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The Connection between Imported Intermediate Inputs and Exports: Evidence from Chinese Firms

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ABSTRACT

We use data on Chinese manufacturing firms to study the connection between individual firm imports and firm export outcomes. Since our panel covers the years 2002 to 2006, we can use changes in import tariffs associated with China's WTO entry as instruments. Our regression results show that firms that expanded their intermediate input imports expanded the volume of their exports and increased their export scope, though the magnitude of the effects differed by import source, firm organizational form, and industry R&D intensity. On these dimensions, we find that imported intermediate inputs from OECD rather than non-OECD countries generated larger firm export improvements, that private Chinese firms derived larger benefits from imported inputs than did foreign invested firms, and that imported intermediates were especially helpful in expanding the exports of firms operating in high R&D intensity industries. Taken together, these results suggest that product upgrading facilitated by technology or quality embedded in imported inputs helped Chinese firms to increase the scale and breadth of their participation in export markets.

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1. Introduction

It is widely believed that China's WTO entry, with its promised market opportunities and guarantees, spurred the exceptional growth in China's exports. Much less noted is the fact that China's imports have grown almost as rapidly as China's exports. For example, in 2002 - China's first full year as a WTO member - China's imports of intermediate inputs by manufacturing firms grew at a rate (58.3%) that exceeded its rate of manufacturing export growth (47.7%). Thus, while the rapid growth of China's imports and exports might be uncorrelated, the coincidence of these trends raises a number of important questions. First, has China's WTO-related trade liberalization contributed to the rise of China's imports? Second, has growing access to imported intermediate inputs contributed to Chinese firms' improved export ability? And third, if firms do benefit from imported inputs, are the effects universal, or are the effects concentrated in particular sectors as related to firm-ownership or industry characteristics?

In general, the benefit of utilizing a variety of inputs is well-known. For example, the benefits of input variety are rigorously and simply demonstrated by Ethier (1982), who shows that holding input level constant, increased input scope raises output. This idea implies that firm productivity will rise when firms import new input varieties. The connection between firm productivity and imported inputs is now an empirical regularity that is documented in many cases, including Kasahara and Rodrigue (2008) for Chile, Halpern, Koren and Szeidl (2009) for Hungary, Smeets and Warzynski (2010) for Denmark and Bas and Strauss-Kahn (2011) for France. Similarly, in work on trade liberalization Amiti and Konings (2009), Goldberg, Khandelwal, Pavcnik, and Topalova (2010), Lileeva and Trefler (2010) and Yu (2011) link firm productivity increases to industry level reductions in tariffs on imported inputs. Indeed, the productivity benefits of importing intermediates may be greater yet if there are complementarities between domestic and foreign inputs, or if new technologies are embodied in foreign versions of the imported inputs.[1]

[1] At the national level, Acharya and Keller (2009) show that technology spillovers are mediated by imports, and that the strength of technology diffusion differs by source country. Similarly, Kugler and Verhoogen's (2009) finding that Colombian firms paid higher prices when they imported intermediates rather than using domestic varieties, and that the use of imported intermediates allowed firms to sell their domestic output at higher prices, suggests that use of imported intermediates helps firms improve product quality.

While many studies document a strong connection between imported inputs and firm productivity, studies examining the effects of imported intermediate inputs on firm exports are limited. Bas and Strauss-Kahn's (2011) work with French firm data, for example, shows that firms who increased their imported varieties of intermediates were able to increase exports on the extensive margin. The importance of imported intermediates for exports is also implied by Bas (2012), who finds that Argentine firms who experienced falling intermediate input tariffs expanded exports more rapidly than did Argentine firms that did not benefit from similar reductions in input tariffs. Finally, Kasahara and Lapham (2007) model the linkages between imported inputs and exports in a heterogeneous firm setting. An important message of their work is that trade barriers that reduce imported input usage may impair firm productivity, and therefore curtail firm exports. However, in the absence of detailed measures of imported inputs, conclusions in this literature are based on correlations with industry tariff changes, rather than observed changes in firm-level usage of imported intermediates.

To study the connection between firm intermediate input imports and export outcomes, we study the activities of Chinese manufacturing firms between 2002 and 2006. This setting is especially useful for addressing this question, since it is possible to assemble detailed firm-level data on firm imports, exports and operational characteristics and because it captures a period with tariff and trade policy changes due to China's December 2001 WTO entry. As Column (3) of Table 1 shows, China's tariff reductions during this period were non-negligible and varied substantially across industries. For example, tariff reductions ranged from a low of 5% in the Smelting & Pressing of Ferrous Metals sector to a high of 46% in the tobacco industry. Thus, we can exploit cross sector heterogeneity in the magnitude of tariff changes as an instrument for firm-level import decisions. This time period is also relevant for studying the relationship between firms' import decisions and export outcomes, since China's membership in the WTO provided Chinese firms with guaranteed future access to export markets, instead of year-to-year uncertainty about the renewal of most-favored nation tariff treatment by importing countries.

Analysis of Chinese trade data reveals a number of robust links between firm-level imports and firm-level exports. First, we find that Chinese firms that increased their expenditure on imported

inputs, or expanded their range of imported inputs, expanded the value and scope of their exports. Our IV estimates suggest that a one percent increase in imported input value boosted firm export value by 1.35 percent, while a one percent increase in the diversity of imported inputs increased firm exports by 1.69 percent. Second, we find that the contribution of imported intermediate inputs from OECD countries was as much as fifty percent larger than the benefits attained through non-OECD intermediates import. Third, we find that the benefits of importing were strongest for Private Chinese firms- firms that were arguably more distant from the technological frontier than were foreign invested enterprises. Finally, when we test how the benefits of importing inputs are related to industry characteristics, we discover that the connection between increased imported intermediates and growth in firm exports was most pronounced for firms in high R&D intensity industries.

Our paper contributes to a number of literatures. First, our work advances the literature on trade liberalization and firm outcomes, by establishing a more direct connection between import tariffs, imported input usage, and firm exports. While Amiti and Konings (2009) and Goldberg, Khandelwal, Pavcnik, and Topalova (2010), and Bas (2012) are able to demonstrate the connection between industry-level liberalization of tariffs on imported inputs and firm productivity, their data do not provide firm-level information on imported intermediates. For this reason, since Chinese data provide firm-level information on the volume, variety and industry composition of firm imports, we are able to evaluate this question more directly.

The results from our paper also contribute to the literature on firm export decisions and capability. By now, evidence from detailed firm-level datasets has established that "better", i.e. larger, older or more capital-intense, firms are more likely to export.[2] From Melitz's (2003) foundation, this literature interprets these regularities as showing that firms are more likely to export due to a core firm attribute which is generally interpreted as firm-specific productivity. However, while firm sorting based on productivity is now well-understood, it is an open question whether firms can enhance their capability by taking further steps such as engaging in innovation or importing

[2] Bernard, Jensen, Redding and Schott (2007) survey this literature, and provide examples from detailed U.S. Census data on firm trade. Notably, Chinese exporting firms are more labor-intense than are Chinese domestic firms, a factor Lu (2010) and Ma, Tang and Zhang (2011) attribute to China's comparative advantage in labor-intense industries.

intermediate inputs.[3] For this reason, by providing evidence on the interplay between trade environment changes, firm input sourcing decisions, and firm export outcomes, it is our goal to provide evidence that firm export capability is enhanced by the use of imported intermediate inputs.

Our results also provide insights into the nature of technological diffusion, since we are able to demonstrate that the benefits of imported intermediates on firm exports were heterogeneous, though systematically related to firm ownership type, import source, and industry R&D intensity. In particular, while the literature has long shown that international R&D spillovers are related to imports, the presence of firm identifiers in our data set allows us to verify that the benefits of imported inputs were disproportionately accrued by Private Chinese firms, who were at a technological disadvantage, rather than being captured by multinational firms that were active in China, and heavy users of imported inputs.[4] Further, since the benefits are stronger when inputs are purchased from richer and more technologically advanced OECD locations, and because the benefits are larger for firms that operate in R&D intense sectors, our estimates suggest that firm capability and export are improved by the import of higher-quality and higher technology inputs.

Finally, our work sheds light on the exceptional output and productivity growth of Chinese firms. In particular, Brandt, Van Biesbroeck and Zhang (2009) note that a number of favorable conditions in China's manufacturing sector, including China's entry to the WTO, may have contributed to the rapid productivity growth of Chinese firms between 1998 to 2006. Thus, by showing that firms' ability to increase imports helped firms to expand their exports, our work suggests that China's trade liberalization contributed to the high productivity growth achieved by many Chinese firms during this period.

[3] In related work, Amiti and Khandelwal (forthcoming) provide evidence that firms upgrade export product quality when tariff reductions increase import competition in the home market. Mechanisms supporting changes in product quality are shown by Bustos (2011), who finds a connection between trade liberalization and Argentine firm innovation, and Verhoogen (2008) who shows how competition introduced by currency shocks caused Mexican firms to improve product quality.

[4] The Chinese technological gap by firm ownership is documented by Brambilla's (2009) work that reveals that private Chinese firms developed only 50% as many new products as were developed by multinational firms. See Keller (2010) for a comprehensive discussion of international trade and spillovers.

The rest of this paper is organized as follows. Section 2 introduces our data and provides some background on recent import and export developments in China. Section 3 provides a theoretical framework for our empirical investigation. Section 4 describes our empirical strategy for estimating the impact of imported intermediate inputs on firm export performance and summarizes our results. To demonstrate the robustness of the results, Section 5 details work with a number of alternative specifications. Section 6 concludes.

2. Data

Our data set is formed by combining firm-level operating data on Chinese firms with firm-level customs data on trade transactions for the years 2002 to 2006. We choose this time period since it provides significant changes in trade policy, due to China's December 2001 WTO entry, which we exploit to identify the connection between firm imports and firm exports. [5]

The first data set, Chinese Customs data on imports and exports, provides detailed information on the universe of China's trade transactions. In addition to firm identifiers, this dataset includes information on many important transaction characteristics, including customs regime (e.g., processing trade or ordinary trade), 8-digit HS product code, transaction value, quantity, and source or destination country. By using firm-identifiers that are provided in the Customs data set, we are able to construct our key variables which describe firm-level imports and exports.

The second key dataset for our project is from China's National Bureau of Statistics, which conducts firm-level surveys on manufacturing enterprises. These data collected from Chinese firms include key operational data, such as firm employment, ownership type (eg. State-owned enterprise, foreign invested firm, or private firm), sales value, R&D expenditure and industry. Although the two data sets use different firm identifiers, both datasets include extensively detailed

[5] China implemented major reclassifications of their Harmonized System Codes in 2002 and 2007. Thus, to ensure consistency in our measurement of export and import scope (measured by the number of distinct HS codes) data sample is restricted to the years 2002 to 2006.

firm contact information (e.g., company name, telephone number, zip code, contact person). For this reason, by matching on contact information, we are able to generate firm-level observations that combine information on the trade and operational activities of Chinese firms.[6] Fuller discussion of the datasets and variable construction are included in the Data Appendix.

The sample is limited to manufacturing firms, since we are interested in learning how imported intermediate inputs contributed to firm export outcomes.[7] Next, following Arkolakis, Demidova, Klenow and Rodriguez Clare (2008), we use UN BEC groups to identify imported intermediate inputs. Finally, since processing trade firm activities are not suitable for our exercise, we limit our focus to firms' engaged in ordinary export. One reason for this choice is the fact that firms engaged in processing trade produce their products solely for export. Thus, since these firms are selected into export by definition, imported inputs have no effect on the export decisions for this group of firms. Second, since processing trade firms export all of their output, they are exempt from all tariffs. Consequently, lack of tariff variation for this firm subgroup is problematic, since tariff changes are the key instrument for firm intermediate input imports.[8]

Summary statistics from our dataset reveal a positive connection between a firm's intermediate input imports and firm exports.[9] If we define *importers* as firms that imported in at least one of the years between 2002 and 2006 and *non-importers* as those firms that didn't import in any of those years, Table 2's Panel A shows that importing firms exported portfolios that had greater product scope. For example, while the average non-importing firm exported less than one unique [(HS-8 product), (export-destination)] pair in 2002, the average importing firm had a product-destination export scope of 10.2. The contrasting export scope of importing versus non-importing firms persisted, and was equally strong in 2006. Similarly, Table 2's Panel A illustrates the contrast in export values for importing versus non-importing firms: exports were much larger for importing

[6] To address noise or misreported data values, the data were cleaned according to the process of Feenstra, Li and Yu (2011).
[7] Retail, wholesale, or intermediary firms are excluded from the sample. Since firm activities are classified by 4-digit Chinese Industrial Classification (CIC) industry codes, we are able to use each firm's CIC code to link our firm-level observations with industry data (eg. Industry R&D intensity, External Finance Dependence of the industry).
[8] Manova and Yu's (2011) finding that Chinese firms selecting into processing trade are different than firms engaged in ordinary export, further suggests against the pooling of ordinary and processing exporters in a single analysis.
[9] Hereafter, unless otherwise noted, "import" refers to imports of intermediate inputs by non-processing firms, while"export" refers to exports by firms engaged in ordinary trade.

firms than for non-importing firms. For example, in 2002 the average export by non-importing firms was about 63 thousand dollars while the value for importing firms was roughly 20 times larger.

Since non-importers were more likely to operate exclusively in the domestic market, the contrast in export outcomes is not entirely unexpected. Thus, it is important to note that the contrast remains, even if we restrict our comparison of importers and non-importers to the group of *exporting* firms.[10] Among exporting firms, Panel B in Table 2 indicates that the average product-country export scope for importing firms was twice as large as the product-country export scope for non-importing firms. In addition, the export value shipped by non-importing Chinese exporters was only half as large as the export value shipped by Chinese exporters who imported intermediate inputs.

Finally, Panel C of Table 2 shows that the firm probability of transitioning from no export to export was very different for importing versus non-importing firms. Among non-exporting firms 66% of importing firms started to export in the next year. In contrast, only 8% of firms that were both non-importing and non-exporting made the transition to export.

While the raw data clearly show that importing firms had greater export success and engagement than did non-importing firms, these data correlations alone are not sufficient to prove whether firm import activity was causally linked to firm export outcomes. To explore the connection more formally, we model the connection between intermediates and exports, and then move to a more formal empirical analysis of the question.

[10] *Exporters* are defined as firms that exported during at least one of our sample years.

3. A Model of Firm Incentives, Importing and Exporting

We assume that firms have heterogeneous capability as in Melitz (2003). Firms pay a fixed cost to enter into business, and upon entry, the firm learns its productivity ζ. Based on the firm's productivity draw, the firm's production function is:

$$(1) \quad Y = e^{\zeta} K^{\beta_k} L^{\beta_l} \left[\int_0^{N(d)} m(j)^{\frac{\theta-1}{\theta}} dj \right]^{\frac{\beta_m \theta}{\theta-1}}$$

As in Kasahara and Rodrigue (2008), we assume that firms combine capital *K*, labor *L* and intermediate materials *M* according to a Cobb-Douglas production function. The one element that deserves attention is the input of materials. Here, the contribution of materials inputs is represented not only by the quantity of materials utilized, $m(j)$, but by the diversity of inputs, $N(d)$. Firms may decide to source inputs from home (*d=0*) or to source globally (*d=1*). If the firm sources its inputs from home, its range of inputs is limited to the range of inputs available domestically, N_h. By contrast, if the firm sources globally, the range of available inputs is $N_g (> N_h)$. In the case where intermediate inputs are symmetric, firms source an equal amount of each input, $\overline{m}$, and total input usage is given by $M = N(d)\overline{m}$. In this symmetric case, output can be rewritten as:

$$(2) \quad Y = e^{\zeta} N(d)^{\frac{\beta_m}{\theta-1}} K^{\beta_k} L^{\beta_l} M^{\beta_m}$$

In turn, this production function implies that total factor productivity, *A*, is:

$$(3) \quad \ln A(d, \zeta) = \frac{\beta_m}{\theta-1} \ln(N(d)) + \zeta$$

As originally shown in Ethier (1982), holding inputs constant, firm output is elevated by increased input variety. In this setting, the firm's productivity, based on the firm's entry draw, rises when firms increase their scope of imported intermediate inputs.

While firms could maximize output by utilizing the full range of intermediate inputs, we do not observe this in practice. Presumably, firms draw from a narrower range of inputs since expanding

the range of intermediate inputs involves fixed costs.[11] To capture this feature of import behavior, we assume that importing firms face a per-period importing cost f_i for each additional input imported by the firm. In addition, as in Halpern, Koren, and Szeidl (2009), we assume that the per-product importing cost is non-uniform, and the per-period costs can be ranked in ascending order: $f_1 < f_2 < f_3 . < .. f_N$. Thus, firms will import intermediate inputs in order from 1 to *N*, stopping at the input where the marginal increase in firm profitability due to the import of the last input no longer exceeds the fixed cost of importing the next input.

Naturally, firms will only import inputs if the marginal increase in per-period profits associated with the input exceeds the per-period fixed cost of utilizing the imported input. However, it is important to note that the marginal cost of utilizing input i is $p_i(1+\tau_i)$, where p_i is the cost of importing product i and τ_i is the tariff assessed on import product i. For this reason, when tariffs fall, the marginal cost of production falls, while the marginal contribution of new inputs remains fixed holding output and factor prices constant. Thus, when tariffs reduce the marginal cost of using imported inputs, we expect that firms will increase their import of intermediate inputs. In turn, because additional imported inputs elevate the firm's productivity, the firm in a Melitz (2003) setting will experience an increase in profitable export opportunities. While the benefits of importing will not affect the export decisions of all firms, firms whose marginal profits from exporting rise more than the fixed cost of exporting will be able to increase the level or scope of their export market participation.

[11] Halpern, Koren and Szeidl's (2009) estimates from a cross-section of Hungarian firms suggests that the cost of importing an additional type of input was $3,300 for the average firm and $1,000 for the median firm.

4. Estimation

Our goal is to study the link between firm intermediate input imports and the expansion of firm exports, especially in the case where import utilization was facilitated by trade liberalization. To this end, the analysis is divided into two parts. First, we study the connection between firm intermediate input imports and firm export growth, both in terms of export value and the diversity of export products and destinations. In addition, to understand the factors underpinning the connection, we explore how the strength of the relationship relates to the origin of the imports, firm ownership type, and R&D intensity at the industry level. Following the initial analysis, the second section uses instrumental variables based on industry tariff changes to address the potential endogeneity of firm-level import decisions. The results from IV estimation confirm a causal and stronger connection between intermediate imports and export performance.

4.1 Imported Inputs and Firm Exports

4.1.1 Baseline Results

We begin by estimating a number of panel regressions that assess whether firm exports were related to the use of imported intermediate inputs. Our basic regressions relate the log of firm *i* (in industry *j*) export value in year *t*, to the firm's use of imported intermediate inputs and a set of controls. [12]

$$(4) \quad \ln(ExportValue)_{ijt} = \alpha + \beta \ln(\text{Im}\_Inputs)_{ijt} + \gamma X_{ijt} + \sum_t \delta_t + \varepsilon_{ijt} .$$

Our controls include firm characteristics, X_{ijt}, such as firm size, labor productivity and firm age, and a set of time dummies, δ_t. The firm-period error term $\varepsilon_{ijt} = \zeta_{ij} + \eta_{ijt}$ includes a firm fixed effect ζ_{ij} and an iid component η_{ijt}.

Since we are interested in learning whether Chinese firm exports were related to the level and/or diversity of imported intermediate inputs, we experiment with different measures of imported intermediates when we estimate equation (4). Our results displayed in Table 3/Panel A confirm a positive relationship between the use of imported intermediates and the level of firm exports. In

[12] To avoid undefined values, we add one to all variables before taking logs.

column (1), for example, the regression coefficient suggests that a 10% increase in imported intermediate inputs elevated firm exports by 1.84%. Columns (2) and (3) show that firm exports also rose when firms increased the diversity of their imported intermediate inputs, as measured by the number of unique HS-8 product counts (Import_prod) and the number of import source countries (Import_cty) or the number of unique HS-8 product-country intermediate import combinations (Import_prod_cty). Finally, since contributions due to import value and import diversity may not be mutually exclusive, we simultaneously include regressors for imported intermediate input value and diversity in the specifications of Column (4) and (5). The results indicate that firm increases in import levels and import diversity both boosted firm export.

While our initial specification includes firm fixed effects to control for time-invariant factors that lead to a correlation between imported intermediate inputs and exports, it is possible that both imported intermediate inputs and exports are endogenously determined by variables that are time-varying. For instance, factors such as firm size, productivity or firm age lead to the appearance of co-moving exports and imported intermediate inputs, even if there is no causal connection between the two. To account for such firm-level variation over time, our next regressions include measures of firm employment to control for firm size, output per worker to control for firm labor productivity and firm age. However, as shown in the last five columns of Table 3 Panel A, inclusion of firm characteristics does not change the sign or magnitude of the coefficients on imported intermediate inputs.

Although the initial specification assumes that the benefits of intermediate input usage are quickly realized, the validity of this assumption is tested by the regressions in Table 3 Panel B. The new specifications modify equation (4) by including both contemporaneous and lagged measures of imported inputs. We note two results in this modified setting. First, while firm exports are positively related to both lagged and contemporaneous values of imported intermediate inputs, coefficients on lagged import values are only about half as large as those for contemporaneous import value. Second, lagged measures of firm import scope either have no effect on current exports, or have a positive but much smaller impact than that of the contemporaneous measures of import scope. As before, the estimated coefficients on import value or import scope are not

affected by the regressions' inclusion or exclusion of firm characteristics, such as employment, age or labor productivity. Thus, since the key import coefficient estimates are not affected by the inclusion or exclusion of time-varying firm regressors the remainder of the paper only reports regression results from the original specification (4) which includes firm fixed effects, but not time-varying firm characteristics.

While our full sample results reveal a positive relationship between imported intermediate inputs and firm exports, the sample response is based on firms that were differentially engaged in export. This pooling of firms may obscure important differences in firm export responses to the import of intermediate imports. For example, some domestic firms imported intermediate inputs but only produced for the domestic market. Thus, imported intermediate inputs had no influence on the export levels or export diversity for this group of firms. The sample also includes firms that started out as purely domestic and later transitioned to export. Compared with firms that exported continuously, the effect of improved access to imported intermediate inputs on firm exports may have been especially large for these firms, as their export decision included both the extensive margin decision (to start export), as well as the intensive margin decision (about the level of export).

Due to the potential for differential responses related to a firm's international engagement, we divide our data into subsamples that separately examine "traders" - firms that had at least one import or export transaction during the sample period - and "exporters" - firms that exported in at least one of the sample years. We also delineate "importers" - firms that imported in at least one of the sample years - and "survivors" - the subset of firms who were present in each of the sample years from 2002 to 2006. Our new regressions are displayed in Table 4 Panel A. Notably, the imported input coefficients are very similar to those from our full sample, which suggests that selection into export or import do not affect our estimated coefficients on intermediate input imports.

Since organizational form may influence the sensitivity of firm exports to firm imported inputs, the next set of regressions divides the data into four ownership groups: Private, SOE (state-owned enterprises), non-HMT (Hong Kong, Macau and Taiwan) foreign and HMT foreign. We run

regressions for each firm group individually, and display the results in columns (5) to (8) of Panel A in Table 4. While we find a positive association between imported inputs and export outcomes for all firm groups, the responsiveness of Private and SOE firm exports is roughly twice the magnitude noted for HMT and non-HMT foreign firms.

We complete our exploration of effects by firm group by adding the product and country scope of firm imports to the regression framework. In the new regressions, shown in Table 4 Panel B, the importance of import value is just as strong as it was in Panel A. However, we now find that firm exports are also increased by firm import scope. Nonetheless, while the coefficients on import scope are all positive and significant, differences across firm groups are not statistically distinct. [13]

4.1.2 Industry R&D Intensity and Firm Export Responses

While our panel regressions strongly confirm that increasing firm intermediate imports boosted firm exports, it is natural to ask whether specific mechanisms support this connection. Two factors seem particularly important. First, if imported inputs convey embedded technology or quality-enhancing product improvements, the technology or quality contained in imported intermediates will affect the strength of the connection between intermediates imports and firm exports. Formally, Equation (1) assumes that all intermediate inputs contribute symmetrically to output, regardless of source location. However, since imported inputs are likely to differ in terms of their embedded technology or quality level, inputs with a higher technology or quality level will provide a greater contribution to TFP, and thus may contribute more to export expansion.

Since Chinese trade data do not provide direct information on technology or quality level of imported intermediates, we draw inferences based on source country income. To test whether inputs imported from rich countries were particularly helpful in supporting firm export

[13] In above regressions we exclude processing trade due to the fact that all imported intermediate inputs in processing trade are exempt from all tariffs so that we cannot use tariff changes as an instrumental variable for processing imports. It is however reasonable to expect that imported intermediate inputs also play a similar role in processing trade. When we extend our sample to include processing trade as well as ordinary trade, our estimated coefficients for imported intermediate inputs becomes larger than those reported here. Similarly, we also study how imported intermediate inputs affect firms' export as a share of firms' total sales. We find that firms shifted their focus toward export sales when they import more intermediate inputs. Results of these extra regressions are unreported for brevity but available upon request.

performance we introduce separate import measures in specification (4), which enable us to observe how the benefits of inputs imported from richer OECD countries compared with the benefits of non-OECD input imports.[14] Our new results, which are shown in Table 5 examine the responses for the full sample as well as the trader and surviving firm samples. Regardless of sample, we find that the export expansion benefits due to OECD-sourced inputs were about fifty percent larger than the benefits of sourcing intermediates from non-OECD countries. In contrast, although our full sample estimates suggest that OECD based import diversity is more beneficial than the diversity of non-OECD intermediate inputs the differential benefits are not also evident in the trader and survivor subsamples.

If technological connections help explain the importance of imported intermediates, industry characteristics may also affect the strength of the connection between intermediate input imports and firm exports. For example, if firms in R&D intensive industries are more reliant on the embedded technology or quality contained in imported inputs, imported inputs may contribute more to firm export expansion in high R&D intensity industries. If so, this implies that β_m in Equation (2) is larger for firms in high R&D industries, and therefore from Equation (3) firms in R&D intensive sectors will derive a greater benefit from imported inputs than do firms in industries that are less reliant on R&D.

Due to export quotas governed by the Multifiber Arrangement (MFA) and its successor, the Agreement on Textile and Clothing (ATC), firm export responses in Textile and Clothing sector faced constraints during our sample period.[15] Thus, before we test for differential responses based on industry R&D intensity, we test whether the Textile and Clothing industry had export responses that differed from other industries. To this end, the first two columns in Table 6 Panel A include two textile industry interaction terms: the terms interact firm imported input value and firm

[14] Since OECD membership has evolved over time, we define OECD countries based on OECD membership before 1990. In addition, due to differences in technological development, we include Israel and exclude Turkey from the OECD group. Countries included in our OECD group are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Israel, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States. Alternatively, we also check the different impacts for imported inputs from G-7 countries. The results are similar to those based on OECD membership.

[15] Brambilla, Khandelwal and Schott (2010) and Khandelwal, Schott and Wei (2011), describe the impact of these policies.

product-country import counts with an indicator for textile and clothing firms. While we do not find any evidence that imported input scope had any differential effect on firms in the textile and clothing sector, our estimates indicate that the contribution of imported input value to firm export was 25-30% smaller in the textile and clothing sector, and the difference was highly significant. Thus, since textile and clothing firms respond differentially, and the differential response is consistent with quota limits on exports, our regressions for cross-industry export responses focus on the universe of all firms excluding firms from the textile and clothing sector.

To look for the importance of sectoral R&D intensity, our next estimation specification adds interactions between firm intermediate input imports and measures of industry R&D intensity.[16] Our interaction terms are based on two different measures of industrial R&D intensity: the first is the industry R&D expense as a fraction of industry sales (*R&D*) while the second is the industry's median level of firms' new product shares in output (*Newprod*). The results from our R&D regressions are reported in columns (3)-(6) of Table 6 Panel A. Regardless of our choice of R&D-intensity measure, we find that imported input usage provided a greater boost to the exports of firms that operate in R&D-intense industries.[17]

Next, since R&D intensity is often correlated with other industry characteristics, we need to verify that our R&D results remain, even if we control for other sector characteristics, such as capital intensity, industry intensity of imported input use or industry external finance dependence. For example, if an industry relies heavily on imported intermediate inputs, then imported inputs may be more important for the export success of firms in the industry than is the case for firms in other industries. Similarly, trade in imported intermediates may require the support of credit and financial intermediaries just as exports do.[18] Thus, if credit constraints limit firm utilization of imported inputs, and credit constraints bind more differentially for firms in R&D intense sectors, R&D interaction terms will reflect information about the importance of credit constraints.

[16] Industry R&D intensity is not added as a regressor, since industry R&D intensity is time invariant, and therefore absorbed by the firm fixed effects.
[17] The relatively large coefficients of the interaction terms between log level of import value and *R&D* expense share in columns (3) and (4) are due to the small value of R&D intensities measures in most of the industries.
[18] Amiti and Weinstein (2009), Auboin (2009), Bricogne et al (2009), Campbell et al (2009), Chor and Manova (2010), Haddad et al (2010), and OECD (2009) all show evidence of trade contraction associated with contraction in trade finance.

To verify that R&D interaction effects are related to technology rather than other correlated industry characteristics, we expand our regression specification to simultaneously include interactions between firm use of imported intermediates and additional industry characteristics, and provide the results in Table 6 Panel B. While a few of the new interaction terms have marginally significant results, as is the case for interactions based on industry capital intensity, the coefficient on the R&D interaction term remains positive and highly significant. In fact, the coefficient on the interaction between firm-level imported inputs and industry R&D intensity is larger in magnitude than the earlier coefficients of Table 6 Panel A.

We are also able to demonstrate that the importance of R&D intensity is not driven by industry differences in the intensity of imported inputs. To measure industry-level reliance on imported inputs, we construct the ratio of imported inputs to total exports for each industry.[19] We find that the coefficient on the import intensity interaction term is negative and insignificant, while the coefficient on the R&D intensity interaction term remains positive and highly significant. In Column (5) of Table 6 Panel B we uncover a positive and significant coefficient on the interaction term between firm imports and industry-level external finance dependence, which indicates that imported inputs are more helpful in promoting export growth for firms that are in industries more reliant on external financing. However, when the industry importance of external finance and R&D intensity are both included, the results from Column (6) demonstrate that the positive and significant coefficient on the external finance dependence interaction and the earlier positive and significant coefficient on the R&D intensity interaction term are both preserved.

As a final check, we include interactions between import value and all of the above mentioned industry characteristics: R&D intensity, capital intensity, imported input intensity and external finance dependence. The results are shown in column (7) of Table 6 Panel B. Notably, while the coefficients on the new interaction terms are consistent with our earlier findings, the R&D intensity interaction also remains positive and significant. Thus, it appears that imported

[19] We also tried an alternative measure of import intensity: the industry's share of imported inputs as a ratio of the industry's total output. However, the results do not change.

intermediate inputs are particularly helpful in increasing the exports by firms in R&D intensive industries.

4.1.3 The Effect of Imported Inputs on Export Scope

To test whether firm-level imports affect export scope, the dependent variable for Equation (4) is replaced by firm-level counts of unique HS-8 product-country destination pairs. Because the dependent variable is now a non-negative count variable, the specification is estimated via negative binomial panel regressions and the results are reported in Table 7.[20] Our results based on the full sample, which are displayed in Columns (1)-(2) show that firms that increased their reliance on imported intermediates were more successful in increasing their export scope, regardless of whether we measure the imported inputs with import values or with a combination of import value and the import variety. If we repeat the analysis after dividing the sample into subgroups based on firm ownership our results in Columns (3)-(6) demonstrate that firm-level imported intermediate inputs were especially helpful in expanding the export scope of private Chinese firms. Indeed the estimated coefficient for private firms is almost twice as large as the coefficient for foreign invested firms.

We also examine whether the effect of firm imports on export scope depends on the source country origin of firm imports. Columns (7), for example, shows that the value of inputs imported from OECD countries expanded firm export scope 60% more than did imported inputs from non-OECD countries. However, column (8) shows that the benefit of import variety, which was positive and significant, was similar regardless of import origin.[21]

To summarize our results, panel regressions strongly confirm that firm-level intermediate input imports (measured by value or variety) helped Chinese firms to export larger volumes of

[20] Due to our inclusion of firm fixed effects, the results in Table 7 have fewer observations per group than those in Table 4. This is because the negative binomial model with firm fixed effects excludes firms that had no change in the dependent variable during the panel years. To retain the full sample, we repeated our analysis, and treated the firm effects as random. Although use of random effects restores our ability to utilize data from the full sample, the estimated coefficients for the import variables are essentially unchanged.

[21] We also examined whether the impacts of firm imports on its export scope rely on industry characteristics. However, we do not find any evidence of differential effects due to industry R&D intensity of imported input on export scope.

manufactured goods and to achieve greater export scope. In addition, imported inputs generated stronger export benefits for Chinese private firms than for foreign invested firms, and the benefits were also related to industry characteristics and country of origin. Indeed, since imports from OECD countries have a larger effect on firms' export performance than imported inputs from non-OECD countries, and because the effects are larger for firms operating in more R&D intensive industries, the data suggest that technology or quality embedded in the imported inputs support firm-level export growth.

4.2 Endogeneity

Our initial regressions include firm fixed effects and time-varying measures of firm characteristics to control for non-causal correlations between imported inputs and exports. However, due to potential endogeneity issues, we now turn to instrumental variables estimation and use import tariffs as instruments for firm-level intermediate input import decisions

4.2.1 Tariffs and Firm Import Decisions

As shown in section 3, the marginal benefit of imported intermediates is determined by technology while tariff reductions reduce the marginal cost of importing inputs [$p_i(1+\tau_i)$]. Thus, since tariff reductions increase the marginal profits associated with intermediate input import expansion, we expect to see a negative association between China's import tariffs and the use of imported intermediates.

After joining the WTO, China phased-in tariff reductions according to its negotiated accession agreements. However, since firms often import more than a single input, we examine how changes in an industry's average tariff affect a firm's import level and scope. For this purpose, we define the duty on imported inputs in industry j in year t as:

$$(5) \quad Duty_{jt} = \sum_{p=1}^{P_j} \omega_{pj} \tau_{pt}$$

Time varying product tariffs (τ_{pt}) are levied on each product p in year t according to the tariff code. The number of importable inputs for industry j is P_j, and the importance of each product for

production in industry j is represented by the weight ω_{pj} with $\sum\omega_{pj} = 1$. Since we do not have product-level information on inputs that the firm sources domestically, we use data on firm imports at the industry level in 2006 to define the range of importable products P_j for each industry. In our main specifications, we use data on the value shares in total imported inputs of each imported input at the industry level in 2006 to form the weights ω_{pj}.[22]

To assess the effect of tariffs on firm-level imports, we examined three import response margins: 1) firm import value, 2) dichotomous firm import decisions and 3) firm product-country import scope. Regressions linking each of these import decisions to import tariffs are reported in Table 8. Whether we run OLS with controls for ownership type and industry-year fixed effects, as in Column (1), or a panel regression with year and firm fixed effects, we find that tariffs had negative and significant effect on imports. Both regression specifications indicate that a one log point tariff reduction increased firm import value by 4.7%.

The data also show that import tariffs influenced firms' dichotomous decision to import. Since the dependent variable takes the value of zero or one (if the firm imports), the regressions shown in Columns (3) and (4) are based on probit estimation instead. Further, since import decisions may depend on the firm's previous import status, we add an indicator variable that is set to one if the firm imported any inputs in the previous year. Regardless of our method for controlling for firm effects and heterogeneity across groups, the results in Columns (3) and (4) show that higher tariffs discouraged firms from importing. The regressions also show that firm import decisions were positively related to previous import activity, as would be the case if firms face sunk costs of importing.

Our final analysis turns to firm import scope. For this test, we measure firm import scope as the count of each firm's distinct (HS-8 product)-(Source-country) import pairs and run regressions using panel negative binomial models. Our results are robust to the type of firm effect included:

[22] To test for robustness, we constructed alternative tariff measures based on other input weights. For example, since Head, Jing, and Ries (2011) note geographic differences in the pattern of Chinese imports, which suggests the possibility of heterogeneous production techniques by province, we experimented with weight ω_{pjk} - the average 2006 use of imported input p by industry j firms in province k. We also generated a firm-level tariff measure based on firm imports of intermediate inputs in 2006, where the firm's expenditure shares on each product p were used as weights.

firms that benefited from import tariff reductions expanded their range of imported inputs.[23] Similar to our results regarding firm import participation, we find that firm import scope was positively related to the firm's import scope in the previous period.

Since the regressions uniformly confirm that firms increased their imports of intermediate inputs as industry-level import tariffs declined we now use China's WTO-entry tariff reductions as instruments for firm use of intermediate inputs.

4.2.2 Imported Inputs and Firm Exports: IV Estimation

Our IV specification returns to Equation (4), but now uses our industry tariff measure, ln(Duty), as an instrument for imported inputs. As before, we include firm fixed effects to control for time-invariant firm specific shocks and report our results in Table 9. The new IV estimates indicate that increasing a firm's imported intermediate input value by a one percent increased the firm's export value by 1.35 percent. Since the elasticity estimate from the standard panel estimation was much smaller it appears that the failure to control for endogeneity of imported inputs causes a downward bias in the estimated effects on exports.[24] The role of endogeneity is also observed if we measure firm import intensity by import scope at the product and country or product-country level, rather than by using import value.[25] For all measures of firm import variety, we find that the IV estimates are larger in magnitude. Further, the estimates are economically meaningful. For example, the IV results based on product-country import scope predict that if a firm increased its (HS-8 product)-(country) import diversity by one percent, the firm would increase its export value by 1.69 percent.

To learn whether firm-ownership differences are still meaningful in an IV setting, we apply our IV specification to each firm subgroup and report the results in columns (5) to (8) of Table 9. Notably,

[23] Firm effects are treated as random in Columns (5) and (6) and fixed in Columns (7) and (8). Because firm fixed effects exactly identify firms that had constant import scope over the panel, Columns (7) and (8) estimates are only based on firms that changed their import score during the sample period.
[24] The standard panel estimate of the same equation without IV, as shown in Table 3 column (1), was (0.184).
[25] Since we are instrumenting for count measures of import activity, the first stage regressions are panel negative binomial estimations. The effects of using IV can be seen by comparing columns (2), (3), and (4) in Tables 3 and 9.

we continue to find the patterns we observed earlier. First, for all types of ownership, aside from SOEs, the IV estimates suggest larger impacts of imported intermediate inputs on exports than the impacts estimated without IV. Second, the estimated benefits of imported intermediate inputs are twice as large for Private Chinese firms as they are for foreign invested firms. This, it appears that China's tariff liberalization created the largest export benefits for Private Chinese firms.

Next, to evaluate how R&D intensity affected the connection between imported intermediates and firm exports while using IV estimation, we classified industries as high or low R&D based on the median R&D intensity of 4-digit CIC industries. As before, we measure industry R&D intensity by two measures- one based on R&D expenses (*R&D*), while the other is based on new product shares in output (*Newprod*).

Table 10 reveals a stark contrast: firms in high R&D industries derived great benefit from the import of intermediate inputs, while there is no apparent connection between imported intermediates and exports for firms in less R&D intense sectors. For example, if industry R&D intensity is measured by the R&D expense measure, the coefficient on imported intermediate inputs for high R&D industries is 1.122 and highly significant. This coefficient is very similar to the full sample estimate of 1.350, and is in direct contrast with the negative and insignificant results for the low R&D sectors. Since the lack of response by low R&D sectors might reflect policy driven export constraints on textile firms, we exclude textile and clothing firms, and repeat our low R&D sector regressions. However, the low R&D sector response is still negative and lacking in statistical significance. Finally, since the dichotomous importance of imported intermediates is noted when we turn to the R&D measure based on the new product measure, we are confident in concluding that imported intermediates are especially helpful in allowing firms in high R&D sectors to increase their exports.

5. Robustness Checks

To further confirm the stability of our results, we ran a number of robustness checks that investigate our choice of specification, provide controls for other sources of shocks, and which provide alternative measures for our IV strategy. Each of these experiments is discussed in turn.

5.1 Changes Specification

While our panel is based on annual observations, it is possible that firms require more than a year to realize the full benefits arising from their import of intermediate inputs, or that firms require more than a year to respond to tariff changes. Thus we use specification (6) to run IV regressions based on firm-level export changes over the period of 2002 to 2006:

$$(6) \quad \Delta \ln(ExportValue)_{ij} = \alpha + \beta \Delta \ln(\text{Im}\_Inputs)_i + \gamma X_{ij,2002} + \sum\nolimits_j \lambda_j + \sum\nolimits_g \Psi_g + \kappa_{ij}$$

In this analysis, the dependent variable is the change in log export value for 2006 compared with 2002 for firm *i* in industry *j*. The independent variables are defined similarly as the difference in the log level of imported intermediate input value for 2006 minus the log value of the variable in 2002.[26] We generate similar variables for tariff changes that we can use to instrument the changes in imported intermediate inputs. Though firm fixed effects drop out when we apply time differences to the original regression given by (4), we add in the 2002 values of firm employment and per-worker sales, $X_{ij,2002}$, to control for heterogeneity in firm size and productivity. Finally, to account for the possibility of differential time trends by industry, *j*, or firm ownership type, *g*, we add time-trend variables λ_j, Ψ_g to our estimating equation. We assume that the error term κ_{ij} is iid.

Table 11 reports the IV estimation results for our new estimating equation. The estimated elasticity displayed in Column (1) indicates that one percent increase in a firm's import value helps the firm to boost its export value by 1.948 percent. While this new estimate fails to attain the original level

[26] The one exception is our treatment of the import variable when we run regressions based on import scope. In this case the independent variable is defined as the difference between the firm-level count of unique HS-8 product-country imports in 2006 minus the firm-level count of unique product-country imports in 2002.

of significance (the *p*-value is 0.173), the estimate is close in magnitude to the Table 9 IV regression run in the panel setting. Similarly, the changes specification is applied to groups of firms identified by ownership type, the results shown in Columns (2), (3) and (4) are again a bit less statistically significant than they were in the earlier panel IV regressions run in levels. However, the qualitative finding that imported inputs measured by import value, had the greatest benefit for Private firms, is maintained.

The full sample result displayed in Column (5) implies that if a firm adds an additional product-country import its export value will increase by 0.49 percent. While the new estimate is only of borderline significance (p-value of 0.117), and is slightly lower than the estimate from the earlier Panel IV results, it is nonetheless significantly higher than our non-IV results reported in Table 3. Finally, when we test for the effects of imported input diversity on export value by firm ownership type, our estimates for private firms grow further, and are highly significant. Thus, all three tests strongly show that the benefits of import diversity are larger for private firms than they are for foreign invested enterprises.

5.2 Trade Shocks and Import Competition

While our results demonstrate a strong relationship between the use of imported intermediate inputs, and firm export, such a correlation could arise if time-varying firm-level shocks are responsible for these simultaneous changes in inputs usage and export. One shock that may be especially problematic would be shocks to export demand. While there are no available measures of firm-specific export demand, it is reasonable to assume that changes in a firm's year to year export demand will be tied to developments at the industry level. Thus, to evaluate this conjecture, we add the log level of 4-digit industry export value to our IV regressions.

Similarly, domestic firms may also be affected by inflows of competing imports stimulated by trade liberalization. If trade liberalization due to tariff cuts on final goods imports stimulates local competition, and causes firms to increase their productivity it is possible that firms will be able to improve their performance in export markets.[27] To make sure that our results are due to the

[27] For related arguments, see Amiti and Konings (2007), Topalova and Khandelwal (2001) and Yu (2011).

reductions of intermediate input tariffs rather than China's reductions in final goods tariffs, we add the log level of 4-digit industry final output tariff to our IV regression specifications. [28]

Since we want to ensure that the results are not driven by firms that had large export shares, we restrict the sample by excluding the largest firms. Table 12 presents the results for these subsamples of firms. Columns (1) to (3) of Table 12 exclude exporting firms that are above 95th percentile ranked according to their export shares in each 4-digit CIC industry, with pure domestic firms excluded when firms are ranked. Columns (4) to (6) instead exclude exporting firms that are above 75th percentile.[29] The results show that the inclusion of the export demand and output import competition variables does not have significant effect on the estimated coefficients on import levels (compared with the results in Table 9). Thus it does not appear that industry level shocks to export demand or output import competition or inclusion of large exporters were responsible for the positive correlation between firm imported input use and firm exports that we report.

5.3 Import Real Exchange Rates as Instrumental Variables

In order to further check the robustness of our IV results, we construct an alternative instrument variable, the industrial level import real exchange rate. Similar to the construction of industrial tariff, the industrial import real exchange rate (*RERimp*) for industry j in year t is defined as a weighted average of real exchange rate:

$$(7) \quad RERimp_{jt} = \sum_{c=1}^{C_j} \omega_{cj} rer_{ct}$$

where rer_{ct} is the real exchange rate between China and country c in year t, expressed as Chinese units of baskets per basket of foreign country, obtained from Penn World Table. The total number of countries industry j imports from is C_j and ω_{cj} is the share of imports from country c in industry

[28] The 4-digit industry output tariff is constructed in a similar way as the intermediate input tariff. We follow Equation (5) but use the value shares in total export value for each exported output at the industry level in 2006 as the weights.

[29] Within exporting firms, the median export share was 0.15%, while the average export share was 1.1%. Columns (1) to (3) of Table 12 exclude firms with more than 4.4% of industry export share, eliminates top 5% of exporting firms as measured by market share. Columns (4) to (6) impose more stringent restrictions, excluding firms with more than 0.6% of industry export share so that the top 25% of exporting firms are dropped.

j's total imports averaged over years 2002-2006.[30] Using constant weights for real exchange rates of different years enables us to exploit the time series variations of the real exchange rates so that our measure is not affected by changing bilateral trade volumes. Similarly, we construct industrial level export real exchange rate (*RERexp*) based on Equation (7) as well but using export shares as the weights. [31]

We use import real exchange rate as an instrumental variable for imported intermediate inputs and include export real exchange rate as a regressor to control export changes due to the changes of export real exchange rates. IV regressions are estimated following the specification (4). Table 13 presents the results. Column (1) uses import real exchange rate as the sole IV and column (2) includes both import real exchange rate and import tariff as IVs. The results present an elasticity of export values to imported intermediate inputs at around 2.6 to 3.3. Compared with the results using tariff as the sole IV, the estimated elasticity is a bit larger but the magnitudes are still comparable. In columns (3) and (4), when we restrict the sample to "Traders" or "Survivors" and use import real exchange rate as the sole IV, the estimated elasticity becomes slightly smaller. Since all these estimates are highly significant, they again confirmed the causal relation between imported intermediate inputs and exports. Finally, in columns (5) and (6) we run similar IV regressions for domestic Private firms and foreign firms respectively. We found that the benefits from imported inputs are about twice as large for Private firms than those for foreign firms. This again is consistent with our previous findings.

5.4 Endogeneity of the Instruments

One final concern regarding the use of intermediate input tariffs as instruments is that the intermediate input tariff itself might be endogenous. A possible explanation for our findings is that reductions in destination country tariffs after China's WTO accession increase China's exports, and that these destination country tariff reductions were positively correlated with China's tariff reductions.

[30] Alternatively, we use real exchange rates from International Financial Statistics (IFS) of IMF to construct our measures. The results are similar.

[31] When we include our export-weighted measure of the real exchange rate the import-weighted real exchange rate will not have a direct effect on exports.

We argue that our results are very unlikely to be driven by the tariff reductions in the destination countries. First, if destination country tariff reductions do increase Chinese exports, our measure of industrial export demand controls for these changes. In fact, as Table 12's results demonstrate, controlling export demand does not affect our results in any significant way. Second, even if import tariffs are endogenous, destination country tariff changes should not affect the bilateral real exchange rates. As reported in Table 13, using real exchange rates, instead of input tariffs, as instruments for imported intermediate inputs confirms that imported intermediate inputs do contribute to firms' export success.

Third, we can explicitly control for the effects of destination country tariff changes, if we construct an index of industry-specific destination tariffs as follows:

$$Dest\_duty_{jt} = \sum_{p=1}^{P_j} \sum_{c=1}^{C_j} \left(\left(\frac{X_{pcj}^{2006}}{\sum_{c=1}^{P_j} \sum_{p=1}^{C_j} X_{pcj}^{2006}} \right) \tau_{pct} \right)$$

In this formula X_{pcj}^{2006} is the export value of product *p* by industry *j* to country *c* in 2006 and τ_{pct} is product *p*'s *ad valorem* tariff imposed by export destination country *c* in year *t*. This measure of destination tariff is then included in the IV regressions. We find that including this destination tariff measure does not have significant impacts on our estimation of the effects of imported intermediate inputs. [32]

[32] The results are available upon request.

V. Conclusions

Our paper uses firm-level trade and operational data from a large dataset of Chinese manufacturing firms to test how the use of imported inputs contributes to firm export activity. Controlling for time-invariant firm fixed effects, we find that firms that expanded the value or variety of their intermediate input imports expanded the value and scope of their exports. Since our analysis encompasses the years following China's WTO entry, we are able to exploit China's tariff changes as instruments for firm-level import decisions. When we use these tariff changes as instruments, we uncover a stronger connection. The estimates imply that a one percent increase in a firm's intermediate input import value will expand the firm's exports by 1.35 percent. These results, suggest that China's WTO entry tariff liberalization has indeed helped to spur China's export growth.

While our study finds a strong positive effect of imported intermediate imports on firm exports, we find that the strength of the relationship differs systematically on a few notable dimensions which all suggest that export improvements occur when imports provide local firms with intermediate inputs of superior quality or technology. First, if we distinguish firms by ownership type, we find that Private Chinese firms derived larger benefits from imported inputs than did foreign invested firms. Since Private Chinese firms began the decade at a disadvantage relative to their foreign competitors, the differential benefit suggests that China's increasing openness, due to improvements in access to imported inputs, facilitated productivity improvements by Private Chinese firms. Our paper also shows evidence that the benefits due to intermediate input imports are related to source country. Here, the fact that the contribution of imported intermediate inputs from the more technological-advanced OECD countries is larger than that of imports from non-OECD countries also suggests that imported intermediates are most beneficial when they convey superior technology or quality. Finally, we find that imported intermediates are especially helpful in expanding the exports of firms that operate in R&D intense industries. Taken together, these results suggest that firm access to high quality or sophisticated imported intermediates helps explain the strength of the connection between firm-level imports and the development of individual firm export capability.

Table 1: Chinese Industry Characteristics and Tariff Reductions

Industry Name	CIC Code	Tariff (%)	Tariff Reduct-ion (%)	External Finance Depen-dence	R&D	New Product Intensity	Capital Intensity	Import Intensity
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Food Processing	13	9.792	17.452	1.005	0.0004	0.015	54.044	0.135
Food Manufacture	14	14.115	21.778	1.024	0.0009	0.023	49.104	0.211
Beverages	15	9.602	28.683	1.031	0.0016	0.043	83.346	1.104
Tobacco	16	7.555	46.868	0.911	0.0035	0.008	174.050	25.513
Textiles	17	9.356	30.002	1.117	0.0014	0.045	36.648	0.071
Apparel, Footwear & Hats	18	13.489	35.654	1.167	0.0005	0.019	13.847	0.025
Leather, Fur, & Feather Products	19	8.758	20.292	1.064	0.0003	0.018	21.142	0.042
Timber, Wood, Bamboo, Rattan, Palm & Straw Products	20	2.156	26.873	1.049	0.0004	0.028	28.894	0.621
Furniture	21	8.667	29.646	1.116	0.0007	0.033	30.378	0.038
Paper & Paper Products	22	4.958	10.512	1.045	0.0005	0.019	52.058	4.488
Printing, Reproduction of Recording Media	23	8.385	31.256	0.984	0.0010	0.048	55.065	2.368
Articles For Culture, Education & Sporting Activities	24	9.918	17.737	1.128	0.0014	0.042	24.108	0.059
Processing of Petroleum, Coking, & Fuel	25	5.267	7.418	1.135	0.0008	0.031	86.013	0.408
Raw Chemical Materials	26	6.558	18.975	1.060	0.0027	0.054	55.901	0.795
Drugs	27	7.093	12.434	0.970	0.0087	0.140	87.379	0.207
Chemical Fibers	28	8.392	26.443	1.124	0.0019	0.100	83.842	2.785
Rubber	29	10.767	13.890	1.119	0.0009	0.044	36.646	0.730
Plastics	30	9.444	29.708	1.116	0.0008	0.036	45.441	0.655
Non-metallic Mineral goods	31	7.079	16.504	1.067	0.0015	0.051	43.471	0.276
Smelting & Pressing of Ferrous Metals	32	1.737	5.495	1.078	0.0016	0.060	53.127	1.568
Smelting & Pressing of Non-ferrous Metals	33	2.360	8.074	1.046	0.0014	0.061	52.412	0.310
Metal Products	34	7.272	10.342	1.161	0.0013	0.035	30.403	0.161
General Purpose Machinery	35	7.035	11.079	1.207	0.0045	0.092	36.629	0.520
Special Purpose Machinery	36	7.349	14.051	1.182	0.0059	0.121	38.740	0.747
Transport Equipment	37	8.895	17.150	1.187	0.0053	0.105	40.004	0.894
Electrical Machinery & Equipment	39	6.992	16.485	1.309	0.0049	0.123	33.110	0.460
Computers & Electronic Equipment	40	3.520	19.349	1.179	0.0093	0.174	42.405	1.543
Measuring Instruments & Machinery for Cultural Activity & Office Work	41	5.591	19.927	1.150	0.0109	0.126	31.443	1.043
Artwork	42	10.030	23.493	1.055	0.0006	0.027	17.026	0.022

Notes: Column (2) reports the median 4-digit CIC (Chinese Industrial Classification) industry tariff level (average over 2002-2006) within each CIC 2-digit industry. Column (3) reports the median 4-digit CIC industry tariff reduction during 2002-2006 in percentage terms relative to its level in 2002 for each 2-digit industry. In columns (4) to (8), the reported values for each 2-digit CIC industry are the median value of the 4-digit CIC industry measures within each 2-digit industry.

Table 2: Descriptive Statistics on Firm Imports and Firm Export Performance

Panel A: Export Performance of Importers vs. Non-importers: All Firms

	Non-Importers			Importers		
Year	Obs.#	Export Product Country Pair	Export Value	Obs.#	Export Product Country Pairs	Export Value
	(1)	(2)	(3)	(4)	(5)	(6)
2002	148463	0.68	63648	24986	10.20	1130821
2006	256100	1.31	160551	39730	16.64	2886438

Panel B: Export Performance of Importers vs. Non-importers: Exporting Firms

	Non- Importers			Importers		
Year	Obs.#	Export Product Country Pair	Export Value	Obs.#	Export Product Country Pairs	Export Value
	(1)	(2)	(3)	(4)	(5)	(6)
2002	14503	6.92	651550.3	20228	12.60	1396811
2006	26510	12.64	1551011	31801	20.78	3606118

Panel C: Export Participation Rate for Non-Exporting (t-1) Firms

	Non-Importers	Importers
Participation Rate	0.08	0.66

Notes: Panel A shows the number of firms, average number of unique export product-country pairs and average export value of importers and non-importers in year 2002 and 2006. Firms are classified as "Importers" if they imported during any year in the sample. "Non-Importers" had no imports in any year between 2002 and 2006. Panel B reports a number of outcomes - average number of export product-country pairs and average export value of importers and non-importers – for "exporters", defined as firms that exported during any year in the sample from 2002 to 2006. Panel C shows the export participation rates for importing and non-importing firms that were not exporters in the previous year. "Export Product Country Pairs" reports the number of distinct product (8-digit HS) and country destination pairs exported by the firm. "Export Value" is the average value of firm exports in dollars. "Participation Rate" is the percentage of non-exporting firms that become exporters in the next year, reported by firm import category.

Table 3: Imported Inputs and Firm Exports

Panel A: The Effect of Contemporaneous Imported Intermediate Inputs

Dep Variable	Ln (export_value)									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ln (import value)	0.184***			0.139***	0.175***	0.176***			0.135***	0.168***
	(0.003)			(0.003)	(0.003)	(0.003)			(0.003)	(0.003)
Import_prod		0.011***		0.012***			0.010***		0.011***	
		(0.002)		(0.002)			(0.002)		(0.002)	
Import_cty		0.392***		0.194***			0.374***		0.182***	
		(0.011)		(0.010)			(0.010)		(0.010)	
Import_prod_cty			0.023***		0.014***			0.022***		0.013***
			(0.002)		(0.002)			(0.002)		(0.002)
Ln(employment)						0.524***	0.526***	0.563***	0.507***	0.516***
						(0.010)	(0.010)	(0.011)	(0.010)	(0.010)
Firm age						0.004***	0.004***	0.004***	0.004***	0.004***
						(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Per worker output						0.223***	0.228***	0.243***	0.217***	0.220***
						(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Constant	1.642***	1.709***	1.796***	1.618***	1.629***	-1.997***	-1.960***	-2.133***	-1.906***	-1.953***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.069)	(0.070)	(0.071)	(0.069)	(0.069)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1064547	1064547	1064547	1064547	1064547	1058924	1058924	1058924	1058924	1058924
Groups	3.13e+05	3.13e+05	3.13e+05	3.13e+05	3.13e+05	3.13e+05	3.13e+05	3.13e+05	3.13e+05	3.13e+05
R-2 Within	0.041	0.036	0.023	0.045	0.043	0.048	0.043	0.032	0.052	0.050
R-2 Between	0.225	0.116	0.043	0.201	0.211	0.223	0.151	0.102	0.214	0.219
R-2 Overall	0.191	0.105	0.038	0.178	0.184	0.204	0.141	0.095	0.198	0.201

Panel B: Contemporaneous and Lagged Imported Intermediate Inputs

Dep Variable	Ln (export_value)									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ln (import value)	0.154***			0.118***	0.147***	0.150***			0.116***	0.143***
	(0.004)			(0.004)	(0.004)	(0.004)			(0.004)	(0.004)
Lag Ln (import value)	0.075***			0.064***	0.073***	0.072***			0.062***	0.070***
	(0.003)			(0.004)	(0.003)	(0.003)			(0.004)	(0.003)
Import_prod		0.011***		0.011***			0.010***		0.010***	
		(0.002)		(0.002)			(0.002)		(0.002)	
Lag Import_prod		-0.001		0.001			-0.001		0.001	
		(0.001)		(0.001)			(0.001)		(0.001)	
Import_cty		0.318***		0.155***			0.309***		0.149***	
		(0.012)		(0.012)			(0.012)		(0.012)	
Lag Import_cty		0.114***		0.028***			0.108***		0.025***	
		(0.009)		(0.010)			(0.009)		(0.010)	
Import_prod_cty			0.019***		0.012***			0.018***		0.011***
			(0.002)		(0.002)			(0.002)		(0.002)
Lag Import_prod_cty			0.005***		0.001			0.004***		0.001
			(0.001)		(0.001)			(0.001)		(0.001)
Ln(employment)						0.461***	0.469***	0.506***	0.447***	0.455***
						(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Firm age						0.002**	0.002**	0.002**	0.002**	0.002**
						(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Per worker output						0.212***	0.219***	0.236***	0.206***	0.209***
						(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Constant	2.134***	2.243***	2.367***	2.104***	2.116***	-1.014***	-0.981***	-1.124***	-0.943***	-0.982***
	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)	(0.101)	(0.102)	(0.103)	(0.100)	(0.101)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	751112	751112	751291	751112	751112	747704	747704	747880	747704	747704
Groups	3.13e+05	3.13e+05	3.13e+05	3.13e+05	3.13e+05	3.12e+05	3.12e+05	3.12e+05	3.12e+05	3.12e+05
R-2 Within	0.031	0.024	0.013	0.034	0.032	0.035	0.029	0.018	0.038	0.037
R-2 Between	0.234	0.119	0.048	0.212	0.223	0.238	0.151	0.101	0.225	0.232
R-2 Overall	0.222	0.114	0.044	0.202	0.211	0.230	0.146	0.099	0.217	0.224

Standard errors in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01

Table 4: Imported Inputs and Firm Exports – Effects by Firm Type

Panel A: Import Value and Firm Exports

Dep Variable	Ln (export value)							
	Trader	Exporter	Importer	Survivor	Private	SOE	Non-HMT Foreign	HMT Foreign
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln (import value)	0.170***	0.226***	0.175***	0.189***	0.240***	0.266***	0.136***	0.108***
	(0.003)	(0.004)	(0.003)	(0.004)	(0.005)	(0.020)	(0.006)	(0.005)
Constant	6.967***	7.840***	6.430***	2.275***	0.753***	0.573***	5.919***	4.251***
	(0.027)	(0.030)	(0.033)	(0.011)	(0.009)	(0.012)	(0.040)	(0.029)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	264991	233807	164722	422556	745224	95638	109869	113816
Groups	69515.000	61188.000	41767.000	84558.000	2.31e+05	30123.000	34907.000	36007.000
R-2 Within	0.083	0.097	0.096	0.049	0.050	0.054	0.043	0.033
R-2 Between	0.002	0.012	0.001	0.278	0.167	0.346	0.093	0.075
R-2 Overall	0.011	0.043	0.016	0.213	0.139	0.321	0.079	0.059

Panel B: Import Value, Import Variety and Firm Export

Dep Variable	Ln (export value)							
	Trader	Exporter	Importer	Survivor	Private	SOE	Non-HMT Foreign	HMT Foreign
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln (import value)	0.162***	0.217***	0.166***	0.181***	0.234***	0.243***	0.122***	0.097***
	(0.003)	(0.004)	(0.003)	(0.004)	(0.006)	(0.019)	(0.005)	(0.005)
Import_prod_cty	0.013***	0.013***	0.013***	0.013***	0.015*	0.023***	0.013***	0.019***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.009)	(0.006)	(0.001)	(0.002)
Constant	6.918***	7.786***	6.347***	2.254***	0.752***	0.569***	5.852***	4.223***
	(0.028)	(0.031)	(0.035)	(0.011)	(0.009)	(0.012)	(0.041)	(0.030)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	264991	233807	164722	422556	745224	95638	109869	113816
Groups	69515.000	61188.000	41767.000	84558.000	2.31e+05	30123.000	34907.000	36007.000
R-2 Within	0.084	0.098	0.099	0.051	0.050	0.059	0.048	0.035
R-2 Between	0.000	0.013	0.003	0.253	0.164	0.313	0.091	0.069
R-2 Overall	0.012	0.042	0.021	0.205	0.138	0.294	0.081	0.058

Note: "Trader" firms are defined as firms that had at least one import or export transaction during the sample period. "Exporter" firms are firms that exported in at least one of the sample years, and "importer" firms are firms that imported in at least one of the sample years. "Survivor" firms are firms that were active in all years between 2002 and 2006. SOE are state-owned enterprises. Private firms are non-SOE domestic firms. HMT are foreign firms from Hong Kong, Macau and Taiwan and non HMT Foreign are foreign firms from other foreign countries. Standard errors in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01

Table 5: Imported Inputs and Firm Exports- Differential Effects by Import Origin

Dep Variable	Ln (export value)					
Sample	Full Sample	Full Sample	Trader	Trader	Survivor	Survivor
	(1)	(2)	(3)	(4)	(5)	(6)
Ln (import value) OECD	0.148***	0.141***	0.135***	0.129***	0.152***	0.146***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
Ln (import value) Non-OECD	0.109***	0.103***	0.100***	0.094***	0.108***	0.102***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
Import_prod_cty OECD		0.012***		0.010***		0.010***
		(0.002)		(0.002)		(0.002)
Import_prod_cty Non-OECD		0.008**		0.010***		0.009***
		(0.003)		(0.003)		(0.003)
Constant	1.647***	1.639***	6.992***	6.962***	2.280***	2.266***
	(0.008)	(0.008)	(0.027)	(0.027)	(0.011)	(0.011)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
N	1064547	1064547	264991	264991	422556	422556
Groups	3.13e+05	3.13e+05	69515.000	69515.000	84558.000	84558.000
R-2 Within	0.041	0.042	0.083	0.083	0.049	0.050
R-2 Between	0.201	0.191	0.000	0.000	0.243	0.227
R-2 Overall	0.174	0.169	0.012	0.013	0.194	0.188

Note: "Trader" firms are defined as firms that had at least one import or export transaction during the sample period. "Survivor" firms are firms that were active in all years between 2002 and 2006. OECD countries refer to countries that are OECD member before 1990 but exclude Turkey and include Israel. Standard errors in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01

TABLE 6: Industry R&D Intensity and the Effects of Imported Inputs

Panel A: Industry R&D Intensity Interacted with Imported Intermediate inputs.

Dep Variable	Ln (export value)					
	Full Sample	Full Sample	Non-Textile Sector	Non-Textile Sector	Non-Textile Sector	Non-Textile Sector
	(1)	(2)	(3)	(4)	(5)	(6)
Ln (import value)	0.191***	0.182***	0.184***	0.175***	0.174***	0.165***
	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
Import_prod_cty		0.014***		0.014***		0.015***
		(0.002)		(0.002)		(0.002)
Ln (import value)* Textile Indicator	-0.048***	-0.047***				
	(0.008)	(0.008)				
Import_prod_cty* Textile Indicator		0.004				
		(0.003)				
Ln (import value)* R&D			2.068***	1.916***		
			(0.470)	(0.515)		
Import_prod_cty* R&D				-0.057		
				(0.087)		
Ln (import value)* Newprod					0.213***	0.200***
					(0.035)	(0.036)
Import_prod_cty* Newprod						-0.013*
						(0.007)
Constant	1.639***	1.626***	1.463***	1.450***	1.462***	1.449***
	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)	(0.009)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
N	1064547	1064547	929001	929001	929001	929001
Groups	3.13e+05	3.13e+05	2.75e+05	2.75e+05	2.75e+05	2.75e+05
R-2 Within	0.041	0.043	0.045	0.046	0.045	0.047
R-2 Between	0.219	0.207	0.244	0.231	0.242	0.230
R-2 Overall	0.187	0.181	0.212	0.205	0.211	0.205

Note: The zero/one Textile Indicator is set to one for firms in the textile and clothing sectors. Industry R&D is the share of industrial R&D expenses over industrial sales. Newprod is the median level of firms' new product share in their output for firms within each industry defined by 4-digit CIC code. Column (3) to (6) exclude the textile and clothing sector. Standard errors in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01.

Panel B: Imported Intermediate Input use Interacted with other Industry Characteristics

Dep Variable	Ln (export value)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln (import value)	0.201***	0.196***	0.193***	0.185***	0.077***	0.069***	0.078***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.020)	(0.020)	(0.022)
Ln (import value)* K intensity	-0.000*	-0.000**					-0.000
	(0.000)	(0.000)					(0.000)
Ln (import value)* Import intensity			-0.000	-0.001			-0.000
			(0.000)	(0.000)			(0.000)
Ln (import value)* External Finance Dep					0.100***	0.101***	0.097***
					(0.017)	(0.017)	(0.018)
Ln (import value)* R&D		2.202***		2.113***		2.088***	2.167***
		(0.475)		(0.470)		(0.468)	(0.473)
Constant	1.464***	1.463***	1.465***	1.463***	1.463***	1.462***	1.462***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	929001	929001	928950	928950	929001	929001	928950
Groups	2.75e+05	2.75e+05	2.75e+05	2.75e+05	2.75e+05	2.75e+05	2.75e+05
R-2 Within	0.044	0.045	0.044	0.045	0.045	0.045	0.045
R-2 Between	0.248	0.246	0.247	0.246	0.245	0.243	0.245
R-2 Overall	0.214	0.214	0.214	0.213	0.213	0.212	0.213

Note: K intensity (capital intensity) is measured by the median level of firms' capital labor ratio for firms within each industry of 4-digit CIC code. Import intensity is the share of imported inputs as a ratio of the total export for each industry. External Finance Dependence is the median level of external financing dependence by 4-digit CIC industries constructed following Rajan and Zingales (1998). R&D is the share of industrial R&D expenses over industrial sales. All Columns exclude textile and clothing sector. Standard errors in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01.

TABLE 7: Firm Imports and Export Scope

Dep Variable	Number of Export Product Country Pairs							
	Full Sample	Full Sample	Private	SOE	Non-HMT Foreign	HMT Foreign	Full Sample	Full Sample
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln (import value)	0.056***	0.054***	0.057***	0.070***	0.031***	0.029***		
	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)		
Import_prod_cty		0.002***	0.001***	0.002***	0.002***	0.003***		
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
Ln (import value) OECD							0.043***	0.041***
							(0.001)	(0.001)
Ln (import value) Non-OECD							0.027***	0.025***
							(0.001)	(0.001)
Import_prod_cty OECD								0.001***
								(0.000)
Import_prod_cty Non-OECD								0.001***
								(0.000)
Constant	0.237***	0.237***	-0.346***	0.065	1.054***	0.883***	0.262***	0.263***
	(0.009)	(0.009)	(0.014)	(0.047)	(0.017)	(0.018)	(0.008)	(0.008)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	189307	189307	79393	5542	57573	41436	189307	189307
Log lik.	-3.45e+05	-3.45e+05	-1.41e+05	-9038.332	-1.02e+05	-7.41e+04	-3.45e+05	-3.45e+05
Chi-squared	28420.773	29564.217	16412.618	533.741	6261.378	3208.982	28550.231	29325.569
Groups	49551	49551	21222	1484	16069	11616	49551	49551

Note: All columns are Panel Negative Binomial regressions with firm fixed effects and year fixed effects controlled. All columns exclude textile and clothing sectors. SOE are state-owned enterprises. Private firms are non-SOE domestic firms. HMT are foreign firms from Hong Kong, Macau and Taiwan and non HMT Foreign are foreign firms from other foreign countries. OECD countries refer to countries that are OECD member before 1990 but exclude Turkey and include Israel. Standard errors in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01.

TABLE 8: Import Duties and Firms' Imports

Dep Variable	Ln (import value)		Current Import Status		Count of Import Product-Country Pairs			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln (Duty)	-0.046***	-0.047***	-0.072***	-0.022***	-0.135***	-0.147***	-0.082***	-0.055***
	(0.009)	(0.012)	(0.009)	(0.005)	(0.011)	(0.009)	(0.012)	(0.016)
Lag Import Status			2.400***	2.781***		4.301***		0.340***
			(0.007)	(0.006)		(0.009)		(0.010)
Ownership FE	Yes		Yes					
Industry-Year FE	Yes		Yes					
Firm Fixed Effects		Yes					Yes	Yes
Firm Random Effects				Yes	Yes	Yes		
Year FE		Yes		Yes	Yes	Yes	Yes	Yes
N	984214	1064547	676325	731909	1064547	731909	164686	108284
Groups		313435		306267	313435	306267	41747	33526
Log lik.	-2.56e+06	-1.85e+06	-1.10e+05	-1.21e+05	-5.52e+05	-3.81e+05	-2.54e+05	-1.59e+05
Chi-squared			2.81e+05	2.15e+05	866.872	2.10e+05	727.934	1171.032
R-2 Within		0.001						
R-2 Between		0.001						
R-2 Overall	0.220	0.001						
F	58100.550	213.498						

Note: Column (1) is estimated by OLS, while column (2) is estimated using panel regression with firm fixed effects. Column (3) runs probit regression while column (4) run panel probit with firm random effects. Including random effect instead of fixed effect is because panel probit regression has no fixed effect option. Columns (5) to (8) are estimated by Panel Negative Binomial regressions. Columns (5) and (6) control firm random effects while Columns (7) and (8) control firm fixed effects. Standard errors in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01.

TABLE 9: Imported Inputs and Firm Exports—Instrumental Variables Estimation

Dep Variable	Ln (export value)							
	Full Sample	Full Sample	Full Sample	Full Sample	Private	SOE	Non-HMT Foreign	HMT Foreign
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln (import value)	1.350***				2.027*	39.017	0.095	1.217
	(0.500)				(1.227)	(478.529)	(1.207)	(1.319)
Import_prod_cty		1.691***						
		(0.451)						
Import_prod			1.068***					
			(0.285)					
Import_cty				0.572***				
				(0.153)				
Constant	0.219	0.637**	0.825***	-10.707***	0.294	-16.277	6.127	1.336
	(0.538)	(0.276)	(0.226)	(3.303)	(0.316)	(208.083)	(6.155)	(3.464)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	929001	929001	929001	929001	745224	95638	109869	113816
Groups	274709	274709	274709	274709	231362	30123	34907	36007
R-2 Within	.	0.019	0.019	0.019	.	.	0.041	.
R-2 Between	0.262	0.000	0.000	0.000	0.197	0.346	0.081	0.091
R-2 Overall	0.230	0.001	0.001	0.001	0.164	0.321	0.067	0.072
First Stage Results								
1st Stage Dep. Var.	Ln (import value)	Import prod_cty	Import_prod	Import_cty	Ln (import value)			
Ln (Duty)	-0.044***	-0.036***	-0.056***	-0.105***	-0.025**	-0.005	-0.074	-0.011
	(0.014)	(0.013)	(0.013)	(0.011)	(0.012)	(0.033)	(0.070)	(0.073)
Constant	1.169***	0.686***	0.910***	21.848***	0.303***	0.433***	5.701***	2.993***
	(0.029)	(0.028)	(0.029)	(2.889)	(0.027)	(0.071)	(0.150)	(0.158)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	929001	929001	929001	929001	653648	91828	92525	91000
Groups	274709	274709	274709	274709	203934	28858	29547	29030
Log lik.	-1.59e+06	-4.90e+05	-4.71e+05	-3.44e+05	-9.44e+05	-1.17e+05	-2.00e+05	-1.98e+05
Chi-squared		697.841	661.707	1356.830				
R-2 Within	0.001				0.003	0.001	0.002	0.001
R-2 Between	0.000				0.000	0.000	0.000	0.000
R-2 Overall	0.000				0.000	0.000	0.000	0.000
F	186.900				269.197	6.573	25.469	12.058

Note: All regressions use Ln (Duty) as instrumental variable for imported inputs variables. Column (1), (5), (6), (7) and (8) present linear panel IV regression results with firm and year fixed effects included. Column (2), (3) and (4) use Panel Negative Binomial regressions in the first stage and linear panel regressions with fixed effects in the second stage. SOE are state-owned enterprises. Private firms are non-SOE domestic firms. HMT are foreign firms from Hong Kong, Macau and Taiwan and non-HMT Foreign are foreign firms from other foreign countries. Standard errors in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01.

TABLE 10: R&D Intensity and the Impact of Imported Inputs - Instrumental Variables Estimation

Dep Variable	Ln (export value)					
R&D Measure	R&D Expenses as a share of industry sales (*R&D*)			Median of new product share in firms' output (*Newprod*)		
	Low *R&D*	Low *R&D no* Textile	High *R&D*	Low *Newprod*	Low *Newprod* no Textile	High *Newprod*
	(1)	(2)	(3)	(4)	(5)	(6)
Ln (import value)	-3.770	-0.845	1.122***	-10.042	-1.814	0.834***
	(5.096)	(0.787)	(0.288)	(24.387)	(2.123)	(0.280)
Constant	5.186	2.536***	0.211	10.445	3.316*	0.649
	(4.285)	(0.678)	(0.434)	(20.491)	(1.835)	(0.424)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
N	576474	460507	407740	583390	461384	400824
Groups	183565	148815	130016	184661	148072	127132
Chi-squared	80310.193	3.93e+05	3.75e+05	12899.612	1.68e+05	4.62e+05
R-2 Between	0.199	0.205	0.298	0.201	0.212	0.296
R-2 Overall	0.165	0.173	0.269	0.168	0.181	0.265

Note: All regressions are estimated using linear panel IV regressions and all use Ln (Duty) as instrumental variable for log imported inputs. Column (1) reports the IV results for industries with low R&D intensity, where R&D intensity is measured by the share of industrial R&D expenses over industrial sales (*R&D*) and high/low R&D intensity is defined based on whether the industry's R&D intensity is above the median R&D intensity among 4-digit CIC industries. Column (2) repeat column 1 but exclude Textile and Clothing sectors (CIC 2-digit code "17" and "18"). Column (3) reports the IV results for industries with high R&D intensity. Columns (4) to (6) repeat columns (1) to (3) but use the median level of firms' new product shares in their outputs for firms within each industry defined by 4-digit CIC code (*Newprod*) to measure R&D intensity. Standard errors in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01.

TABLE 11: Imported Inputs and Firm Exports, IV on Changes Estimation

Dep Variable	ΔLn (export value)							
	Full Sample	Private	Non-HMT Foreign	HMT Foreign	Full Sample	Private	Non-HMT Foreign	HMT Foreign
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔLn (import value)	1.948	2.883	1.195	1.930				
	(1.428)	(3.395)	(2.085)	(2.351)				
Δ(Import_prod_cty)					0.490	0.513***	0.083	0.150
					(0.312)	(0.070)	(0.101)	(0.132)
Ln(emp) in 2002	-0.053	-0.156	-0.041	-0.163	-0.116*	-0.112***	-0.030	-0.059
	(0.047)	(0.208)	(0.066)	(0.266)	(0.070)	(0.030)	(0.049)	(0.092)
Per worker Sale in 2002	0.042	-0.138	0.007	0.158				
	(0.036)	(0.224)	(0.071)	(0.170)				
Constant	0.080	1.624	-0.274	-0.818	-0.017	0.784***	-0.294	0.001
	(0.283)	(2.065)	(0.650)	(1.009)	(0.349)	(0.177)	(0.327)	(0.532)
Firm Ownership FE	Yes				Yes			
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	76930	50794	10454	10089	77099	50869	10477	10094
Chi-squared	366.678	154.990	136.713	33.835	298.844	347.392	215.343	103.495

Note: All regressions are IV regressions. First four columns use changes in Ln (Duty) from year 2002 to year 2006 as instrumental variables. Instruments in columns (5) to (8) are Δln(Duty), Lag import status and the interaction between Lag importer status and Δln(Duty). Private firms are non-SOE domestic firms. HMT are foreign firms from Hong Kong, Macau and Taiwan and non-HMT Foreign are foreign firms from other foreign countries. State-owned enterprises are suppressed due to relatively less observation and highly insignificant estimates. Standard errors in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01.

TABLE 12: Imported Inputs and Firm Exports: Controls for Export Demand and Import Competition

Dep Variable	Ln (export value)					
	Firms with export share < 4.4%			Firms with export share < 0.6%		
	Full Sample	Private	Foreign	Full Sample	Private	Foreign
	(1)	(2)	(3)	(4)	(5)	(6)
Ln (import value)	1.769**	3.469	1.071*	1.116**	1.499	0.614
	(0.688)	(4.388)	(0.564)	(0.448)	(1.480)	(0.393)
Export demand	0.073***	0.031	0.144***	0.101***	0.067***	0.224***
	(0.014)	(0.058)	(0.027)	(0.010)	(0.022)	(0.024)
Import competition	0.042	0.117	0.091	-0.001	0.010	0.075
	(0.042)	(0.207)	(0.058)	(0.032)	(0.075)	(0.056)
Constant	-1.484***	-0.928*	-1.615	-1.508***	-1.006***	-2.181*
	(0.545)	(0.534)	(1.819)	(0.291)	(0.131)	(1.146)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
N	1054754	741270	218543	1017179	726243	197160
Groups	312632	230969	63958	307691	228871	60826
Chi-squared	4.94e+05	63379.033	6.19e+05	5.62e+05	1.53e+05	5.99e+05
R-2 Between	0.234	0.182	0.114	0.202	0.141	0.108
R-2 Overall	0.196	0.145	0.092	0.162	0.108	0.087

Note: All regressions are IV regressions, using Ln (Duty) as instrumental variable for Ln (import value). *Export demand* is the log value of industry level export value and *Import competition* is the log value of China's importing tariff charged on products that are exported by each industry. *Import competition* is constructed in a similar way as Ln (Duty). The only difference is that Ln (Duty) uses industry imports in 2006 as weights for each product while *Import competition* uses industry exports in 2006 as weights. Columns (1) to (3) exclude firms with more than 4.4% of industry export share, eliminates top 5% of exporting firms as measured by market share. Columns (4) to (6) impose more stringent restrictions, excluding firms with more than 0.6% of export share so that the top 25% of exporting firms are dropped. Private firms are non-SOE domestic firms. Foreign firms are foreign owned firms including both foreign firms from Hong Kong, Macau and Taiwan and foreign firms from other foreign countries. Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE 13: Imported Inputs and Firm Exports: IV with Real Exchange Rates

Dep Variable	Ln (export value)					
Instrumental Variable	Ln(RERimp)	Ln(RERimp) & Ln(Duty)	Ln(RERimp)			
Sample	Full Sample	Full Sample	Trader	Survivor	Private	Foreign
	(1)	(2)	(3)	(4)	(5)	(6)
Ln (import value)	3.303***	2.612***	3.064***	2.562***	4.758**	2.742**
	(0.812)	(0.586)	(0.986)	(0.712)	(1.885)	(1.083)
Ln(REREXP)	0.297	0.396*	1.440*	0.556*	0.054	0.939
	(0.258)	(0.204)	(0.871)	(0.312)	(0.440)	(0.646)
Constant	-2.048**	-1.394**	-6.964*	-2.095*	-0.493	-6.069
	(0.813)	(0.595)	(3.863)	(1.083)	(0.379)	(4.282)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	984163	984163	262867	385629	699709	220536
Groups	290932	290932	69087	77430	216814	63570
Chi-squared	1.91e+05	2.91e+05	2.29e+05	1.64e+05	37464.651	1.69e+05
R-2 Between	0.240	0.240	0.004	0.270	0.197	0.115
R-2 Overall	0.207	0.207	0.001	0.220	0.162	0.096
First Stage Results						
1st Stage Dep. Var.	Ln (import value)					
Ln(RERimp)	-0.279***	-0.250***	-0.750***	-0.401***	-0.160**	-0.560***
	(0.068)	(0.069)	(0.237)	(0.108)	(0.064)	(0.215)
Ln(REREXP)	0.123*	0.134*	0.311	0.153	0.159**	-0.069
	(0.069)	(0.069)	(0.253)	(0.108)	(0.064)	(0.230)
Ln (Duty)		-0.029**				
		(0.014)				
Constant	1.301***	1.317***	4.769***	1.961***	0.280**	4.609***
	(0.117)	(0.117)	(0.422)	(0.184)	(0.109)	(0.384)
R-2 Within	0.002	0.002	0.005	0.003	0.003	0.002
R-2 Between	0.000	0.000	0.005	0.000	0.001	0.002
R-2 Overall	0.000	0.000	0.000	0.000	0.000	0.001
F	185.623	159.742	165.627	158.037	237.037	40.036

Note: All regressions are IV regressions. Column (1) is for the full sample using Ln (RERimp) as instrumental variable for imported inputs. Column (2) includes Ln(Duty) together with Ln (RERimp) as instrumental variables. Columns (3) to (6) are IV regressions for subgroup of firms using Ln (RERimp) as instrumental variable. "Trader" firms are defined as firms that had at least one import or export transaction during the sample period. "Survivor" firms are firms that were active in all years between 2002 and 2006. Private firms are non-SOE domestic firms. Foreign firms include both foreign firms from Hong Kong, Macau and Taiwan (HMT) and non-HMT Foreign frims. Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

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Data Appendix

Firm Level Variables

China's National Bureau of Statistics (NBS) conducts an annual survey of manufacturing enterprises. When aggregated to the industry level, these data are the basis of the industrial statistics reported in China's Statistical Yearbook. Two types of firms are included in the survey: (1) all SOEs, and (2) non-SOEs with annual sales at or above five million *Renminbi*. From this data set, we attain information on individual firm operations and financial statistics, such as firm employment and firm sales. This data set also provides information on the ownership structure of the firms that allows us to assign firms to one of the following four designations: (1) State Owned Enterprise, or SOE, (2) Private, (3) Hong Kong, Macau and Taiwan, or HMT, and (4) other non- HMT foreign. Due to noise or misreporting in the data, the data are cleaned following the procedures of Feenstra, Li and Yu (2011).

The NBS data set for 2002 to 2006 was matched to firm-level data on imports and exports, which is constructed from the transaction level Chinese Customs data (hereafter Customs data set). Since the two datasets use different firm identification numbers, the first round of matching is based on the firm names provided in the two data sets. However, to verify firm identity, and to maximize the number of successful matches while excluding spurious matches, the matching process is extended to a number of firm identifiers including zip-code, phone number, street address and manager's name.

There are two ways to evaluate the success of the matching procedure. We first compare the matched vs. non-matched firms in the Customs data set. On the export side, we matched 52% of total number of observations but 80% of total export values. On the import side, we matched 64% of total number of observations and 66% of total import values. Although these numbers, especially the matched import value, might seem low, there are reasons that these numbers could *underestimate* the true successfulness of the matching. One possible reason is that although we exclude the intermediaries and wholesalers in the Customs data set according to their names when we perform the matching, there might be leftover intermediaries and wholesalers in the Customs data set while the NBS data set only covers manufacturing firms.[33]

The second but more accurate way to evaluate the matching process is to compare the matched vs. non-matched firms in the NBS data set. The NBS data set also reports each firm's total export value. For all firms that report positive export value in the data, we matched 77% of the total number of firms and 86% of the total export value of these firms. These numbers are significantly higher than those from the Customs data. Unfortunately, the NBS data set does not report the import value so we cannot evaluate the success of the match on import side from this dataset. However, it is reasonable to believe that it should also be higher than those evaluation numbers from the Customs data set. Either way, the matched sample coverage of trade value is comparable to, if not better than, the 75% value match reported in Bernard, Jensen and Schott (2010) for US firms.

[33] Following Ahn, Khandelwal and Wei (2011), we identify the set of intermediary firms based on Chinese characters that have the English-equivalent meaning of "importer", "exporter", and/or "trading" in the firms' name.

After firm-identifiers for the NBS and Customs data sets were matched, we merged the trade data to the information on firm characteristics and operations. The original Customs data record all firm-level trade transactions according to the Chinese 8-digit HS code and import country of origin, or export country of destination. Observations that list China as the export destination or China as the source country for imports were excluded. Finally, since processing trade imports are not subject to tariffs and may have different economic determinants than ordinary trade, our core data set is based on the subset of firms that were not engaged in processing trade.

For each of the years in our sample, we constructed our firm-level trade measures by summing over the relevant firm import or export transactions. On the export side, our measures of firm export performance include *Export Value*, the total value of firm exports in the year, and *Export Prod-Cty*, which is a count variable representing the number of unique HS-8 digit product, export country destination pairs present in the firm's export activity. Before we generated our firm-level import measures, we identified imported intermediate inputs, following Arkolakis, Demidova, Klenow and Rodriguez Clare's (2008) work, that defines intermediate input imports as any imports of products belonging to the UN BEC groups, 41, 521, 111, 121, 21, 22, 31, 322, 42 and 53. As with the export data, we formed our annual firm-level measures of imported intermediate input value, *Import Value*, as the sum of all intermediate input import transaction value of the firm. *Import Prod-Cty*, which is a count variable representing the number of unique HS-8 digit product, country source pairs present in the firm's intermediate input imports. Similarly, *Import_prod* is the count of unique HS-8 digit product intermediate input imports by the firm, while *Import_cty* is the count of unique country sources in the firm's intermediate input import activity.

To characterize tariffs faced by Chinese firms, we used Equation (5) to generate tariff measures for each 4-digit Chinese CIC industry. These tariff measures attached the tariff measures to firms, according to the firm's 4-digit industry code. The tariff data are from WTO.[34] Similarly, in order to construct firm import real exchange rates and export real exchange rates, we generated the real exchange rate measures for each 4-digit Chinese CIC industry according to Equation (7), and then attached the real exchange rate measures to firms according to their industry codes. The bilateral real exchange rate data were taken from the Penn World Table.

Industry Level Variables

To study how the benefits of imported intermediate inputs are related to industry characteristics, we used the NBS data set to construct industry level variables following Kroszner, Laeven and Klingebiel (2007). These industry variables include industry measures of external finance dependence, R&D intensity, new product intensity, imported input intensity and capital intensity. The industry medians for these variables at the 2-digit CIC level are reported in Table 1.

External finance dependence is defined as the fraction of capital expenditures not financed by cash flows from operations. Since the NBS data set does not include direct measures of capital expenditures, we construct a measure of capital expenditure which is defined as the sum of the

[34] See http://tariffdata.wto.org/ReportersAndProducts.aspx.

firm's increase in its long term investment, fixed assets and intangible assets as well as the firm's current year capital depreciation.[35] Cash flow from operations is defined as in Rajan and Zingales (1998, p564): the sum of cash flow, plus inventory reductions, and reductions in receivables.[36] The median level of external finance dependence in each 4-digit CIC industry averaged over the years 2004-2006 is used as the external financing dependence measure for each industry.

Our measure of R&D intensity (*R&D*) is the share of industrial R&D expenses over industrial sales by 4-digit CIC industry for the period 2005-2006.[37] We also create an alternative measure of industry R&D intensity which is defined as the median level of new product share in the total output (*Newprod*) for firms within each 4-digit CIC industry. Similarly, the Capital-to-labor ratio (*K intensity*) is the median level of the ratio of fixed assets over number of employees by 4-digit CIC industry for the period 2002-2006.

Finally, we define imported input intensity as the imported inputs as a ratio to the total exports for each 4-digit CIC industry over the period 2002-2006. We also created an alternative measure, which defines imported input intensity as the ratio of imported inputs to total output for each 4-digit CIC industry. However, our results were similar, regardless of measure chosen.

[35] In contrast with the Compustat dataset of US firms, which records capital expenditures directly (Compustat variable #128), the NBS does not have a direct measure. Capital expenditure are incurred when businesses spend money to buy *fixed assets* or intangible assets, or to add to the value of any existing fixed asset with a useful life extending beyond the taxable year.

[36] Since the NBS data set does not include a measure of payables, we are not able to include payables in our construction of cash flows from operations.

[37] In contrast with Kroszner, Laeven and Klingebiel (2007) we are not able to measure R&D intensity as the median level of R&D expenses over sales in each 4-digit CIC industry. This is because many firms engage in no R&D and consequently the median levels of R&D many Chinese CIC industries is zero. Moreover, R&D expenses are reported in the data set only in year 2005-2006.