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Input-trade liberalization, export prices and quality upgrading ☆

Maria Bas [a,b,1], Vanessa Strauss-Kahn [c,*]

[a] Sciences Po, 28, rue des Saints-Pères, 75007 Paris, France
[b] CEPII, 28, rue des Saints-Pères, 75007 Paris, France
[c] ESCP-Europe, 79, avenue de la République, 75011 Paris, France

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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. For identification, we make use of a natural control group of firms that are exempted from paying tariffs. 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.

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 et al., 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, 2013). Although upgrading export quality may help firms in developing countries enter profitable markets, it would prove difficult if accessing high-quality inputs is too costly. 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 provides 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 the input trade liberalization, 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. It is also stronger than a full pass-through effect of decreased tariffs on import prices. 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.

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* Corresponding author. Tel.: +33 1 49 23 20 90.
E-mail addresses: maria.bas@sciencespo.fr (M. Bas), vstrauss-kahn@escpeurope.eu (V. Strauss-Kahn).
[1] Tel.: +33 1 53 68 55 77.

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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. Our findings are robust to the use of an alternative measure of quality: results hold when Khandelwal et al. (2013)'s quality estimates are used instead of unit values. This is consistent 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 World Trade Organization (WTO) in 2001 which led to an important decrease in tariffs. Second, it characterizes trade transaction according to a dual trade regime where some firms are exempt from paying tariffs: 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, imported inputs must be used in the production of goods for the export markets only. This dual trade regime is crucial to our approach as it allows us to use a natural control group made of firms not subject to tariffs and thereby to alleviate concerns related to potential endogeneity issues.[2]

Our identification strategy exploits both the variation in input tariffs and the existence of a control group composed of processing firms with similar export characteristics as ordinary firms – we require that for each ordinary firm there is at least one processing firm exporting the same product to the same destination in the same year. Moreover, our analysis focuses on domestic Chinese ordinary and processing firms by excluding foreign-owned companies. With imported input 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 constant initial weights. 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. We include in the estimation several fixed effects which control for sectoral, destination (origin) and location time-varying shocks which may affect firms' prices. Some unobservable shocks however remain (e.g., specific policies at the sectoral–regional level). We make use of the control group of processing firms in order to account for these unobserved variables that affect prices of ordinary and processing firms similarly.

An important concern is the potential endogeneity between tariff changes and the imports or exports of firms. We 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. Importantly, we show that the firms' processing status is exogenous to the level of input tariffs. We also ensure that our control group is similar to our treated group in terms of ownership and export patterns by (i) excluding foreign-owned companies, and (ii) requiring that, for each ordinary firm, there is at least one processing firm exporting the same HS6 product to the same destination in the same year. Our identification strategy also controls for initial firm size trends, sector-year, country-year and province-year fixed effects and, therefore, compares ordinary and processing firms of similar initial size that have experienced similar firm size-related trends and the same sectoral, destination (origin) and location time varying shocks. Firm-product fixed effects help control for differences between ordinary and processing firms. These fixed effects do not, however, capture time-varying features other than input tariffs, that may affect ordinary and processing firms differently in term of objectives or responses to shocks. We address this concern by including in the estimation a time trend by trade status 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). Our results are robust to this alternative specification, which makes us confident in the relevance of our control group.

We also ensure that changes in export prices are not associated with country-product specific demand shocks or increased marginal costs and set out several arguments that endorse our prior hypothesis of a product quality upgrading (for example, we show that the effect of input trade liberalization on prices is specific to differentiated products and do not affect homogeneous goods). Finally, we carried out several robustness tests that show that our estimates are not driven either by the measure of input tariff or our sample. All our findings are robust to alternative explanations and sensitivity tests.

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 et al. (2010); Kugler and Verhoogen (2012); Martin (2012); Manova and Zhang (2012) and Harrigan et al. (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., Pavcnik, 2002; Schor, 2004; Fernandes, 2007; Amiti and Konings, 2007; Topalova and Khandelwal, 2011; 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 et al., 2009). Bas (2012), Goldberg et al. (2010), and Bas and Strauss-Kahn (2014) 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 or 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, 2013) 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 input trade liberalization on firms' imported inputs and exported product prices; Section 5 proposes alternative explanations to the quality upgrading pattern, discusses our findings and presents several robustness checks. Section 6 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:

[2] 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, 2013), these cross-section analyses do not however assess causality.

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 the 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, 2013; Kugler and Verhoogen, 2012; Crozet et al., 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 à 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, 2013; Crozet et al., 2012; Johnson, 2012; Verhoogen, 2008; Kugler and Verhoogen, 2012).[3] 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 denote 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 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. 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 (Johnson, 2012) destination markets.

Kugler 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.[4] Similarly, in a theoretical North-South model of heterogeneous firms and quality upgrading, Demir (2012) extends the framework of Kugler and Verhoogen (2012) and shows the mechanisms through which input trade liberalization leads to export quality upgrading of firms located in the South.

In the next sections, we test for this particular supply channel. We refer to this recent literature on 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.[5] Trade liberalization can also impact firms' decision to improve the quality of their final goods through a demand channel based on expansion of export opportunities as highlighted by Verhoogen (2008). We control for this alternative explanation.

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 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 online appendix reports the reduction in tariffs for aggregated sectors).

Importantly, 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. Fig. A1 in the Appendix A reflects this convergence in tariffs. The left panel shows that HS6 products with the highest initial tariffs experienced the highest reduction over the period while the right panel displays the decrease in HS6 tariffs mean and standard deviation over the 2000–2006 period. 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 that depend 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

[3] Heterogeneous firm 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.

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

[5] As mentioned by Fajgelbaum et al. (2011), low quality firms in developing countries may find it difficult to access the profitable developed countries markets.

are processed and sold on the export market only.[6] 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 a 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 freely traded.

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 U.S. 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 et al. (2010).[7] 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 tariff 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 separated from the "warehousing trade" and "entrepot trade" regimes. We also exclude from our sample intermediary firms as defined in Ahn et al. (2011).[8]

Transactions registered under the processing trade regime correspond to imported inputs that are used in the production of goods for the export markets only. In contrast with those in ordinary trade, imports under processing trade regimes are not subject to tariffs.[9] Ordinary and processing trade encompasses 76% (96%) of total manufacturing imports (exports), in average, over the period.

We restrict our sample to firms importing intermediate inputs through either the ordinary or the processing trade regime.[10] Imports under processing trade regime are necessarily intermediate inputs as they are used for the purpose of processing exports. Imports under ordinary trade include however both intermediate and final goods. In order to abide by the theoretical models described above (e.g., Kugler and Verhoogen, 2012), which highlight the mechanisms at play between the quality of imported intermediate inputs and the quality of exported products, we need to distinguish imports of intermediate inputs from imports of final goods. To identify intermediate inputs, we use the Broad Economic Categories (BEC) classification from the United Nations that organizes HS6 products into final, intermediate and capital goods.[11] These intermediate goods correspond to 70% of all imports (under the ordinary trade regime) in 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.[12]

Our identification strategy 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. We rely on processing firms with similar characteristics to ordinary firms in terms of ownership and export patterns. We exclude from the analysis foreign-owned firms and 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 a 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. On average, we have 8222 ordinary firms and 6617 processing firms per year. Although our matching procedure reduces our sample, the estimated sample is highly representative of the full sample in terms of sectoral composition (see Table A3 in the online 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 3107 products from 156 countries of origin corresponding to 1,345,636 observations at the firm-product-country of origin level over the sample period. Firms export up to 2258 products across 160 destinations. With regards to the main specifications – using export prices as dependent variable – we work with a panel of 2,264,821 firms-HS6-product-country of destination and year observations.

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 Fig. 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.[13] The left panel in Fig. 1 shows the distribution of import prices while the right panel of Fig. 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 increases in imported input and export prices can be interpreted as an upgrade in quality.

3.3. 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 firm-level input tariff measures. Such tariffs are constructed using aggregate data (IO tables are not usually more disaggregated than the

[6] 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.

[7] 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., kilograms 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.

[8] Firms that include in their name Chinese characters with English-equivalent meaning of importer, exporter, and trading are considered intermediary.

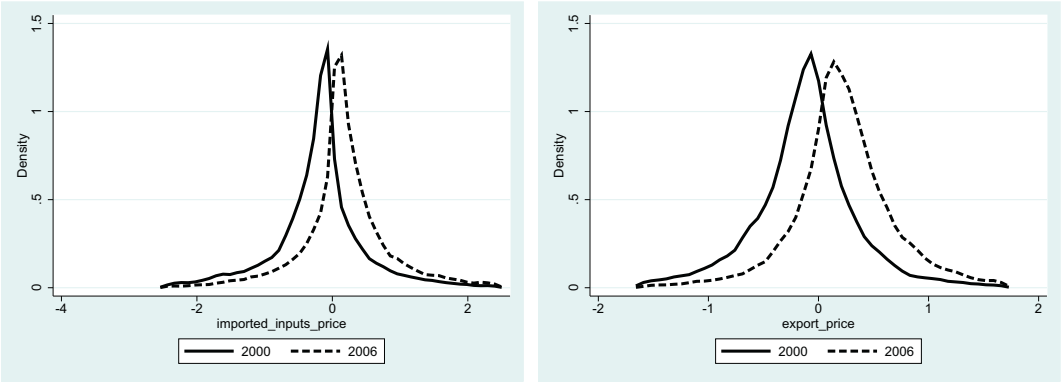
[9] For more information on these custom regimes refer to Table A2 in the online appendix.

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

[11] The BEC classification has been widely used in the literature of international trade to identify intermediate inputs. Recent papers include Amiti et al. (2014), Boler et al. (2012) and Brandt et al. (2012). We tested the accuracy of the BEC classification using our sample of processing firms for which all imported products are, by definition, intermediate inputs. About 90% of the products imported by processing firms in our estimated sample correspond to intermediate goods as defined by BEC nomenclature.

[12] 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).

[13] In Fig. 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.



Source: Author's calculation.

Fig. 1. Distribution of import and export prices in 2000 and 2006. Source: Author's calculation.

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 (2014), we exploit the disaggregated nature of our database by constructing an index of input tariffs for the firm which rely on output tariffs and import data at the HS6 level. 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 exported goods of firm i. We rely on constant weights in order to address issues related to changes in the firm imported input mix – α_k is computed as the initial weight of a specific HS6 product import value. 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. All our results are robust to the use of IO tariffs.[14]

In order to address issues of endogeneity between changes in export 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 (2006), 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).[15] 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 Herfindahl 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. This is consistent with an exogenous input tariff reduction.

3.4. Processing firms as controls

We ensure that our control group is similar to our treated group in terms of ownership and export patterns by relying on domestic Chinese firms (excluding foreign-owned firms) and by requiring that each ordinary firm has at least one corresponding processing firm at the product-destination-year level. By this mean, we attempt to make ordinary and processing firms as similar as possible in their production process and input requirement. We also guarantee a geographical and sectoral overlapping. Other differences across these groups of firms are captured by the firm-product fixed effects, that control for unobservable firms and product characteristics that do not vary over time. Potential intrinsic differences between ordinary and processing firms may however make our treated and control groups differ in term of objectives or responses to shocks. In order to alleviate this issue, we control for initial firm size trends (interactions between firms' initial size and year dummies), thus comparing ordinary and processing firms of similar size and size's growth. We also introduce a time-trend by trade status in a sensitivity tests (Section 5.1). As it does not alter our results, we are confident of the relevance of our control group. 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 trade their products through processing trade regime (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

[14] Results with IO input tariffs are presented in Table 7 of Section 5.2.

[15] 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 95% of total industrial output value.

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)		
Herfindahl 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. Herfindahl (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 (respectively state-owned) firms at the 4-digit industry level. All estimations include 2-digit industry fixed effects. Robust standard errors are in parentheses.

duty-free processing trade status.[16] Such hypothesis however requires that firms have the ability to freely choose their status at a 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 enterprises (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 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 months 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 processing 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.[17] 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.[18] 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 sell 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 (1998) 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 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 in Fig. 2 shows the relative number of processing firms by HS6 sectors and the corresponding average HS6 input tariff level. As many firms are multi-product, a firm's sector is defined according to its main HS6 export sector (i.e., highest HS6 export value). Each firm is thus associated with a specific input tariff (calculated as explained above) 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 (either in number or value) and the level of input tariffs. In order to account for the multi-product 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 one presented here.

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.

3.5. Empirical strategy

3.5.1. 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 – allows us to make use of a natural control group within which to investigate the impact of trade policy. We first 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 input trade on imported input prices.

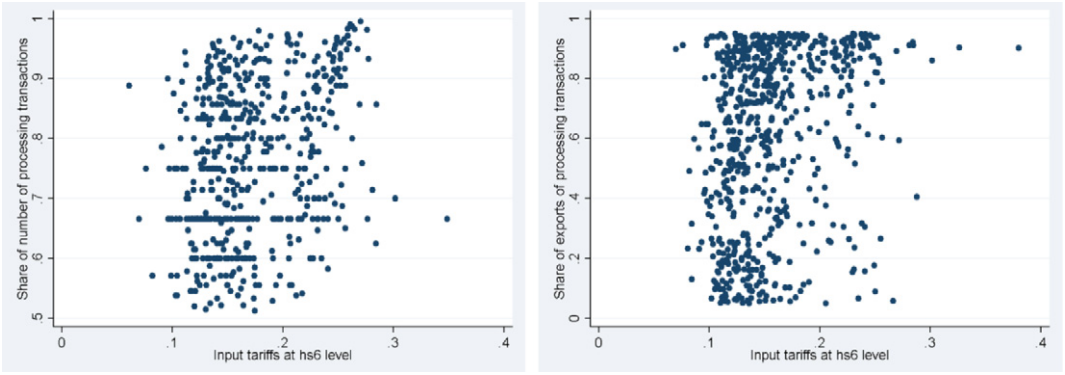
The main estimation strategy is similar to a difference-in-difference approach where ordinary importers are the treated group and processing importers are the control group.[19] Thanks to the control group, we are able to account for unobservable variables (e.g., specific policies that affect similarly both ordinary and processing firms at the sector-province level) that affect import and export prices of ordinary and processing firms. We thus introduce into the analysis a dummy variable which takes the value of one when the firm trades under the ordinary trade 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

[16] Note that tariffs may be very high, reaching 90% for products belonging to HS4 sector 8703 (Motor cars and other 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%).

[17] 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 these changes occurred late 2006, they do not affect our data which covers the 2000–2006 period.

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

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



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

Fig. 2. Share of HS6 processing export in term of the HS6 tariffs, 2000. Source: Author's calculation using unweighted average tariff rates from WITS.

come from the WITS (World Bank) database for the 2000–2006 period. We consider the following specification:

$$P_{ipkct}^{IM} = \beta_1 Ordinary_i * \tau_{k,t-1} + \beta_2 Ordinary_i + \beta_3 \tau_{k,t-1} + \beta_4 Size_{i,t0} * \alpha_t + \alpha_{ik} + \alpha_{ct} + \alpha_{st} + \alpha_{pt} + \eta_{ipkct} \quad (1)$$

where P_{ipkct}^{IM} corresponds to the log of the import price (unit value) of firm i located in province p for input k from country c at time t. 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, which takes a value of one if the firm is ordinary and zero otherwise. $_{Sizei,t0}{}^{*}\alpha_t$ corresponds to initial firm size trends, where the initial size of firm i is defined by the number of imported varieties. α_{ik}, α_{ct}, α_{st} and α_{pt} are firm-product, origin-country-year, HS4-year and province-year fixed effects and η_{ipckt} an i.i.d. component. The trends pick up firm size, origin sourcing country, sector and location time-varying shocks. Note that the dummy variable $Ordinary_i$ does not vary within firms over time.[20] Because of its collinearity with firm-product fixed effect, it will drop from the estimation. We cluster standard errors at the firm level.

3.5.2. 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, $\tau_{it} = \sum_k \alpha_k \tau_{kt}$, where τ_{kt} is the output tariff of HS6 product k in t and k is used in the production of exports of firm i, with α_k being computed as the initial weight of a specific HS6 product import value. There are two main advantages of using a constant initial 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. 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.[21] We focus on the following specification:

$$P_{ipkct}^{EX} = \delta_1 Ordinary_i * \tau_{i,t-1} + \delta_2 Ordinary_i + \delta_3 \tau_{i,t-1} + \beta_4 Size_{i,t0} * \alpha_t + \alpha_{ik} + \alpha_{ct} + \alpha_{st} + \alpha_{pt} + \eta_{ipkct} \quad (2)$$

where P_{ipkct}^{EX} is the log of export price (unit value) of firm i located in province p 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. $Size_{i,t0}{}^{*}\alpha_\tau$ corresponds to initial firm size trends, where the initial size of firm i is defined by the number of imported varieties. α_{ik}, α_{ct}, α_{st} and α_{pt} are firm-product, destination-country-year, HS4-year and province-year fixed effects and η_{ipkct} an i.i.d. component. 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 perfectly collinear with the interaction term between $Ordinary_i$ and firm-level tariffs, and will drop from the estimation. Similarly, $Ordinary_i$, which does not vary within firms over time, is collinear with the firm-product fixed effect and will drop from the estimation.

By including firm-product level fixed effects, we capture the impact of input trade liberalization on within firm-product prices over time and across destinations.[22] We therefore identify causality effects between input tariff cut and imported input and exported product prices. As our variable of interest (the input tariffs) is measured at the firm level, we cluster standard errors at the firm level.

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 (Kugler and Verhoogen, 2012 and Demir, 2012). Following an input tariff cut, the price of intermediate goods (excluding the tariff) may thus increase if firms upgrade the quality of their inputs. We look for such effects in China over the 2000–2006 input trade liberalization period.

We first investigate how ordinary firms modified their imports of intermediate goods following China's accession to the WTO. As explained above, we exploit the uniqueness of our database by using processing firms as a natural control group, while ordinary firms stand as the treated group. As a first insight on the effect of the reduction of input tariffs on firms' imports, we refer to firms' import sophistication measures as in Schott (2008). We regress firms' share of imported inputs sourced

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

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

[22] As shown by Manova and Zhang (2012), Martin (2012), Harrigan et al. (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 to let firm-product export prices vary across export markets.

from developed countries (in value and quantity) and firms' import penetration from developed economies (defined as the share of the number of varieties imported from developed countries) on firm-level input tariffs interacted with the firm's type dummy. The estimation is run at the firm-year level and includes firm's fixed effects as well as firms' primary HS6 export product-year fixed effects (capturing firms' sector orientation). Table 2 shows that the input tariffs' cut increases both the firm-level import market share from developed countries and the import penetration from developed countries.[23] 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.[24]

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 Section 3.5.1 and estimate Eq. (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' initial size trends. Origin-year fixed effects capture unobservable and observable time-varying sourcing country characteristics such as GDP and RER. Sector-year and province-year fixed effects control for sectoral and regional variables such as inflation or local wages.

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 input prices over time and across countries of origin. Relying on column (1), a 10 percentage point fall in input tariffs raises imported input prices by 16%. Next, we distinguish firms by the level of income of the country in which inputs are sourced. We include an interaction term between HS6 input tariffs, firms' ordinary type, and an importer dummy accounting for the main sourcing countries of their inputs (DC/LDC).[25] Importantly, as shown in column (2), 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.

The magnitude of the impact of the input tariffs cut on imported input prices rules out a pure pass-through effect. Actually, a pass-through effect where exporters to China take advantage of the Chinese unilateral trade liberalization to increase their (f.o.b.) prices would at most increase prices in similar proportion to the tariffs' cut. The size of our coefficient suggests that something else is going on (prices increase by more than 10% for a tariffs cut of 10%). Furthermore, the pass-through explanation does not rationalize the increase in the number of imported inputs from developed economies revealed in Table 2 or the fact that imported input prices increase more for intermediate good originated from the most advanced economies.

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 partly captured by the HS4-year fixed effects. We run an additional robustness check by excluding raw material and energy from the firm's input mix.[26] The exclusion of raw materials and energy does not alter our main findings – the coefficient for input tariffs is very similar (see columns (3) and (4) of Table 3).

Finally, we capture potential concentration of suppliers in the foreign country and the impact of import-tariff liberalization in those markets by adding product-origin-country-year fixed effects. Results are presented in columns (5) and (6) of Table 3. Our main findings are robust to this alternative specification. Although the magnitude of the coefficients is higher, they are not statistically different relative to those in columns (1) and (2).

To sum up, our results show that firms facing a decrease in input 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.

Table 2
Input tariffs and imported product sophistication.

	Import market share DC (1)	Penetration DC (2)	Share of imported quantity DC (3)
Tariff(t-1) × ordinary	−0.160***	−0.117***	−0.181***
	(0.029)	(0.024)	(0.031)
Observations	101,495	101,495	101,495
R^2	0.811	0.825	0.799

Notes: This table presents the results of the following equation: $s_{it} = \beta_1 Ordinary_i * \tau_{i,t-1} + \beta_2 \tau_{i,t-1} + \beta_3 Ordinary_i + \alpha_i + \alpha_{kt} + \eta_{lt}$ where s_{it} corresponds in column (1) to the share of imports from DC over total import value, in column (2) to the penetration index of DC computed as the number of varieties imported from DC over total varieties and in column (3) to the quantity share of imported inputs from DC, all at the firm-year level. Estimations include firm fixed effects and HS6-year fixed effects where the sector corresponds to the main HS6 sector of exports of the firm. As our dependent variables are at the firm level, $\tau_{i,t-1}$ corresponds to the firm-level input tariff. It is thus perfectly collinear with the interaction term $Ordinary_i * \tau_{i,t-1}$ and is dropped from the estimation. $Ordinary_i$, which does not vary within firms over time, is collinear with the firm-product fixed effect. It is also dropped from the estimation. Standard errors are clustered at the firm level. *** indicates significance at the level of 1%.

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-year, HS4-year and province-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 in order to improve the quality of exported products, or a change in the markup, as firms increase their

[23] 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.

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

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

[26] We exclude all agricultural and mineral products from the estimation (i.e., products belonging to the HS2 classifications 01 to 27).

[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 et al., 2010, for Hungary, Martin, 2012, for France, Manova and Zhang, 2012, for China, Harrigan et al., 2012, for the US and Kugler and Verhoogen, 2012, for Colombia). Note that Kugler and Verhoogen (2009, 2012) 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.

Table 3
Input tariffs and firms' import prices.

Dependent variable: Import prices (excluding tariff) of firm *i* for product *k* from country *c* in year *t*						
	(1)	(2)	(3)	(4)	(5)	(6)
			Excluding raw materials		Controlling for product-country-year trends	
Tariff(t-1) × ordinary	−1.512***		−1.558***		−1.821***	
	(0.312)		(0.324)		(0.400)	
Tariff(t-1) × ordinary DC		−1.828***		−1.883***		−2.272***
		(0.312)		(0.325)		(0.398)
Tariff(t-1) × ordinary LDC		−1.035***		−1.040***		−1.173**
		(0.340)		(0.360)		(0.467)
Tariff(t-1)	−0.128	−0.024	−0.055	0.051		
	(0.267)	(0.269)	(0.278)	(0.279)		
Observations	1,345,636	1,345,636	1,275,545	1,275,545	1,345,636	1,345,636
R^2	0.921	0.921	0.920	0.920	0.935	0.935

Notes: The table reports estimates of Eq. (1). All estimations include initial firm size trends. Estimations in columns (1) to (4) include firm-HS6, origin country-year, HS4-year and province-year fixed effects. Estimations in columns (5) and (6) include firm-HS6, HS6-origin country-year and province-year fixed effects. 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 (2), (4) and (6), we include not reported dummy variables for the origin country importers (DC/LDC). Standard errors are clustered at the firm level. ***, ** indicate significance at the levels of 1 and 5% respectively.

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.

Table 4 presents the results. We run Eq. (2) with firm-product-destination-time export prices as dependent variable. Columns (1) and (2) show estimates of the impact of input 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) consider only the subsample of products exported to high-income countries whereas columns (5) and (6) focus on products exported towards low-income countries. As for the estimation of imported input prices, we control for initial firm size trends as well as sectoral, destination and location trends. Destination-year fixed effects provide control for distance and general demand conditions.[29]

The input tariff reduction has a positive and significant impact on ordinary importers' export prices. Relying on column (1) of Table 4, a 10 percentage point fall in input tariffs increases export prices by 0.8%. 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 (2)). Furthermore, in line with Hallak and Schott (2011) or Khandelwal (2010), we find a link between export quality and destination countries' level of development. As shown in columns (3) to (6), the quality upgrading effect is specific to products that are exported to high income countries.[30]

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.

4.3. An upgrade in product quality?

4.3.1. 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 et al. (2013) (KSW hereafter) show that by relying on a utility function which accounts for product quality, as in Section 2, and by 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:

$$x_{ikct} + \sigma p_{ikct} = \alpha_k + \alpha_{ct} + \eta_{ikct} \quad (3)$$

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: $\lambda_{ikct} = \eta_{ikct}/(\sigma\text{-}1)$. We estimate quality following this method for each HS2 sector using our Chinese custom database.[31] We then use the estimated quality at the firm-product-country-year level, λ_{ikct}, as the dependent variable in our baseline estimation. We rely on Chinese elasticities of substitution at the HS3 product level estimated by Broda et al. (2006). We also adapt KSW's estimation to the import side, with x_{ikct} and p_{ikct} representing the natural logs of the quantity and price of product k imported by firm i from market c in t.

Columns (1) to (4) of Table 5 present the results. Importantly, the coefficient on firms input tariffs for ordinary firms remains negative and significant. Magnitudes of coefficients are slightly higher than the

[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] 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.

[30] 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. We estimated export prices variation across firms including product-destination-year fixed effects. The coefficient is −0.297, suggesting that ordinary firms with lower input tariffs charge higher export prices. The difference in magnitude with our estimation is a consequence of the fact that our analysis of the within firm-product effect of trade liberalization does not capture variations across firms or variations of export prices related to entry of new, more expensive products on the export market (i.e., a product selection effect). Results are available in Table A4 of the online appendix.

[31] The number of observations is reduced relative to the baseline sample due to (i) missing elasticities of substitution for some sectors and (ii) the fact that the quality estimation is done by sector for HS2 sectors with more than 700 observations.

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)
			Exporters DC		Exporters LDC	
Tariff(t-1) × ordinary	−0.080**		−0.083**		−0.056	
	(0.042)		(0.042)		(0.074)	
Tariff(t-1) × ordinary DC		−0.101**		−0.106**		−0.084
		(0.043)		(0.044)		(0.076)
Tariff(t-1) × ordinary LDC		0.099		0.109		0.274
		(0.124)		(0.130)		(0.180)
Observations	2,264,821	2,264,821	1,883,506	1,883,506	381,315	381,315
R^2	0.903	0.903	0.911	0.911	0.931	0.931

Notes: The table reports estimates of Eq. (2). All estimations include initial firm size trends and firm-HS6, destination country-year, HS4-year and province-year fixed effects. Recall that $\tau_{i,t-1}$ is a firm level variable which is perfectly collinear with the interaction term $Ordinary_i{}^*\tau_{k,t-1}$ and therefore drops from the estimation. $Ordinary_i$, which does not vary within firms over time, is collinear with the firm-product fixed effect. It also drops from the estimation. In columns (2), (4) and (6), we include not reported dummy variables for the origin country importers (DC/LDC). Standard errors are clustered at the firm level. ** indicates significance at the level of 5%.

ones found using unit prices. 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.

4.3.2. Distinguishing homogeneous from differentiated products

We expect the effect of input tariff reduction on export prices via quality upgrading to be stronger for differentiated goods than for homogeneous goods, which have a referenced price and for which exports are more standardized. While change unrelated to quality may affect the prices of both types of products similarly, price changes related to quality concern differentiated products only. We implement this identification strategy by running our baseline regressions of the impact of input tariffs on export prices on the subsamples of homogeneous and differentiated goods separately (columns (5) to (8) of Table 5). Goods are distinguished according to Rauch (1999) classification of product differentiation. Columns (5) and (6) reveal that the decrease in input tariffs has no impact on the price of exported homogeneous goods, while columns (7) and (8) show that the input tariffs' cut increases the price of exported differentiated goods. These results again suggest that we are indeed capturing the effect of trade liberalization on exported products' quality.

5. Alternative explanations and robustness checks

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 then propose several robustness checks.

5.1. Alternative explanations

5.1.1. Controlling for shocks specific to ordinary or processing firms

We already control for several dimensions by which processing and ordinary firms may differ. First, we exclude from our analysis foreign-owned companies to ensure that firms in the control and treated groups have similar characteristics in terms of ownership, technology, input requirements and production process. By restricting our sample to ordinary firms for which there is at least one corresponding processing firm at the product-destination-year level, we also ensure geographic and sectoral similarity between the treated and control groups. Other differences across firms' groups are captured by the firm-product fixed effects and by firms' initial size trends.

One concern remains: 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 regimes 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 firms or if processing firms benefit from specific export advantages other than being duty free).

This section presents an additional sensitivity test showing that our results are robust to time-varying shocks affecting differently ordinary and processing firms over time. We include a time-trend for ordinary firms in our specifications (i.e., an interaction term between time dummy and firms' status). Columns (1) and (2) of Table 6 present the 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 with a similar magnitude, as compared to the baseline specification (columns (1) and (2) of Table 4). Controlling for status specific time shocks does not alter our findings on the impact of input trade liberalization on export prices.

We thus showed that our results are not driven by systematic differences between ordinary and processing firms, which would make our control group inappropriate – as firm's objectives and responses to shocks would differ too widely.

5.1.2. Demand shocks

An increase in export prices may result from greater country-specific demand for HS6-products unrelated to product quality. The export prices rise because firms 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 tariff 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. Results are presented in Table 6, columns (3) and (4). Pass-through effects are

Table 5
Alternative measures of quality.

Dependent variable:	Quality measure from KSW				Export prices (f.o.b.)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Quality imports		Quality exports		Only homogeneous		Only differentiated	
Tariff(t-1) × ordinary	−1.549***		−0.115*		−0.074		−0.093**	
	(0.484)		(0.066)		(0.075)		(0.042)	
Tariff(t-1) × ordinary DC		−1.565***		−0.143**		−0.103		−0.113***
		(0.577)		(0.067)		(0.077)		(0.044)
Tariff(t-1) × ordinary LDC		−1.492		0.159		0.235		0.084
		(1.070)		(0.200)		(0.216)		(0.126)
Observations	1,239,034	1,239,034	1,799,121	1,799,121	199,234	199,234	2,065,587	2,065,587
R^2	0.717	0.904	0.719	0.719	0.895	0.895	0.904	0.904

Notes: In columns (1) to (4) the dependent variable is a measure of import (export) quality estimated using the methodology developed by KSW (2013). In columns (5) to (8), homogeneous and differentiated products are distinguished according to Rauch (1999) classification. All estimations include initial firm size trends, firm-HS6, destination country-year and province-year fixed effects. Recall that $\tau_{i,t-1}$ is a firm level variable which is perfectly collinear with the interaction term $Ordinary_i{}^*\tau_{k,t-1}$ and therefore drops from the estimation. In columns (2), (4), (6) and (8), we also include not reported dummy variables for the origin country importers (DC/LDC). Standard errors are clustered at the firm level. ***, **, * indicate significance at the levels of 1, 5 and 10%, respectively.

also of particular interest. They would occur if firms were to 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 6). Our results remain robust and stable with the inclusion of product-destination-year fixed effects and output tariffs in destination countries. Coefficients are in line with our baseline specification in Table 4.[32] Unsurprisingly, the coefficient on export market 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).

5.2. Robustness checks

We now move on to several robustness checks. Table 7 first presents results obtained with alternative econometric specifications and tariffs' measure. Next, we discuss alternative samples.

The relative number of ordinary firms has changed between 2000 and 2006. As evidenced by Brandt and Morrow (2013), there has been an important entry of ordinary firms over the period. We do not believe that this re-organization of trade within China impacts our result as we are looking at within firm-product prices' changes. As a robustness check, we however run our baseline regression on the subset of firms that are present over the entire period 2000 to 2006. Results found with this balanced sample are reported in columns (1) and (2) of Table 7. Although the sample size is largely reduced, coefficients on the impact of input tariffs' cuts on export prices are still negative and highly significant. Note, however, that the magnitude of the point estimates increases relative to the baseline specification presented in columns (1) and (2) of Table 4. This might be due to the difference in sample size and to the fact that surviving firms are likely to be the biggest, most efficient firms. We run our baseline estimation interacting tariffs for ordinary firms with a dummy accounting for firms' size, where big size firms are above the median. Results, available upon request, confirm the heterogeneous effects of tariff cuts with firm size.

We also verify that our results hold on the subsample of ordinary firms. In columns (3) and (4) of Table 7, we run our baseline regression on the export prices of ordinary firms only. Excluding the control group of processing firms does not qualitatively change our findings. The coefficients on export prices and export prices from developed countries are not statistically different from coefficients of our main specification in columns (1) and (2) of Table 4.

As an alternative specification, columns (5) and (6) of Table 7 estimate the model in first differences including firm's fixed effects in order to control for firm-specific time trends. In this case, the dependent variable as well as all the explanatory variables are expressed in first differences. Although the number of observations for these estimations is significantly reduced, the coefficients of interest on the interaction terms between input tariffs and ordinary status and those depending on the sourcing country (ordinary DC and LDC) remain robust and stable with similar magnitude.

In order to insure that our results are not driven by our tariff specification, we propose an alternative test using Input–Output (IO) built input tariffs. We use Chinese IO tables for 2002 from the National Bureau of Statistics of China (NBSC) for 122 industries in order to construct an alternative measure of input tariffs. For each firm-exported product, we associate the firm sector of activity (at the HS2 level) with the corresponding HS2 inputs derived from the IO table. Tariffs' weights thus correspond to the shares of HS2 sectors in the production of a given HS2 sector. In contrast with our measure of input tariffs, IO tariffs vary at the HS2-year level and are not specific to the firm. Results are reported in columns (7) and (8) of Table 7. It is 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.

Finally, we run our baseline estimation on subsamples of ordinary and processing firms excluding sectors or localizations that may present specific patterns (e.g., high concentration of processing firms or drastic trade changes over the period, such as the phasing out of the Multifiber Agreement). More precisely, we exclude firms from the Canton area, textile, electronics or raw materials from the analysis. The results are presented in Table A5 of the online appendix and show that, by and large, omitting these sectors does not modify our findings.

6. Conclusions

This 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

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

Table 6
Controlling for exogenous demand and trade 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	
	(1)	(2)	(3)	(4)	(5)	(6)
Tariff(t-1) × ordinary	−0.082*		−0.071*		−0.079*	
	(0.046)		(0.041)		(0.042)	
Tariff(t-1) × ordinary DC		−0.098**		−0.090**		−0.103**
		(0.048)		(0.043)		(0.043)
Tariff(t-1) × ordinary LDC		0.056		0.101		0.131
		(0.147)		(0.127)		(0.126)
Tariffs (kc,t-1) HS6-dest					−0.048**	−0.048**
					(0.024)	(0.024)
Ordinary × 2001	−0.082***	−0.081***				
	(0.016)	(0.016)				
Ordinary × 2002	−0.073***	−0.074***				
	(0.018)	(0.018)				
Ordinary × 2003	−0.083***	−0.084***				
	(0.019)	(0.019)				
Ordinary × 2004	−0.072***	−0.072***				
	(0.021)	(0.021)				
Ordinary × 2005	−0.046**	−0.047**				
	(0.023)	(0.022)				
Ordinary × 2006	−0.052**	−0.051**				
	(0.024)	(0.024)				
Observations	2,264,821	2,264,821	2,264,821	2,264,821	1,933,433	1,933,433
R^2	0.903	0.903	0.913	0.913	0.908	0.908

Notes: All estimations include initial firm size trends. Estimations in columns (1),(2), (5) and (6) include firm-HS6, destination country-year, HS4-year and province-year fixed effects, while estimations in columns (3) and (4) include firm-HS6, destination-HS6-year and province-year fixed effects. Recall that $\tau_{i,t\text{-}1}$ is a firm level variable which is perfectly collinear with the interaction term $Ordinary_i{*}\tau_{k,t\text{-}1}$ and, therefore, drops from the estimation. $Ordinary_i$, which does not vary within firms over time, is collinear with the firm-product fixed effect. It also drops from the estimation. In columns (2), (4) and (6), we include not reported dummy variables for the origin country importers (DC/LDC). Standard errors are clustered at the firm level. ***, **, * indicate significance at the levels of 1, 5 and 10%, respectively.

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 input 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 (2014)), input trade liberalization leads to an upgrade in product quality.

Appendix B. Supplementary data

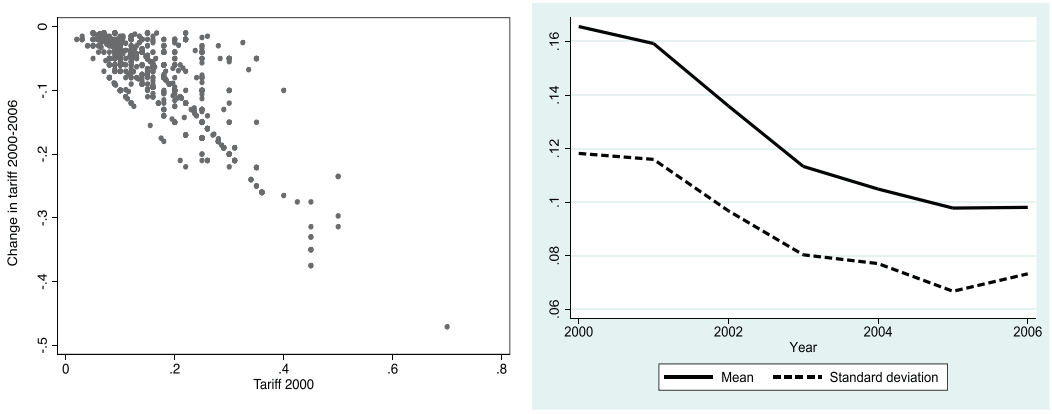
Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jinteco.2014.12.005.

Table 7
Alternative specifications.

Dependent variable: Export prices (f.o.b.) of firm *i* for product *k* in country *c* and year *t*								
	Balance sample		Only ordinary sample		First differences		IO input tariffs	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tariff(t-1) × ordinary	−0.378**		−0.081*		−0.104**		−0.270**	
	(0.155)		(0.046)		(0.050)		(0.108)	
Tariff(t-1) × ordinary DC		−0.375**		−0.096**		−0.105**		−0.285***
		(0.160)		(0.047)		(0.051)		(0.108)
Tariff(t-1) × ordinary LDC		−0.279		0.054		−0.116		−0.036
		(0.434)		(0.148)		(0.124)		(0.158)
Observations	92,090	92,090	1,834,436	1,834,436	435,113	435,113	2,257,164	2,257,164
R^2	0.901	0.901	0.895	0.895	0.055	0.055	0.903	0.903

Notes: All estimations include initial firm size trends. Estimations in columns (1)–(4), (7) and (8) include firm-HS6, HS4-year and destination country-year fixed effects. Estimations in first differences in columns (5) and (6) include firm fixed effects. Recall that $\tau_{i,t\text{-}1}$ is a firm level variable which is perfectly collinear with the interaction term $Ordinary_i{*}\tau_{k,t\text{-}1}$ and, therefore, drops from the estimation, which does not vary within firms over time, is collinear with the firm-product fixed effect. It also drops from the estimation. In columns (2), (4), (6) and (8), we include not reported dummy variables for the origin country importers (DC/LDC). Standard errors are clustered at the firm level. ***, **, * indicate significance at the levels of 1, 5 and 10%, respectively.

Appendix A



Source: Author's calculation using unweighted average tariff rates from WITS at HS6 level. The left panel presents tariffs change between 2000 and 2006 relative to initial tariffs in 2000 at the HS6 product level. The right panel reports the evolution of the mean and standard deviation of HS6 tariffs over the period.

Fig. A1. Tariff changes between 2000 and 2006. Source: Author's calculation using unweighted average tariff rates from WITS at HS6 level. The left panel presents tariffs' change between 2000 and 2006 relative to initial tariffs in 2000 at the HS6 product level. The right panel reports the evolution of the mean and standard deviation of HS6 tariffs over the period.

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