718,078	2,718,078	3,191,873	3,191,873
R-squared	0.915	0.915	0.9230	0.9230	0.919	0.919	0.825	0.825

Notes: Recall that $\tau_{i,t-1}$ is a firm level variable which is prefectly colinear with the interaction term $Ordinary_i * \tau_{k,t-1}$ and therefore drops from the estimation. In columns (2), (4), (6) and (8) we include not reported dummy variables for importers from DC and LDC. Standard errors are clustered at the firm-product level. ***, **, * indicate significance at the level of 1, 5 and 10% respectively.

5.1.3 Higher marginal costs

Of course, the increase in export prices may also result from higher marginal costs. The year fixed effects capture costs increase affecting all firms similarly but do not provide control for sector specific changes in production costs. In order to account for sectoral increase in marginal cost, we first introduce sectoral wages which reflect changes in sectoral labor costs. Wages at the sectoral-year level are constructed using the ORBIS firm-level dataset from Bureau Van Dijk.[34] Mainly representative of medium and large firms in the manufacturing sector (recall that larger firms are more likely to export), the ORBIS dataset includes an average of 130,000 Chinese firms per year over the 2000-2006 period and contains detailed firm level information on wages. Sectoral wages are associated with the median wage paid by all firms producing for the same 3-digit NACE industrial classification. Using correspondence tables between NACE and HS classification, we match sectoral (HS2) wages with our firms from the Chinese customs trade dataset. Columns (7) and (8) of Table 5 show that the introduction of this sectoral cost variable does not modify our main results. Wages unsurprisingly correlate positively and significantly with export prices.

Higher export prices may also result from a lack of competition among HS6 level foreign input suppliers or a surge in raw material and energy prices over the 2000-2006 period. In both cases, export prices increase because imported inputs are more expensive. However, as shown in Table 2, controlling for the concentration of input suppliers and excluding raw material and energy from the set of inputs does not modify our results: As input tariffs fall, imported input prices increase independenlty of the lack of competition of suppliers and the raise in primary product prices. Nevertheless, as a robustness check, we introduce the supplier Herfindahl index in a regression which estimates the export prices. As for input tariffs, firm level supplier Herfindahl indices are computed as a weighted average of the HS6 Herfindahl on inputs used by the firm, with weights remaining constant over time, and corresponding to the average weight of specific import values of HS6 products over the period. Usage of raw material and energy varies across firms' export sector, we thus compute the firm level input tariff ignoring these inputs for the input mix of the firm. As expected, including the Herfindahl index and excluding raw material and energy does not modify our main results (the Herfindahl has a positive sign but is once again not significant). These results are available upon request.

Overall, we find little evidence that the link between the cut in input tariffs and the increase in export prices actually reflects an increase in sectoral production cost in a sector with substantial tariffs cut. Our results on the impact of input-trade liberalization on export

[34]Bureau Van Dijk provides company information for over a 100 million companies around the globe. See https://orbis.bvdinfo.com for further information

prices is robust to the inclusion of the firms' production costs. This supports the explanation of an exported products quality upgrading.

5.2 An upgrade in product quality?

Prices (unit values) are imperfect measures of product quality. An increase in price may indeed reflect higher markups or marginal costs rather than quality upgrading. In the previous section, we attempted to control for these alternative channels and showed that the Chinese trade liberalization, through its reduction in inputs tariffs, increase both imported inputs and export prices independently of product specific demand shock (i.e., markups effects) and cost increases. In this section, we set out several arguments that endorse our prior hypothesis of a product quality upgrading.

First, as shown in Table 6, the cut in input tariffs is associated with a firm-product increase in imported and exported quantities as well as in prices. The concomitance of the increase in imported inputs and export prices as well as imported inputs and export quantities consecutive to a decrease in input tariffs and controlling for firms which have not experienced such tariff cuts is suggestive of a quality upgrading effect. Indeed, while an increase in demand may raise both the quantity and price of exported products and a sourcing effect may increase the quantity and price of imported inputs, it should affect ordinary and processing firms similarly and should be unrelated to the magnitude of the input tariffs cut.

Moreover, our baseline estimations as well as all other tests presented in this paper show that the increase in export prices related to the imported inputs tariffs cut is specific to firms that mainly source their inputs from developed countries. What comes in mind is a scenario whereby firms take advantage of the reduced input tariffs to increase the number and quality of products they import from developed economies producing higher quality inputs. In order to explore this hypothesis, we perform several informative tests, which reinforce the main findings of Section 4.1. First, we examine the evolution in the number of DC and LDC sourcing partners at the firm-product level over the period. We include only firm-imported product pairs that are present in both 2000 and 2006 in order to capture changes in the number and type of suppliers within firm-imported product. It is interesting to note that ordinary firms increased their number of sourcing partners from DC by 10.8% over the period, while the number of sourcing partners from LDCs rose by only 4.7%. Processing firms present the opposite sourcing behaviors: the number of DC suppliers increased by 2.4% while the number of suppliers from LDC increased by 4.3%. Firms benefiting from the tariff cut thus increased their number of DC suppliers two times more than their number of LDC suppliers - this feature is not common to firms exempt from tariffs. The trade liberalization allowed ordinary firms to source inputs

Table 6: **Input tariffs and firms' import and export quantities**

Dependent variable: Export prices (f.o.b.) of firm i for product k in country c and year t				
	(1)	(2)	(3)	(4)
	Quantity imports		Quantity exports	
Tariff(t-1)× ordinary	-1.977***		-0.122*	
	(0.237)		(0.065)	
Tariff(t-1)× ordinary DC		-2.022***		-0.127*
		(0.238)		(0.068)
Tariff(t-1)× ordinary LDC		-1.626***		0.033
		(0.301)		(0.191)
RER(t-1)	-0.038	-0.034	0.022	0.022
	(0.039)	(0.039)	(0.019)	(0.019)
GDP(t-1)	0.301***	0.303***	0.309***	0.309***
	(0.046)	(0.046)	(0.038)	(0.038)
Size Q1	-0.492***	-0.492***	-0.138***	-0.140***
	(0.019)	(0.019)	(0.011)	(0.011)
Size Q2	-0.261***	-0.261***	-0.124***	-0.124***
	(0.016)	(0.016)	(0.010)	(0.010)
Size Q3	-0.139***	-0.139***	-0.085***	-0.085***
	(0.013)	(0.013)	(0.008)	(0.008)
Firm-hs6 product fixed effects	yes	yes	yes	yes
Destination country fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
Observations	2,286,393	2,286,393	3,208,497	3,208,497
R-squared	0.842	0.842	0.721	0.721

Notes: Recall that $\tau_{i,t-1}$ is a firm level variable which is prefectly colinear with the interaction term $Ordinary_i * \tau_{k,t-1}$ and therefore drops from the estimation. In columns (2) and (4), we also include not reported dummy variables for importers from DC and LDC. Standard errors are clustered at the firm-product level. Significance: ***, **, * indicate significance at the level of 1, 5 and 10% respectively.

from more advanced (i.e., higher quality products) markets.

We find very few switches from LDC originated imported inputs to DC originated imported inputs at the product level. In most cases, firms added new suppliers from more advanced economies to their set of existing trade partners. As shown in Table 7, this is especially true for firms that already imported a majority of inputs from DCs; they took advantage of the tariffs' cut to increase the number of varieties they import from these advanced economies. We investigated more carefully the origin of new imported varieties. We defined a new imported input variety as an intermediate good import transaction at the firm-product-country of origin level that is active in 2006 but did not exist in 2000. We then estimated the correlation between new imported varieties and the level of development of the source country by relying in the following equation: $New_{kc} = \beta_1 GDP_c + \beta_1 RER_c + \alpha_k + \eta_{kc}$. New_{kc} takes a value of 1 if the variety at the product-country of origin level is new in 2006, it is zero otherwise. GDP_c and RER_c correspond to the GDP for 2006 in the country of origin and the bilateral real exchange rate between China and the country of origin in 2006. α_k controls for the product dimension. Both the coefficients for GDP and RER are positive and highly significant (at the 1% level). The higher the GDP of the supplier and the stronger the Chinese currency relative to its supplier, the more likely Chinese firms will import a product from this country. This

confirms the positive link between new imported inputs and supplier level of development, and is suggestive of quality upgrading.

Table 7: **Input tariffs and number of DC/LDC suppliers of ordinary importers**

	Importers mainly from DC		Importers mainly from LDC	
	N imported varieties DC	N imported varieties LDC	N imported varieties DC	N imported varieties LDC
	(1)	(2)	(3)	(4)
Tariff(t-1)× ordinary	-0.602***	0.044	-0.823	-0.263
	(0.108)	(0.327)	(0.942)	(0.318)
Firm fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
Observations	151,808	43,118	15,201	24,793
R-squared	0.873	0.839	0.885	0.924

Notes: Table 7 presents the results of the following equation: $numb_{it} = \beta_1 Ordinary_i * \tau_{i,t-1} + \beta_2 \tau_{i,t-1} + \alpha_i + \alpha_t + \eta_{it}$ where $numb_{it}$ correspond to the log of the number of imported variety for different type of importers (i.e, mainly DC or mainly LDC) and of suppliers (i.e., DC or LDC). As our dependent variables are at the firm level, $\tau_{i,t-1}$ corresponds to the firm-level input tariff. It is thus prefectly colinear with the interaction term $Ordinary_i * \tau_{k,t-1}$ and is dropped from the estimation.. Standard errors are clustered at the firm level. ***, **, * indicate significance at the level of 1, 5 and 10% respectively.

5.2.1 Alternative quality measures

In this section, we enhance our measure of quality using insights from Khandelwal's work. Khandelwal (2010) proposes a measure of quality that accounts not only for product prices but also for market shares. Whereas Khandelwal (2010)'s methodology evaluates quality at the product level, Khandelwal, Schott and Wei (forthcoming) (KSW hereafter) show that by relying on an utility function which accounts for product quality as in Section 2 and taking logs on the corresponding demand, the quality for each firm-product-country-year observation can be estimated. It corresponds to the residual of an OLS estimation of the following regression:

$$x_{ikct} + \sigma p_{ikct} = \alpha_k + \alpha_{ct} + \eta_{ikct} \tag{3}$$

where x_{ikct} and p_{ikct} denote the natural logs of the quantity and price of product k produced by firm i and sold in market c in t. The country-time fixed effect α_{ct} controls for price index and income at destination, while the product fixed effect α_k controls for variation across products. The estimated log quality, λ_{ikct} , depends on the residual η_{ikct} and the elasticity of substitution σ: $\lambda_{ikct} = \eta_{ikct}/(\sigma - 1)$. We estimate quality following this method using our Chinese custom database and then use the estimated quality, λ_{ikct}, as the dependent variable in our baseline estimation. For the elasticity of substitution, we chose $\sigma = 6$.[35] We also adapt KSW's estimation to the import side with x_{ikct} and p_{ikct} representing the natural logs

[35]This σ corresponds to the Chinese median elasticity of substitution across sectors according to Broda, Greenfield and Weinstein (2006).

of the quantity and price of product k imported by firm i from market c in t. Our results, presented in columns (1) to (4) of Table 8 are robust to alternative choices of σ. Importantly, the coefficient on firms input tariffs for ordinary firms remains negative and significant. The Chinese trade liberalization, through its decrease in inputs tariffs, allows firms to upgrade the quality of their imported inputs and exported products.

Overall, refining our measure of exported product quality confirms and reinforces our hypothesis that firms take advantage of the unilateral trade liberalization to buy higher quality inputs in order to increase the quality of their exported products.[36]

Table 8: **Alternative measure of quality**

Dependent variable: Export prices (f.o.b.) of firm i for product k in country c and year t						
	(1)	(2)	(3)	(4)	(5)	(6)
	KSW quality Imports		KSW quality Exports		Homogeneous vs. Differenciated	
Tariff(t-1)× ordinary	-1.525***		-0.080**		0.062	
	(0.158)		(0.034)		(0.094)	
Tariff(t-1)× ordinary DC		-1.728***		-0.102***		0.003
		(0.160)		(0.036)		(0.058)
Tariff(t-1)× ordinary LDC		-1.229***		0.032		0.195
		(0.208)		(0.102)		(0.137)
Tariff(t-1)× ordinary×Rauch					-0.198**	
					(0.098)	
Tariff(t-1)× ordinary DC× Rauch						-0.157***
						(0.039)
Tariff(t-1)× ordinary LDC× Rauch						-0.198
						(0.127)
Tariff(t-1)	-1.518***	-1.582***				
	(0.079)	(0.079)				
RER(t-1)	0.168***	0.193***	0.046***	0.046***	-0.067***	-0.067***
	(0.022)	(0.022)	(0.008)	(0.008)	(0.007)	(0.007)
GDP(t-1)	0.217***	0.261***	-0.199***	-0.199***	0.003	0.003
	(0.021)	(0.021)	(0.016)	(0.016)	(0.013)	(0.013)
Size Q1	-0.096***	-0.096***	-0.038***	-0.036***	-0.018***	-0.016***
	(0.011)	(0.011)	(0.006)	(0.006)	(0.005)	(0.005)
Size Q2	-0.051**	-0.051**	-0.036***	-0.036***	-0.017***	-0.018***
	(0.010)	(0.010)	(0.005)	(0.005)	(0.004)	(0.004)
Size Q3	0.018**	0.018**	-0.012***	-0.012***	0.001	0.001
	(0.009)	(0.009)	(0.004)	(0.004)	(0.003)	(0.003)
Firm-hs6 product fixed effects	yes	yes	yes	yes	yes	yes
Destination/origin country fixed effects	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes
Observations	2,286,393	2,286,393	3,208,497	3,208,497	3,208,497	3,208,497
R-squared	0.897	0.897	0.897	0.897	0.915	0.915

Notes: Recall that $\tau_{i,t-1}$ is a firm level variable which is prefectly colinear with the interaction term $Ordinary_i * \tau_{k,t-1}$ and therefore drops from the estimation. In columns (2) , (4) and (6) we also include not reported dummy variables for importers from DC and LDC. Standard errors are clustered at the firm-product level. ***, **, * indicate significance at the level of 1, 5 and 10% respectively.

[36]The changing sign of the RER coefficient may reflect the fact that a depreciation of the Chinese currency leads to buying lower quality inputs and consequently exporting lower quality products. On the import side, the positive and significant coefficient on GDP shows that the higher the growth rate in the origin country of imports, the higer the increase in quality following the input-trade liberalization.

5.2.2 Distinguishing homogeneous from differentiated products.

In the same way, we expect the effect of input tariff reduction on export prices via quality upgrading to be stronger for differentiated goods than for homogeneous goods. While change unrelated to quality may affect the prices of both types of products similarly, price changes related to quality specifically concern differentiated products: the more differentiated the product, the higher the potential gains from increase quality. This is reflected in columns (5) and (6) of Table 8, where the interaction term between firm input tariffs and ordinary status is further interacted with a dummy variable capturing the Rauch (1999) classification of products according to their degree of differentiation. The Rauch dummy takes a value of one when products are differentiated (products are otherwise price-referenced or homogeneous). The coefficient on the triple interaction term between firm input tariffs, ordinary status and Rauch is negative and significant implying that the effect of input tariff cuts on export prices is greater for ordinary firms exporting differenciated products. This again suggests that we capture the effect of trade liberalization on exported products quality.

6 Robustness checks

We now move on to several robustness checks. First, we discuss and test our measure of input tariffs. Second, we confront our findings to alternative samples to ensure that our findings are not driven by intrinsic differences between ordinary and processing firms in term of size, sector/product characteristics and firm-ownership. Finally, we present alternative specifications concerning the hypothesis on the correlation of standard errors.

6.1 Alternative input tariffs

Input tariffs are constructed as a weighted average of tariffs on inputs used in the production of a firm final output, where the weights are constant over the period. Weights are computed as the average import value of a specific input HS6 product over the period. This measure is free of potential reverse causality concerns regarding possible variations in firms' export prices that might affect changes in firms' choice of imported inputs. This firm level input tariff measure also avoids potential biased estimates stemming from changes in the composition of input mix over time due to input tariff reductions. The main advantage of using these weights thus lies in their stability over time.

Our measure of firm level input tariffs is however not perfect. Average weights of HS6 products experiencing the most important drop in tariffs are likely to be high. In the initial year, inputs with high tariffs were scarcely used (i.e., low weight), a sharp decrease in tar-

iffs however shifted demand toward these inputs, drastically raising their import shares and thereby their average weights. Nevertheless for our requirements, as long as the high average weights results from the tariffs cut, we appropriately captured change in imported input costs entailed by trade liberalization. If the change in weights is exogenous to the change in tariffs our results may however be biased upward. In order to insure that our results are not driven by our tariff specification, we propose three alternative tests.

We first verified that at the firm-product level a tariff cut is associated with an increase in import value and therefore in relative weight. We therefore ran a specification similar to (1) with the import value as the dependent variable. We found a coefficient of -3.317 for the tariff*Ordinary explanatory variable, significant at the 1% level. This suggests that changes in imported input weights are related to trade liberalization. Second, we ran our main regression on export prices (i.e., equation (2)) using tariffs constructed with the firm's initial input weights. This measure of tariffs gives a low weight to inputs with the initial highest tariffs. Columns (1) and (2) of Table 9 show the results. Our findings on the impact of trade liberalization on export prices are robust to this alternative tariff measure.

Table 9: **Input tariffs and firms' export: Alternative tariffs**

Dependent variable: Export prices (f.o.b.) of firm i for product k in country c and year t				
	Initial weights		IO weights	
	(1)	(2)	(3)	(4)
Tariff(t-1)× ordinary	-0.185**		-0.065	
	(0.077)		(0.050)	
Tariff(t-1)× ordinary DC		-0.173**		-0.133***
		(0.077)		(0.049)
Tariff(t-1)× ordinary LDC		-0.708		-0.195
		(0.513)		(0.101)
Input tariffs IO			0.580***	0.591***
			(0.033)	(0.034)
RER(t-1)	-0.009	-0.009	-0.063***	-0.063***
	(0.011)	(0.011)	(0.007)	(0.007)
GDP(t-1)	0.096***	0.096***	-0.002	-0.003
	(0.025)	(0.025)	(0.013)	(0.013)
Size Q1	-0.000	0.004	-0.014***	-0.012**
	(0.011)	(0.011)	(0.005)	(0.005)
Size Q2	-0.018**	-0.018**	-0.014***	-0.014***
	(0.009)	(0.009)	(0.004)	(0.004)
Firm-hs6 fixed effects	yes	yes	yes	yes
Destination country fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
Observations	760,058	760,058	3,197,215	3,197,215
R-squared	0.931	0.931	0.915	0.915

Notes: Recall that $\tau_{i,t-1}$ is a firm level variable which is prefectly colinear with the interaction term $Ordinary_i * \tau_{k,t-1}$ and therefore drops from the estimation. In columns (2) and (4), we include not reported dummy variables for ordinary and processing importers from DC and LDC. Standard errors are clustered at the firm-product level. ***, **, * indicate significance at the level of 1, 5 and 10% respectively.

Finally, we use Chinese Input-Output (IO) tables for 2002 from the National Bureau of Statistics of China (NBSC) for 122 industries in order to construct an alternative exogenous

measure of input tariffs. Such measures are much less precise (data are at the 2-digit HS level) and do not reflect the input mix of the firm. Weights correspond to the shares of HS2 sectors in the production of a given HS2 sector. For each firm-exported product, we associate the corresponding HS2 input tariff derived from the IO table. In contrast to our other specifications, tariffs vary at the HS2-year level and are not specific to the firm. We thus need to slightly modify our specification and include the HS2 tariff as a control variable in the estimation. Results are reported in columns (3) and (4) of Table 9. It is however important to note that, despite the highly aggregated feature of IO table data and the imprecise measure of firms input tariffs, our results are fairly robust to this alternative measure of tariffs.

6.2 Are processing a good control group: alternative samples

Processing firms might be quite different from firms that export through ordinary trade in term of size, ownership, exported products and destination markets. By restricting our sample to ordinary firms for which there is at least one corresponding processing firm at the product-destination-year level, we ensure a geographic and sectoral overlapping across the treated and control groups. Although time-invariant differences in firm-level attributes are controlled for by the fixed effects, one may wonder whether large discrepancies in size or ownership across the two groups may affect the results. In order to alleviate this concern, we run our baseline estimation on a subsample of ordinary and processing firms which are similar in term of size in addition to exporting the same product to the same destination markets in the same year. Columns (1) and (2) of Table 10 report results for firms with size higher than the median. As shown in the table, using this alternative sample does not modify our main results.[37]

We also verified that our results are not related to ownership status. Foreign-owned firms are present both under the ordinary and the processing trade regime, they were however historically the first to benefit from the processing trade regime and are highly represented under this status. If processing firms are simply assembling product for foreign multinationals, do they really choose the quality of their imported and exported products? In contrast, state-owned firms are primarily importing intermediates through the ordinary trade regime. Since firm-ownership might be correlated with trade regime, firms objectives might be quite different across the treated and the control groups and/or specific shocks related to the ownership status might affect export prices differently across ordinary and processing firms.

We already addressed this concern by including a time trend on the ordinary dummy variable thereby capturing time varying specific shocks affecting processing and ordinary firms differently. As an alternative robustness test, we exclude foreign firms from the estimated

[37] We also tested for different size thresholds. Results are similar and available upon request.

Table 10: **Alternative samples: size and ownership status.**

Dependent variable: Export prices (f.o.b.) of firm i for product k in country c and year t						
	(1)	(2)	(3)	(4)	(5)	(6)
	Similar size		Excluding foreign firms		Only private firms	
Tariff(t-1)× ordinary	-0.148***		-0.163***		-0.071	
	(0.049)		(0.032)		(0.060)	
Tariff(t-1)× ordinary DC		-0.195***		-0.186***		-0.141**
		(0.052)		(0.034)		(0.064)
Tariff(t-1)× ordinary LDC		-0.037		-0.090		0.208
		(0.146)		(0.096)		(0.164)
RER(t-1)	-0.233***	-0.233***	-0.086***	-0.087***	-0.219***	-0.218***
	(0.023)	(0.023)	(0.009)	(0.009)	(0.024)	(0.024)
GDP(t-1)	-0.053	-0.054	0.011	0.011	0.093***	0.092***
	(0.034)	(0.034)	(0.017)	(0.017)	(0.035)	(0.035)
Size Q1	0.004	0.007	-0.012**	-0.010*	0.004	0.005
	(0.009)	(0.009)	(0.006)	(0.006)	(0.011)	(0.011)
Size Q2	-0.005	-0.005	-0.012**	-0.013**	-0.017*	-0.020*
	(0.008)	(0.008)	(0.005)	(0.005)	(0.010)	(0.010)
Size Q3	0.020***	0.019***	0.008*	0.008*	0.027***	0.025***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.009)	(0.009)
Firm-hs6 fixed effects	yes	yes	yes	yes	yes	yes
Destination fixed effects	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes
Observations	1,245,140	1,245,140	2,438,305	2,438,305	977,880	977,880
R-squared	0.910	0.910	0.905	0.905	0.903	0.903

Notes: Recall that $\tau_{i,t-1}$ is a firm level variable which is prefectly colinear with the interaction term $Ordinary_i * \tau_{k,t-1}$ and therefore drops from the estimation. In columns (2), (4) and (6), we include not reported dummy variables for importers from DC and LDC. Standard errors are clustered at the firm-product level. ***, **, * indicate significance at the level of 1, 5 and 10% respectively.

sample. Table 10, columns (3) and (4), provides the results. In columns (5) and (6), we restrict the estimated sample to private firms. As shown in the table, our baseline results are not driven by time-varying shocks affecting foreign-owned or state-owned firms differently nor by the distinct nature (and diverging incentives) of processing and ordinary firms.[38]

Similarly, Electronics and Textile are highly represented in processing trade activities and encountered drastic trade changes over the period (i.e., the phasing out of the Multifiber Agreement).[39] We checked whether our results could be driven by these two important sectors. We ran our baseline regressions excluding textile (exported products corresponding to HS2 codes higher than 50 and lower than 63), electronics (products corresponding to HS2 codes 85) and raw materials (all products with HS2 codes below 30) in turns. Table 11 shows that, by and large, omitting these sectors does not modify the results.

[38] As common in the literature when working with unit values and because of potential noise in these variables, we exclude transactions with the 1% biggest and lowest unit values from our database (We also tested alternative threshold for outliers). Results, available upon request, are similar to the ones obtained in our baseline specifications

[39] Khandelwal, Schott and Wei (forthcoming) investigate the patterns of Chinese exporters before and after the elimination of externally imposed export quotas.

Table 11: **Alternative samples: controlling for specific sectors**

Dependent variable: Export prices (f.o.b.) of firm i for product k in country c and year t						
	(1)	(2)	(3)	(4)	(5)	(6)
	No textile		No electronic		No raw materials	
Tariff(t-1)× ordinary	-0.084**		-0.144***		-0.126***	
	(0.033)		(0.031)		(0.031)	
Tariff(t-1)× ord DC		-0.115***		-0.170***		-0.148***
		(0.035)		(0.032)		(0.032)
Tariff(t-1)× ord LDC		0.073		-0.027		-0.027
		(0.099)		(0.096)		(0.094)
RER(t-1)	-0.060***	-0.060***	-0.072***	-0.072***	-0.066***	-0.066***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
GDP(t-1)	0.009	0.009	0.009	0.009	0.002	0.002
	(0.015)	(0.015)	(0.014)	(0.014)	(0.013)	(0.013)
Size Q1	-0.019***	-0.017***	-0.016***	-0.014***	-0.017***	-0.015***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)
Size Q2	-0.017***	-0.017***	-0.017***	-0.017***	-0.018***	-0.018***
	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Size Q3	0.000	0.001	0.003	0.003	0.001	0.001
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Firm-hs6 fixed effects	yes	yes	yes	yes	yes	yes
Destination fixed effects	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes
Observations	2,540,343	2,540,343	2,845,063	2,845,063	3,173,145	3,173,145
R-squared	0.914	0.914	0.912	0.912	0.915	0.915

Notes: Recall that $\tau_{i,t-1}$ is a firm level variable which is prefectly colinear with the interaction term $Ordinary_i * \tau_{k,t-1}$ and therefore drops from the estimation. In columns (2), (4) and (6), we include not reported dummy variables for importers from DC and LDC. Standard errors are clustered at the firm-product level. ***, **, * indicate significance at the level of 1, 5 and 10% respectively.

6.3 Alternative specifications

In the previous specifications we chose to cluster standard errors at the firm-product level. The rationale for this choice is based on the fact that we did not observe firm-product level input tariffs due to data limitations (there was no information on the allocation of inputs for multi-products firms) while firm-product standard errors might be correlated over time across destinations (origins). Nevertheless, since we relied on input tariffs at the firm level varying over time, standard errors might also be correlated within firms and over time. Columns (3) and (4) of Table 12 presents an alternative specification with standard errors clustered at the firm-year level. All the variables of interest remain robust and stable under this alternative clustering method. Finally, since the structure of the data is at the firm-product-destination level, we also present an additional test relying on multi-way clustering with standard errors clustered at the firm, HS6 product and country level following the methodology described by Cameron, Gelbach and Miller (2011) (columns (5) and (6)).

Table 12: **Alternative specifications**

Dependent variable: Export prices (f.o.b.) of firm i for product k in country c and year t				
	(1)	(2)	(3)	(4)
	cluster firm-year		multi-way clustering firm-hs6-destination	
Tariff(t-1)× ordinary	-0.121**		-0.121***	
	(0.049)		(0.040)	
Tariff(t-1)× ordinary DC		-0.144***		-0.144***
		(0.050)		(0.032)
Tariff(t-1)× ordinary LDC		-0.014		-0.014
		(0.205)		(0.093)
RER(t-1)	-0.067***	-0.067***	-0.067***	-0.067***
	(0.009)	(0.009)	(0.027)	(0.027)
GDP(t-1)	0.003	0.003	0.003	0.003
	(0.019)	(0.019)	(0.047)	(0.047)
Size Q1	-0.018*	-0.015	-0.018*	-0.015**
	(0.009)	(0.009)	(0.006)	(0.006)
Size Q2	-0.017**	-0.018**	-0.017**	-0.018**
	(0.007)	(0.008)	(0.005)	(0.005)
Size Q3	0.001	0.001	0.001	0.001
	(0.005)	(0.005)	(0.002)	(0.002)
Firm-hs6 fixed effects	yes	yes	yes	yes
Destination country fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
Observations	3208497	3208497	3208497	3208497
R-squared	0.915	0.915	0.915	0.915

Notes: Recall that $\tau_{i,t-1}$ is a firm level variable which is prefectly colinear with the interaction term $Ordinary_i * \tau_{k,t-1}$ and therefore drops from the estimation. In columns (2) and (4), we include not reported dummy variables for importers from DC and LDC. Standard errors are clustered at the firm-product level. ***, **, * indicate significance at the level of 1, 5 and 10% respectively.

7 Conclusions

The paper examines the impact of trade liberalization on the evolution of within firm-product imported input and exported product prices. In order to identify causal links between cuts in input tariffs and trade prices, we take advantage of a rich and unique database of Chinese firms' trade data that covers the Chinese accession to the WTO in 2001 and characterizes trade transaction according to a dual regime where some firms are exempt from paying tariffs. This is crucial to our approach as it allows us to rely on a quasi-natural experiment where firms not subject to tariffs stand as the control group. We obtain two robust results: (i) firms take advantage of the input-trade liberalization to increase both the number of inputs varieties they import and the price of their imported varieties, and (ii) in response to the tariff cut, ordinary firms (i.e., the treated group paying the tariffs) increase their export prices, especially if the inputs are sourced from the most developed economies and the output is exported to high income countries. Our results suggest a scenario where firms exploit the input trade liberalization to upgrade the quality of their inputs in order to upgrade the quality of their exported products. Indeed, the alternative explanation of higher export prices reflecting a rise in markups is unlikely to be associated with higher imported input prices and to be specifically

related to increased imports from the most developed economies.

The positive link between imported input prices and export prices, first revealed by Kugler and Verhoogen (2012), is then confirmed within firm-product over time and across destinations, following a trade liberalization episode. This result accentuates the positive role that unilateral trade liberalization may have on firms and export performances. In addition to expanding the number of goods produced and exported (see Goldberg et al. 2010, Bas and Strauss-Kahn 2012), input trade liberalization leads to an upgrade in product quality.

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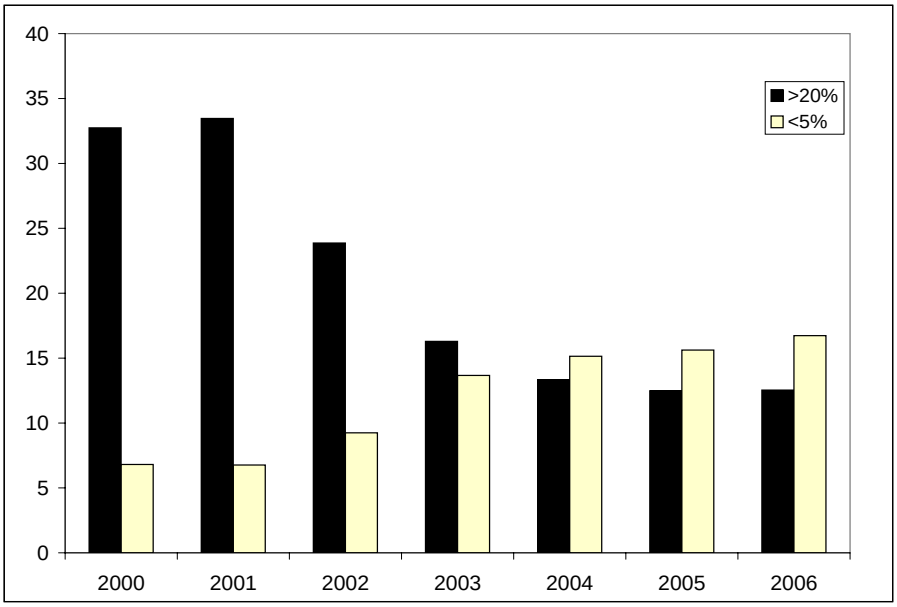
8 Appendix

Figure A1: Share of HS6 sectors under various tariffs level



Note: Based on Figure 2 of Brandt et al. (2012). Source: Author's calculation using unweighted average tariff rates from WITS.

Table A1: Chinese Industrial Tariff Reduction between 2000 and 2006.

Industry name	Change in tariffs (percentage points)	Percentage reduction in tariffs
Coke, refined petroleum products and nuclear fuel	-066	10.49
Fabricated metal products, except machinery and equipment	-1.86	14.46
Leather and footwear	-4.55	23.18
Non-metallic mineral products	-4.39	26.26
other transport equipment	-3.18	27.56
Basic metals	-2.32	31.44
Wearing apparel; dressing and dyeing of fur	-7.60	31.73
Medical, precision and optical instruments, watches and clocks	-4.33	32.00
Tobacco products	-18.83	33.04
Furniture	-6.93	33.51
Rubber and plastics products	-5.47	35.31
Machinery and equipment	-5.24	35.50
Chemicals and chemical products	-3.70	36.03
Electrical machinery	-5.59	38.47
Food products and beverages	-12.28	41.93
Radio., television and communication equipment	-7.73	45.47
Textiles	-10.23	50.00
Wood and products of wood and cork	-6.34	55.32
Motor vehicules, trailers and semi-trailers	-18.37	56.02
Publishing, printing and reproduction of recorded media	-5.56	57.26
Paper and paper products	-9.07	61.20
Office, accounting and computing machinery	-10.71	74.48

Notes: Author's calculation using unweighted average tariff rates from WITS.

Table A2: Definition of the three main custom regimes.

Regime code	Regime name	Definition
10	Ordinary trade	Unilateral imports or exports through customs
14	Processing and assembling	The type of inward processing in which foreign suppliers provide raw materials, parts or components under a contractual arrangment for the subsequent re-exportation of the processed products. Under this type of transaction, the imported inputs and the finished outputs remain property of the foreign supplier.
15	Processing with imported materials	The type of inward processing other than processing and assembling in which raw materials or components are imported from the manufacture of the export oriented products, including those imported into Export Processing Zone and the subsequent re-exportation of the processed products from the Zone.

Notes: The other custom regimes are: International aid, Donation by overseas Chinese, Compensation trade, Goods on consignment, Border trade, Equipement imported for processing trade, Contracting projects, Goods on lease, Equipement/materials investment by foreign-invested enterprise, Outward processing, Barter trade, Duty-free commodity, Warehousing trade, Entrepot trade by bonded area, Other. Source: The General Administration of Customs of China

Table A3: Descriptive evidence of the sample (average over the period 2000-2006).

Industry name	full sample # firms (shares)	estimated sample # firms (shares)	# ordinary firms	# processing firms	# products
Food products and beverages	8.4%	5.1%	891	415	95
Textiles	5.3%	5.8%	433	1,053	151
Wearing apparel; dressing and dyien	11.8%	15.5%	358	3,651	191
Leather and footwear	5.4%	5.9%	304	1,219	37
Wood and products of wood	1.9%	1.8%	285	186	27
Paper and paper products	2.8%	2.2%	294	262	40
Publishing, printing and reproduction	0.4%	0.4%	79	36	17
Coke, refined petroleum products and nuclear fuel	0.4%	0.0%	10	3	2
Chemicals	11.9%	6.9%	1360	422	183
Rubber and plastic products	18.8%	18.4%	2,460	2,281	87
Other non-metallic mineral products	3.5%	2.5%	412	230	71
Basic metals	2.2%	1.2%	178	141	81
Metal products	4.7%	5.3%	730	650	140
Machinery and equipement	6.0%	6.6%	983	575	232
Office, accounting and computing machinery	1.2%	1.5%	55	322	8
Electrical machinery	4.5%	5.3%	443	916	86
Radio, television and communication equipement	3.9%	4.3%	313	799	57
Medical, precision and optical instruments	1.7%	2.0%	169	347	117
Motor vehicles, trailers and semi-trailers	0.7%	0.7%	142	46	19
Other transport equipement	0.4%	0.5%	42	81	22
Furniture	4.7%	7.1%	1433	136	
Other sectors	0.0%	1.6%	182	221	20
Total	100%	100%	10,517	15,289	1,821
Total	(# 42,398)	(# 25,806)			

Notes: Author's calculation. The table report mean values over the period 2000-2006. The full sample corresponds to all firms that export and import. Our estimated sample requires that firms are either ordinary or processing and that for each treated firm (ordinary) there is a at least one control firm (processing) at the product-destination-year level.

Table A4: Across firms analysis of input tariffs on export prices.

Dependent variable: Export prices (f.o.b.) of firm i for product k in country c in year t		
	(1)	(2)
Tariff(t-1)× ordinary	-0.849***	-0.637***
	(0.143)	(0.141)
Ordinary importer	-0.022	0.160***
	(0.025)	(0.052)
Tariff(t-1)× ordinary DC		-0.883***
		(0.161)
Tariff(t-1)× ordinary LDC		-0.643**
		(0.307)
Ordinary importer from DC		-0.010
		(0.027)
Ordinary importer from LDC		-0.264***
		(0.041)
Processing importer LDC		-0.175***
		(0.024)
Size Q1	-0.199***	-0.176***
	(0.018)	(0.018)
Size Q2	-0.152***	-0.157***
	(0.018)	(0.019)
Size Q3	-0.114***	-0.111***
	(0.017)	(0.017)
Product-destination-year fixed effects	Yes	Yes
Observations	3,208,497	3,208,497
R-squared	0.603	0.604

Notes:Recall that $\tau_{i,t-1}$ is a firm level variable which is prefectly colinear with the interaction term $Ordinary_i * \tau_{k,t-1}$ and therefore drops from the estimation. Standard errors are custered at the firm level. ***, **, * indicate significance at the level of 1, 5 and 10% respectively.