Tariffs, Vertical Oligopoly and Market Structure: Empirical Investigation*

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Abstract

We study the impact of tariffs on the margins of intermediate-input trade and examine their impact on optimal tariffs for intermediate inputs. Using China Customs disaggregate product-level data from 2000 to 2008, we find that (i) China's WTO accession and the resulting input import tariff reductions increase China's input imports through both the extensive and intensive margins; (ii) after China's WTO accession, China's input import tariffs are higher, the more concentrated and hence the less competitive China's input markets (at the product level). We confirm that these findings are robust in alternative specifications. The estimation results are consistent with the theoretical prediction of the endogenous market structure by Ara and Ghosh (2017).

Keywords: Tariffs, Intermediate-input Trade, Extensive Margin, Intensive Margin
JEL Classification Numbers: F12, F13

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1 Introduction

Intermediate inputs are a large and growing share of international trade. As shown by Johnson and Noguera (2012), intermediate inputs account for approximately two thirds of international trade.[1] It is often argued that the rapid growth in intermediate inputs has triggered by "vertical specialization" or "offshoring" which allows each country to specialize only in a particular stage of final-good production sequences fragmenting production processes across the globe (Yi, 2003, 2010). These pieces of evidence suggest that distinguishing intermediate-input trade from final-good trade is crucial for understanding current world trade flows.

Despite the importance of intermediate-input trade, the existing literature of trade policy has not explicitly considered intermediate inputs. For empirical assessments of the optimal tariff, the literature exclusively exploits the theoretical formula that the optimal tariff is the inverse of a foreign export supply elasticity ϵ^s (Broda et al., 2008; Soderbery, 2018):

$$\widehat{t} = \frac{1}{\epsilon^s}.$$

Should tariffs on intermediates be lower? Does the optimal tariff just depend on an export supply elasticity? There is a widely shared intuition that tariffs should be lower (or zero) on imported inputs, as is clear from criticism of Trump tariffs on steel, aluminum, and other input imports. Recent theory with numbers corroborates this showing that intermediate inputs quantitatively matter for welfare; for example, Costinot and Rodríguez-Clare (2014) show that a 40% worldwide tariff results in a 1.1%–7.0% welfare loss, which is more significant with intermediate inputs.

In this paper, we empirically investigate the optimal tariff for intermediate inputs. We build on the theory by Ara and Ghosh (2017) who show that the extensive margin ("market thickness") plays a crucial role in characterizing the optimal tariff (a market is thicker if it accommodates a greater number of firms and more competitive). In particular, the optimal tariff is given by

$$\widehat{t} = f(m, n),$$

where m is the number of Home importing firms and n is the number of Foreign exporting firms, which are either exogenous or endogenous. If m and n are invariant to tariffs in the exogenous market structure, they find that $\widehat{t}$ is higher, the more (less) competitive the Home import (Foreign export) market. In contrast, if m and n are variant to tariffs in the endogenous market structure, they find that $\widehat{t}$ is higher, the less competitive the Home import market and the Foreign export market. Critically, the difference in the role of the extensive margin leads to the difference in the characterization in the optimal tariff. We therefore need to first examine the impact of tariffs on the margins of intermediate-input trade and then examine their impact on the optimal tariff for intermediate inputs.

[1] Decomposing Japan's imports from China into production use and consumption, Ito (2018) shows that the increase in imports for production use is more prominent than for consumption.

To test which market structure is more likely in practice, we focus on China's input imports. For being consistent with theory, we treat China as an importing country (Home) and "the rest of the world (ROW)" as an exporting country (Foreign), and examine the following two hypotheses. The first hypothesis is concerned with the impact of input tariffs on the margins of intermediate-input trade: reductions in China's input import tariffs increase only the intensive margin (both the extensive and intensive margins) for China's input imports in the exogenous (endogenous) market structure. The second hypothesis is concerned with the impact of the margins of input trade on the optimal tariff: China's input import tariffs are higher, the more (less) competitive China's input markets in the exogenous (endogenous) market structure.

Using disaggregate product-level data from 2000 to 2008 collected by China Customs, we find empirical support for the prediction of the endogenous market structure. For the first hypothesis, we find that reductions in China's input tariffs increase both margins for China's input imports, and the effect is stronger particularly after China's accession into the WTO. However, tariffs have a statistically smaller impact on the extensive margin than the intensive margin. For the second hypothesis, on the other hand, we find that after China's WTO accession, China's input import tariffs are higher, the more concentrated and the less competitive China's input markets (at the product level), where "competitiveness" is measured by the Herfindahl-Hirschman index or the share of state-owned-enterprises. We also confirm that these findings are robust in alternative specifications. These include China's input exports in which the ROW (China) is treat as Home (Foreign) and the ROW imposes input import tariffs on China's input exports. We find a similar pattern between China's input exports and China's input imports, thereby giving more support to the prediction in the endogenous market structure.

Our paper is closely related to the recent literature that tries to identify the impact of tariffs on the extensive and intensive margins (e.g., Debaere and Mostashari, 2010; Buono and Lalanne, 2012). These papers find that, though tariff reductions have a statistically significant impact on the extensive margin, the impact on the extensive margin is relatively smaller than that on the intensive margin.[2] Our finding is different from theirs, because we focus on intermediate-input trade, and more importantly, because we address whether the margins of input trade play a key role in characterizing the optimal tariff. Regarding the impact of the margins of trade on tariff setting, to the best of our knowledge, there exists no empirical work that explores this channel. The closest work is Broda et al. (2008) who find that U.S. import tariffs are significantly higher for products where the U.S. faces higher foreign export supply elasticities.[3] Their focus, however, is on the impact of export supply elasticities, not margins of trade.

The rest of the paper is organized as follows. Section 2 discusses the data source and Section 3 presents the regression specifications. Sections 4, 5, and 6 respectively report the estimation results for China's input imports, China's input exports, and other trade. Section 7 concludes.

[2]Feng et al. (2017) find that reductions in trade policy uncertainty allow Chinese firms to enter the export markets, which contributes to China's export growth after China's WTO accession.

[3]See Soderbery (2018) for the extension of their estimation method to allow for different elasticities of supply for various source countries.

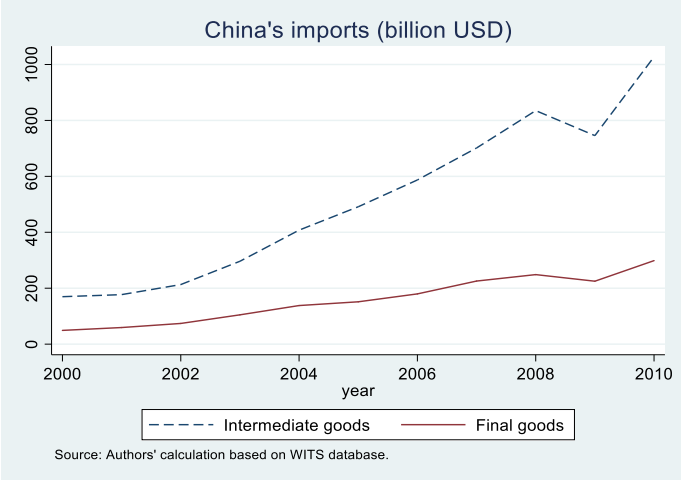

FIGURE 1 – China's imports from the ROW for 2000-2010

2 Data

2.1 China's imports

Our dataset is the census of annual firm-level export and import transactions in China for the period from 2000 to 2009, collected by China Customs. In the main analysis, we will use the data only for 2000-2008 to eliminate the global financial crisis but the result is qualitatively similar. The dataset contains trade value, quantity, and destination at 8-digit Harmonized System (HS) product classification. We use the publicly available concordance tables for 1997, 2002 and 2007 HS codes to make the product code consistent over time. The original dataset from firm-product-level is aggregated into the 6-digit HS product level to obtain the total number of importers from the ROW (extensive margin) and their average import value (intensive margin) in thousand U.S. dollar. Our China Customs dataset covers a total of over 5,000 products at the 6-digit level from manufacturing industries.

We divide our dataset into final goods and intermediate inputs by applying United Nations' classification of Broad Economic Categories. We mainly restrict ourselves to ordinary imports.[4] Figure 1 presents China's imports from the ROW for 2000-2010 within the above restriction. It is evident from the figure that intermediate-input imports are a large and growing share than final-good imports in China, which is consistent with the empirical regularity demonstrated by Johnson and Noguera (2012). Further, the rapid growth is fostered by China's WTO accession in December 2001 that leads to reductions in China's import tariffs. This impacts on intermediate-input imports more prominently than final-good imports.[5]

[4] As stressed by Dai et al. (2016), distinguishing between processing and ordinary trade is crucial for China's trade. It is interesting to explore this difference and we also make the empirical estimations for processing imports. See Tables A.3 and A.4 in the Appendix.

[5] For a cross-industry distribution between the two types of trade, see Table A.7 in the Appendix.

TABLE 1 – Descriptive statistics on China's import growth rates for 2000-2008

Margin	No. of obs.	Mean	S.D.	25th	Median	75th
Total	23,705	14.8%	94.9%	–13.2%	13.6%	41.1%
Extensive	23,705	4.6%	32.0%	–7.4%	5.3%	19.3%
Intensive	23,705	10.2%	86.4%	–17.1%	7.8%	34.0%

(a) Intermediate-input imports

Margin	No. of obs.	Mean	S.D.	25th	Median	75th
Total	14,254	23.2%	116.9%	–19.5%	20.9%	64.7%
Extensive	14,254	12.7%	42.8%	–6.9%	10.5%	31.8%
Intensive	14,254	10.5%	105.1%	–28.5%	9.6%	47.2%

(b) Final-good imports

TABLE 2 – Descriptive statistics on China's import tariffs in 2005

Types of imports	No. of obs.	Mean	S.D.	25th	Median	75th
Intermediate inputs	3,116	8.00	5.31	5	6.5	10
Final goods	1,903	12.34	7.53	8	12	15.85

Table 1 presents some descriptive statics on the import growth rates between 2000 and 2008, decomposing China's total imports into the extensive margin and the intensive margin. As before we report these statistics for intermediate-input imports and final-good imports. Note that the growth rates are higher for final-good imports than intermediate-input imports; and the growth rates of the intensive margin is greater (smaller) than the extensive margin for intermediate-input imports (final-good imports). Comparing these with those in the existing literature, Buono and Lalanne (2012) show that the extensive (intensive) margin accounts for 22% (33%) of the growth rates of total exports for France between 1994 and 2001 without distinguish final goods and intermediate inputs.[6]

2.2 China's import tariffs

The dataset of China's import tariffs is obtained from the Trade Analysis Information System (TRAINS) database in the World Integrated Trade Solution (WITS) website. For each product at the 6-digit HS level, the tariff dataset provides detailed information on tariff lines, average, minimum and maximum ad-valorem tariff duties.

[6]Focusing on the impact of reductions in trade policy uncertainty, Feng et al. (2017) show that the contribution of new entrants (i.e., extensive margin) is important for China's export growth between 2000 and 2006, though they do not pay attention to the intensive margin.

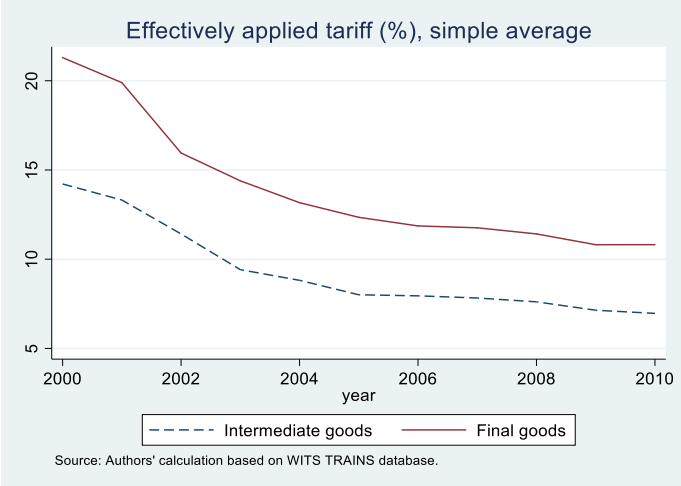

FIGURE 2– China's import tariffs on the ROW for 2000-2010

Following the literature (e.g., Buono and Lalanne, 2012), we measure tariff reductions faced by the ROW using *effectively ad-valorem applied tariffs* at the product-country-time level from the TRAINS database. In addition, since Foreign is treated as the ROW, we use China's simple average of ad-valorem applied tariffs on world exports. This means that world exports include not only exports from WTO members but also exports from non-WTO members (such as Vietnam that became a WTO member in January 2007). Our tariff measure takes both types of countries into account, which is crucial for estimating the optimal tariff.[7]

Table 2 reports the descriptive statistics on China's import tariffs on world exports in 2005 for final goods and intermediate inputs. We find that the average import tariffs on intermediate inputs are lower than those on final goods; and the variations on intermediate inputs are also lower than those on final goods. To show that these patterns are not specific to a particular year, Figure 2 illustrates changes in the simple average of China's effectively applied tariffs on world exports between 2000 and 2010 during which China's import tariffs on final goods (intermediate inputs) decreased from 21.3% (14.2%) in 2000 to 10.8% (6.0%) in 2010. These tariff reductions are sharper particularly after China's WTO accession in 2001.

We recognize that the Chinese government does not optimally choose the import tariffs as the theory predicts. As argued by Broda et al. (2008), however, the insight that the optimal tariff is increasing in market power does not require governments to maximize welfare. It is also hard to believe that the Chinese government sets randomly the tariff rates without taking account of trading environments to which Chinese firms belong. Given considerable tariff variations across imported products, our purpose here is to capture these variations by the market thickness that crucially affects market power.

[7]For example, Brora et al. (2008) focus mainly on non-WTO members because WTO members are constrained to charge MFN tariffs to other WTO members.

TABLE 3 – Descriptive statistics on China's HHI and SOE share in 2005

	No. of obs.	Mean	S.D.	25th	Median	75th
HHI in ordinary imports	3,031	0.260	0.264	0.072	0.162	0.339
HHI in whole imports	3,031	0.225	0.241	0.06	0.132	0.292
SOE share in ordinary imports	3,031	0.186	0.249	0.010	0.081	0.252
SOE share in whole imports	3,031	0.164	0.216	0.026	0.08	0.202

TABLE 4 – Correlations between the key variables in 2005

	HHI in ordinary	HHI in whole	SOE in ordinary	SOE in whole
HHI in ordinary	1			
HHI in whole	0.7590^{***}	1		
SOE in ordinary	0.0748^{***}	0.1259^{***}	1	
SOE in whole	0.0849^{***}	0.1471^{***}	0.7970^{***}	1

Note: $^{*}p < 0.10,\ ^{**}p < 0.05,\ ^{***}p < 0.01$

2.3 China's market thickness

The dataset of "market thickness" is hard to obtain and there is no established measure for it. It is natural, however, to assume that a thicker market accommodates a larger number of firms and hence it is more competitive. From this reason, we employ the Herfindahl-Hirschman index (HHI) at the 6-digit HS product level. To complement this, we also use the share of state-owned-enterprises (SOEs) at the 6-digit HS product level.[8] Both of the variables are calculated for the case of ordinary imports and whole imports (i.e., ordinary imports plus processing imports) from the China Customs data.

Table 3 reports the descriptive statistics on China's HHI and SOE shares in 2005. We find that the HHI is on average higher than the SOE shares (in terms of values and numbers) with greater variations; and the higher the HHI, the higher the SOE shares across products. Table 4 reports simple correlations between the key variables. As expected, the correlation between the HHI and the SOE shares is significantly positive at the 1% level.

3 Specifications

3.1 Specifications for the extensive and intensive margins

We first consider the response of the extensive and intensive margins to exogenous tariff changes which is different between the exogenous and endogenous market structures. More specifically, reductions in China's input import tariffs increase China's input imports by an increase in only

[8] In China, it is known that SOEs are less productive than non-SOEs (Feng et al., 2017); and the higher the share of SOEs, the harder for new non-SOEs to enter (Freund and Sidhu, 2017; Yao et al., 2018).

the intensive margin (both the intensive and extensive margins) in the exogenous (endogenous) market structure. To test this hypothesis, let Q_{jt}, m_{jt} and q_{jt} denote China's input imports, the number of Chinese importers, and China's average imports in product j and year t respectively, which satisfy $Q_{jt} = m_{jt} * q_{jt}$. Then, we conduct the following regressions:

$$\ln Q_{jt} = \alpha_0 + \alpha_1 \ln(1+\tau_{jt}) + \alpha_2 WTO_j + \alpha_3 (1+\tau_{jt}) * WTO_j + \theta_j + \theta_t + \epsilon_{jt}, \tag{1}$$

$$\ln m_{jt} = \beta_0 + \beta_1 \ln(1+\tau_{jt}) + \beta_2 WTO_j + \beta_3 (1+\tau_{jt}) * WTO_j + \theta_j + \theta_t + \epsilon_{jt}, \tag{2}$$

$$\ln q_{jt} = \gamma_0 + \gamma_1 \ln(1+\tau_{jt}) + \gamma_2 WTO_j + \gamma_3 (1+\tau_{jt}) * WTO_j + \theta_j + \theta_t + \epsilon_{jt}, \tag{3}$$

where τ_{jt} is the simple average of China's effectively applied tariffs, WTO_j is a dummy variable which is one after year 2002, θ_j is the product fixed effects, θ_t is the year fixed effects, and ϵ_{jt} is an error term. We employ the fixed effects model and include the two fixed effects to control for any product-specific and macroeconomic shocks. Further, the WTO dummy is included in (1)-(3) to examine whether China's WTO accession caused a structural change in China's imports.[9]

Our interests lie in the coefficients on $\ln(1+\tau_{jt})$. We hypothesize that $\alpha_1, \alpha_3 < 0$, $\beta_1 = \beta_3 = 0$, and $\gamma_1, \gamma_3 < 0$ in the exogenous market structure (see Lemma 3.1 in Ara and Ghosh (2017)). In contrast, we hypothesize that $\alpha_1, \alpha_3 < 0$, $\beta_1, \beta_3 < 0$, and $\gamma_1, \gamma_3 \gtreqless 0$ in the endogenous market structure (see Lemma 4.2 in their paper).

To explore this possibility alternatively, we divide the full sample into "before WTO" (2000-2001) and "after WTO" (2002-2008), and regress (1)-(3) without the WTO dummy for each subsample. This allows us to investigate whether China's WTO accession caused a structural change more clearly. We hypothesize that only for the "after WTO" periods, α_1, β_1 and γ_1 are the same signs with those of the full sample with the WTO dummy, while leaving them insignificant for the "before WTO" periods.

3.2 Specifications for the impact of market thickness

We next consider the impact of market thickness on the optimal tariff, which is different between the exogenous and endogenous market structures. More specifically, China's input import tariffs are higher, the more (less) competitive China's input markets in the exogenous (endogenous) market structure. As noted in Section 2.3, we employ the HHI and the SOE shares to measure competitiveness at each product. Let HHI_{jt} and SOE_{jt} ($\widetilde{HHI}_{jt}$ and $\widetilde{SOE}_{jt}$) denote China's HHI and SOE share in terms of ordinary (whole) imports in product j and year t respectively. Then,

$$\ln(1+\tau_{jt}) = \delta_0 + \delta_1 HHI_{jt} + \delta_2 WTO_j + \delta_3 HHI_{jt} * WTO_j + \theta_j + \theta_t + \epsilon_{jt}, \tag{4}$$

$$\ln(1+\tau_{jt}) = \eta_0 + \eta_1 SOE_{jt} + \eta_2 WTO_j + \eta_3 SOE_{jt} * WTO_j + \theta_j + \theta_t + \epsilon_{jt}, \tag{5}$$

$$\ln(1+\tau_{jt}) = \xi_0 + \xi_1 \widetilde{HHI}_{jt} + \xi_2 WTO_j + \xi_3 \widetilde{HHI}_{jt} * WTO_j + \theta_j + \theta_t + \epsilon_{jt}, \tag{6}$$

$$\ln(1+\tau_{jt}) = \zeta_0 + \zeta_1 \widetilde{SOE}_{jt} + \zeta_2 WTO_j + \zeta_3 \widetilde{SOE}_{jt} * WTO_j + \theta_j + \theta_t + \epsilon_{jt}. \tag{7}$$

[9] We also examine a simple Chow test in the time series of China's imports; see Appendix B.

TABLE 5 – Extensive and intensive margins in China's ordinary input imports

	I $\ln Q_{jt}$	II $\ln m_{jt}$	III $\ln q_{jt}$	IV $\ln Q_{jt}$	V $\ln m_{jt}$	VI $\ln q_{jt}$
$\ln(1+\tau_{jt})$	–0.494***	–0.261***	–0.233***	–0.064	–0.096***	0.032
	(0.074)	(0.032)	(0.055)	(0.069)	(0.030)	(0.053)
WTO_j	1.472***	0.642***	0.830***	1.962***	0.801***	1.162***
	(0.144)	(0.058)	(0.112)	(0.144)	(0.058)	(0.113)
$\ln(1+\tau_{jt}) * WTO_j$	–0.232***	–0.034	–0.197***	–0.137***	0.001	–0.138***
	(0.056)	(0.023)	(0.044)	(0.055)	(0.023)	(0.043)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	Yes	Yes	Yes
No. of observations	26,662	26,662	26,662	26,662	26,662	26,662
R^2	0.865	0.944	0.799	0.880	0.951	0.812

(a) Full sample

	Before WTO			After WTO		
	I	II	III	IV	V	VI
$\ln(1+\tau_{jt})$	–0.643	–0.062	–0.581	–0.195***	–0.045*	–0.150***
	(0.416)	(0.157)	(0.355)	(0.066)	(0.026)	(0.055)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	5,739	5,739	5,739	20,923	20,923	20,923
R^2	0.953	0.983	0.921	0.901	0.963	0.841

(b) Before/after WTO

Note: Standard errors in brackets ($^*p < 0.10,\ ^{**}p < 0.05,\ ^{***}p < 0.01$)

We hypothesize that $\delta_1, \delta_3 < 0, \eta_1, \eta_3 < 0$, $\xi_1, \xi_3 < 0$ and $\zeta_1, \zeta_3 < 0$ in the exogenous market structure (see Proposition 3.1 in Ara and Ghosh (2017)). In contrast, we hypothesize the opposite signs in the endogenous market structure (see Proposition 4.1 in their paper).

4 Estimation results

4.1 Estimation results of the extensive and intensive margins

Panel (a) of Table 5 presents the impact of tariffs on China's input imports in (1)-(3). Columns I-III do not include the year fixed effects in the regression. The coefficients on $\ln(1+\tau_{jt})$ are all negative at the 1% level, which suggests that reductions in China's input import tariffs increase China's input imports through both the extensive and intensive margins.[10] The coefficients on WTO_j is all positive, which suggests that China's WTO accession and the resulting import tariff reductions increase China's imports through both the extensive and intensive margins.

[10] Following Buono and Lalanne (2012), we do not consider a lag in the regressions, but the results are qualitatively similar if we take one-period lag for China's import tariffs.

Columns IV-VI include the year fixed effects in (1)-(3). The coefficient on $\ln(1+\tau_{jt})$ in column V is significant and negative at the 1% level and the others are not significant, which suggests that only the extensive margin increases by reductions in China's input import tariffs. However, as in columns I-III, the coefficients on $\ln(1+\tau_{jt}) * WTO_j$ in columns IV and VI are negative and significant, while the coefficient in column V is not significant. This suggests that import tariff reductions have a small impact on the extensive margin.

Panel (b) of Table 5 reports the estimation results dividing the full sample into the "before WTO" and "after WTO." In the "before WTO," the coefficients on $\ln(1+\tau_{jt})$ are all negative but not significant, which implies that reductions in China's import tariffs have virtually no effect on China's imports through both of the margins. In contrast, in the "after WTO," the coefficients on $\ln(1+\tau_{jt})$ are all negative and significant, and the results in columns IV-VI mean that reductions in China's input tariffs from 10% to 0% increase China's input imports, extensive margin, and intensive margin by 1.8%, 0.4%, and 1.4% respectively.[11] Note that the coefficient in column V is smaller than that in column VI, which confirms that tariff reductions have a smaller impact on the extensive margin than the intensive margin. While the extensive margin plays a smaller role in China's imports, it is true that input tariff reductions have a statistically significant impact on the margin. Thus we can safely conclude that the result in Table 5 supports the prediction in the endogenous market structure.

The finding in line with the recent literature showing that tariff reductions have a limited impact on entry of new firms and instead they mainly induce incumbent firms to increase their shipments (e.g., Debaere and Mostashari, 2010; Buono and Lalanne, 2012). However, the crucial difference is that we focus only on the impact of import tariffs between the two countries (China and the ROW) with fixed distances. In this sense, our estimation is differernt from that typically employed in the gravity equation. The difference may explain why the estimated coefficients on $\ln(1+\tau_{jt})$ are smaller than those in the literature.

4.2 Estimation results of the impact of market thickness

Table 6 reports the impact of market thickness on input import tariffs in (4)-(6). Column I (II) corresponds to (4) where market thickness is measured by China's HHI without (with) the year fixed effects. The coefficients on HHI_{jt} are negative (though not significant), but the coefficients on $HHI_{jt} * WTO_j$ are positive at the 1% level, which means that after China's WTO accession, China's import tariffs are higher, the more concentrated and the less competitive China's market. Columns III and IV correspond to (5) where market thickness is measured by the SOE share. The coefficients on $SOE_{jt} * WTO_j$ are positive at the 1% level, which means that after China's WTO accession, China's import tariffs are higher, the higher share of SOEs and the less competitive China's market. The results hold not only for ordinary imports but also whole imports. As with Table 5, the result in Table 6 also supports the prediction in the endogenous market structure.

[11] The increase in China's input imports, for example, is calculated as $-\ln(1+0.10) * (-0.195) = 0.018$.

TABLE 6 – Tariffs and market thickness in China's ordinary input imports

$\ln(1+\tau_{jt})$	I	II	III	IV	V	VI	VII	VIII
HHI_{jt}	–0.005	–0.045						
	(0.028)	(0.030)						
$HHI_{jt} * WTO_j$	0.150***	0.114***						
	(0.030)	(0.030)						
SOE_{jt}			–0.041*	–0.067***				
			(0.022)	(0.022)				
$SOE_{jt} * WTO_j$			0.141***	0.071***				
			(0.023)	(0.023)				
$\widetilde{HHI}_{jt}$					–0.215***	–0.244***		
					(0.033)	(0.033)		
$\widetilde{HHI}_{jt} * WTO_j$					0.298***	0.275***		
					(0.036)	(0.036)		
$\widetilde{SOE}_{jt}$							0.019	–0.026
							(0.020)	(0.020)
$\widetilde{SOE}_{jt} * WTO_j$							0.097***	0.028*
							(0.035)	(0.036)
WTO_j	–0.474***	–0.533***	–0.468***	–0.524***	–0.505***	–0.568***	–0.454***	–0.510***
	(0.014)	(0.015)	(0.011)	(0.012)	(0.013)	(0.014)	(0.010)	(0.011)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	No	Yes	No	Yes
No. of observations	26,662	26,662	26,662	26,662	26,662	26,662	26,662	26,662
R^2	0.889	0.899	0.889	0.899	0.890	0.900	0.889	0.899

Note: Standard errors in brackets ($^{*}p < 0.10,\ ^{**}p < 0.05,\ ^{***}p < 0.01$)

In every column, the coefficients on WTO_j are negative and statistically significant at the 1% level, which suggests that China's import tariffs are declined significantly by China's WTO accession. This is consistent with Figure 2 in that tariff reductions are sharper particularly after China's WTO accession in 2001.

5 China's input exports

In the previous section, we have treated China as an importing country (Home) that sets tariffs on world exports, but it is possible to consider the opposite situation in which China is treated an exporting country (Foreign) that faces import tariffs by the ROW. This section turns to examining hypotheses 1 and 2 in the context of China's exports. (Theoretically, we have similar predictions between exporting and importing.) As in the previous section, we continue to restrict the analysis to intermediate inputs.

5.1 Specifications

We first consider the response of the extensive and intensive margins to exogenous tariff changes. Since China is now an exporting country, the first hypothesis is modified as follows: reductions in world import tariffs increases China's exports by the increase in only the intensive margin (both the extensive and intensive margins) in the exogenous (endogenous) market structure. Let X_{jt},

n_{jt} and x_{jt} denote China's input exports, the number of Chinese exporters, and China's average exports in product$j$ and year t respectively, which satisfy $X_{jt} = n_{jt} * x_{jt}$. Then, we conduct the following regressions:

$$\ln X_{jt} = \alpha_0 + \alpha_1 \ln(1+\tau_{jt}^W) + \alpha_2 WTO_j + \alpha_3 (1+\tau_{jt}^W) * WTO_j + \theta_j + \theta_t + \epsilon_{jt}, \tag{8}$$

$$\ln n_{jt} = \beta_0 + \beta_1 \ln(1+\tau_{jt}^W) + \beta_2 WTO_j + \beta_3 (1+\tau_{jt}^W) * WTO_j + \theta_j + \theta_t + \epsilon_{jt}, \tag{9}$$

$$\ln x_{jt} = \gamma_0 + \gamma_1 \ln(1+\tau_{jt}^W) + \gamma_2 WTO_j + \gamma_3 (1+\tau_{jt}^W) * WTO_j + \theta_j + \theta_t + \epsilon_{jt}, \tag{10}$$

where τ_{jt}^W is the simple average of world effectively applied tariffs on China's input exports. We hypothesize the same signs for $\alpha_1, \alpha_3, \beta_1, \beta_3, \gamma_1$ and γ_3 as those in the previous section.

We next investigate the impact of market thickness on the optimal tariff, in which case the second hypothesis is given as follows: world import tariffs are higher, the more (less) competitive China's market in the exogenous (endogenous) market structure. Accordingly, we have

$$\ln(1+\tau_{jt}^W) = \delta_0 + \eta_1 \widetilde{HHI}_{jt}^E + \delta_2 WTO_j + \delta_3 \widetilde{HHI}_{jt}^E * WTO_j + \theta_j + \theta_t + \epsilon_{jt}, \tag{11}$$

$$\ln(1+\tau_{jt}^W) = \eta_0 + \eta_1 \widetilde{SOE}_{jt}^E + \eta_2 WTO_j + \eta_3 \widetilde{SOE}_{jt}^E * WTO_j + \theta_j + \theta_t + \epsilon_{jt}, \tag{12}$$

where $\widetilde{HHI}_{jt}^E$ and $\widetilde{SOE}_{jt}^E$ are the HHI and the SOE share in China's input *exports*. (The variables in (4)-(5) are those in China's input *imports*.) Note that we examine the relationship between Foreign competitiveness and Home tariffs in (11)-(12), which has a similar flavor to some of the existing literature. (As reviewed in the Introduction, the literature has primarily examined the relationship between Foreign export supply elasticities and Home tariffs.) As with (8)-(10), we hypothesize the same signs for $\delta_1, \delta_3, \eta_1, \eta_3, \zeta_1$ and ζ_3 as those in the previous section.[12]

5.2 Estimation results

Table 7 presents the impact of tariffs on China's input exports in (8)-(10). We find that the results in Table 7 are similar with those in Table 5.[13] Nonetheless, we find some important differences. In Panel (a), the coefficient on $\ln(1+\tau_{jt}^W) * WTO_j$ are significantly positive in columns II and V, which suggests that China's WTO accession and the resulting import tariff reductions *decrease* the number of China's exports. This may reflect that tariff reductions induce foreign entry into China, which force less productive firms to stop exporting. In Panel (b), the coefficient in column V is negative but not significant, which suggests that China's WTO accession and the resulting import tariff reductions have a smaller impact on the extensive margin in exports than imports. The result implies that, relative to imports, tariff reductions might not be sufficient to help new firms to export, or a fixed entry cost might be greater for exports.

[12] In contrast to China's imports, the Foreign government sets same tariffs between ordinary inputs and processing inputs for China's exports. From this reason, we only consider the HHI and the SOE share in whole exports.

[13] For example, in Panel (b) of Table 7, the results in columns IV-VI mean that reductions in world tariffs from 10% to 0% increase China's input exports, extensive margin, and intensive margin by 2.0%, 0.3%, and 1.7% respectively.

TABLE 7 – Extensive and intensive margins in China's ordinary input exports

	I $\ln X_{jt}$	II $\ln n_{jt}$	III $\ln x_{jt}$	IV $\ln X_{jt}$	V $\ln n_{jt}$	VI $\ln x_{jt}$
$\ln(1+\tau_{jt}^{W})$	–0.740***	–0.478***	–0.262***	–0.182**	–0.177***	–0.006
	(0.089)	(0.032)	(0.073)	(0.087)	(0.029)	(0.075)
WTO_j	1.635***	0.609***	1.026***	2.104***	0.730***	1.374***
	(0.147)	(0.053)	(0.122)	(0.145)	(0.050)	(0.122)
$\ln(1+\tau_{jt}^{W}) * WTO_j$	–0.238***	0.077***	–0.315***	–0.014	0.195***	–0.209***
	(0.064)	(0.024)	(0.053)	(0.061)	(0.022)	(0.052)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	Yes	Yes	Yes
No. of observations	26,641	26,641	26,641	26,641	26,641	26,641
R^2	0.828	0.918	0.727	0.858	0.944	0.746

(a) Full sample

	Before WTO			After WTO		
	I	II	III	IV	V	VI
$\ln(1+\tau_{jt}^{W})$	0.114	0.063	0.051	–0.229***	–0.038	–0.191**
	(0.207)	(0.056)	(0.191)	(0.086)	(0.028)	(0.075)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	5,777	5,777	5,777	20,864	20,864	20,864
R^2	0.951	0.983	0.903	0.878	0.953	0.783

(b) Before/after WTO

Note: Standard errors in brackets ($^{*}p < 0.10,\ ^{**}p < 0.05,\ ^{***}p < 0.01$)

Next, Table 8 presents the impact of market thickness on import tariffs in (11)-(12). Again, the coefficients in columns I and II are qualitatively similar between exports and imports. The coefficients on $\widetilde{HHI}_{jt}^{E} * WTO_j$ are positive at the 1% level, which suggests that after China's WTO accession, world import tariffs are higher, the more concentrated and hence the less competitive China's market. As with Table 7, however, there are some noticeable differences between exports and imports. The coefficients in columns III-IV tend to be blurred and the results seem to depend on the measure of competitiveness. In particular, the coefficient on $\ln(1+\tau_{jt}^{W}) * WTO_j$ in column IV is not significant (though negative), which might result from the insignificant effect on the extensive margin for the case of exports. As with Table 6, the coefficients on WTO_j are negative and statistically significant at the 1% level and thus world import tariffs on China's exports are declined significantly by China's WTO accession.

Overall, we find that the relationship in China's input imports generally continues to hold in China's input exports. Compared with imports, however, the relationship is relatively weaker in exports through the impact on the extensive margin. We may safely conclude that the results in Table 7 and 8 give more support to the prediction in the endogenous market structure.

TABLE 8 – Tariffs and market thickness in China's ordinary input exports

$\ln(1+\tau_{jt}^{W})$	I	II	III	IV
$\widetilde{HHI}_{jt}^{E}$	0.019	–0.038*		
	(0.022)	(0.022)		
$\widetilde{HHI}_{jt}^{E} * WTO_j$	0.088***	0.048**		
	(0.023)	(0.023)		
$\widetilde{SOE}_{jt}^{E}$			0.025	–0.001
			(0.018)	(0.018)
$\widetilde{SOE}_{jt}^{E} * WTO_j$			0.073***	0.010
			(0.019)	(0.019)
WTO_j	–0.202***	–0.242***	–0.194***	–0.227***
	(0.007)	(0.008)	(0.008)	(0.009)
Product FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes
No. of observations	26,641	26,641	26,641	26,641
R^2	0.847	0.858	0.847	0.858

Note: Standard errors in brackets ($^{*}p < 0.10,\ ^{**}p < 0.05,\ ^{***}p < 0.01$)

6 Discussions

So far we have restricted our attention to intermediate-input trade only. It is natural to address whether the results also hold for total trade (i.e., intermediate inputs plus final goods). Similarly, it is interesting to address whether the estimation results for hypotheses 1 and 2 apply not only for China but also for different countries. In what follows, we will mainly consider imports (the results for exports are similar as shown above) and briefly describe the estimation results for the following three datasets: (i) China's ordinary total imports, (ii) China's processing input imports, and (iii) Japan's input imports. The detailed estimation results are relegated to the Appendix.

6.1 China's ordinary total imports

When regressing (1)-(3) without distinguishing intermediate inputs and final goods, we find that the estimation results are qualitatively similar to those in Table 5 (see Table A.1 in the Appendix for details). The estimated coefficients on $\ln(1+\tau_{jt})$ are relatively bigger in total imports than input imports, however, which would stem from the fact that China's import tariffs are higher for final goods than intermediate inputs (see Figure 2 and Table 2). More interestingly, we find that the estimated coefficient on the extensive margin is much smaller for total imports than input trade only. This means that trade liberalization of final goods reduces the number of firms that export in a liberalizing country.[14]

[14]This is known as "firm delocation" in the literature (see, e.g, Melitz and Ottaviano, 2008). Indeed, we find that the coefficient on the extensive margin is positive and statistically significant if we regress (2) for final-good imports.

When regressing (4)-(7) without distinguishing intermediate inputs and final goods, we find that there are several differences between input imports and total imports (see Table A.2). For example, the coefficients on HHI_{jt} in columns I and II are negative at the 1% level, which are not significant in Figure 6. In contrast, the coefficients on $HHI_{jt} * WTO_j$ in the same columns are still significantly positive at the 1% level, as in Figure 6. The coefficients in the other columns tend to be blurred and the estimated signs in columns V and VIII are overturned (though they are not significant). The results in total imports are thus not so clear relative to those in input imports. The fact that the results fit well with intermediate inputs implies that we might need to distinguish intermediate inputs from final goods to estimate the optimal tariff.

6.2 China's processing input imports

While we have considered ordinary trade, it is interesting to consider China's processing trade because distinguishing between processing and ordinary trade is crucial for China's trade (Dai et al., 2016). To explore this possibility, we also examine (1)-(7) for processing imports (see Tables A.3 and A.4).

The most crucial difference arises for hypothesis 1. We find that after China's WTO accession, tariff reductions *decrease* input imports of processing firms, which operates through *both* of the margins. As shown by Dai et al. (2016), processing firms are systematically different from non-processing firms in China: processing firms are smaller and less productive than non-processing firms and purely domestic firms. Thus competition pressures outweigh benefits from reductions in trade costs for processing firms who are least productive among other kinds of surviving firms. The difference between processing trade and ordinary trade is consistent with the caveat raised by Dai et al. (2016), even though they confine their analysis to firm exporting rather than firm importing.

6.3 Japan's input imports

We also examine (1)-(7) for Japan's input imports using the national survey data, collected by Japan's Ministry of Economy, Trade and Industry.[15] We aggregate the original firm-level data to the 3-digit industry-level data to implement our analysis, and use the data only for 2000-2008 to make it comparable with the baseline estimations (see Tables A.5 and A.6).

The results are similar with those in Tables 5 and 6 for hypotheses 1 and 2, in that (i) import tariff reductions increase Japan's imports through both of the margins (though tariff reductions have a smaller impact on the extensive margin); (ii) Japan's import tariffs are higher, the more concentrated and hence the less competitive Japan's market (at the industry level). However, the significance levels are lower than those in Tables 5 and 6, probably due to the 3-digit industry-level limitation of the dataset.

[15]It covers all firms with at least 50 employees and paid-up capital is at least 30 million Japanese yen in mining, manufacturing and some service industries. We consider only manufacturing industries, leaving about 10,000 firms.

7 Conclusion

This paper studies the impact of tariffs on the margins of intermediate-input trade and examine their impact on optimal tariffs for intermediate inputs. We show that import tariff reductions after China's WTO accession increase China's imports through both the extensive and intensive margins, though tariffs have a relatively smaller impact on the extensive margin. We also find that after China's WTO accession, China's import tariffs are higher, the more concentrated and hence the less competitive China's markets. We confirm that these two findings similarly hold in alternative specifications, including China's input exports. The estimation results are consistent with the theoretical prediction of the endogenous market structure by Ara and Ghosh (2017).

Our findings suggest that tariff reductions has a statistically significant effect on inducing entry of new firms into import markets, but this effect is limited relative to an increase in import shipments of incumbent firms. One of key policy implications from this is that tariff reductions might not be enough to help new firms to start importing, and this holds not only for final goods but also for intermediate inputs. To facilitate competition from trade liberalization, governments may need to implement other policies to reduce entry barriers. Our analysis also suggests that when governments set tariffs, they have to take account of the extent to which tariffs impact on entry of new firms into import markets.

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Appendix A

TABLE A.1 – Extensive and intensive margins in China's ordinary total imports

	I	II	III	IV	V	VI
	$\ln Q_{jt}$	$\ln m_{jt}$	$\ln q_{jt}$	$\ln Q_{jt}$	$\ln m_{jt}$	$\ln q_{jt}$
$\ln(1+\tau_{jt})$	–0.527***	–0.231***	–0.296***	–0.127***	–0.083***	–0.044
	(0.054)	(0.023)	(0.041)	(0.051)	(0.022)	(0.040)
WTO_j	1.143***	0.600***	0.543***	1.718***	0.785***	0.933***
	(0.118)	(0.048)	(0.093)	(0.118)	(0.048)	(0.093)
$\ln(1+\tau_{jt}) * WTO_j$	–0.087**	–0.018	–0.069**	–0.010	0.011	–0.021
	(0.043)	(0.018)	(0.034)	(0.042)	(0.018)	(0.033)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	Yes	Yes	Yes
No. of observations	42,966	42,966	42,966	42,966	42,966	42,966
R^2	0.871	0.940	0.817	0.886	0.947	0.830

(a) Full sample

	Before WTO			After WTO		
	I	II	III	IV	V	VI
$\ln(1+\tau_{jt})$	–0.617*	–0.107	–0.510*	–0.154***	–0.043**	–0.111***
	(0.356)	(0.134)	(0.304)	(0.044)	(0.018)	(0.036)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	9,325	9,325	9,325	33,641	33,641	33,641
R^2	0.954	0.981	0.928	0.905	0.961	0.855

(b) Before/after WTO

TABLE A.2 – Tariffs and market thickness in China's ordinary total imports

$\ln(1+\tau_{jt})$	I	II	III	IV	V	VI	VII	VIII
HHI_{jt}	–0.079***	–0.120***						
	(0.023)	(0.024)						
$HHI_{jt} * WTO_j$	0.219***	0.180***						
	(0.025)	(0.025)						
SOE_{jt}			0.065***	0.031*				
			(0.019)	(0.019)				
$SOE_{jt} * WTO_j$			0.072***	–0.027				
			(0.020)	(0.020)				
$\widetilde{HHI}_{jt}$					–0.141***	–0.181***		
					(0.026)	(0.026)		
$\widetilde{HHI}_{jt} * WTO_j$					0.267***	0.235***		
					(0.027)	(0.026)		
$\widetilde{SOE}_{jt}$							0.085***	0.038***
							(0.017)	(0.017)
$\widetilde{SOE}_{jt} * WTO_j$							0.081***	–0.021
							(0.015)	(0.014)
WTO_j	–0.541***	–0.611***	–0.488***	–0.546***	–0.548***	–0.618***	–0.490***	–0.547***
	(0.013)	(0.014)	(0.010)	(0.011)	(0.012)	(0.012)	(0.009)	(0.009)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	No	Yes	No	Yes
No. of observations	42,966	42,966	42,966	42,966	42,966	42,966	42,966	42,966
R^2	0.869	0.883	0.869	0.882	0.869	0.883	0.869	0.882

TABLE A.3 – Extensive and intensive margins in China's processing input imports

	I	II	III	IV	V	VI
	$\ln Q_{jt}$	$\ln m_{jt}$	$\ln q_{jt}$	$\ln Q_{jt}$	$\ln m_{jt}$	$\ln q_{jt}$
$\ln(1+\tau_{jt})$	–0.033	–0.098***	0.065	0.262***	–0.009	0.271***
	(0.070)	(0.027)	(0.056)	(0.073)	(0.027)	(0.060)
WTO_j	1.211***	0.175***	1.036***	1.719***	0.449***	1.269***
	(0.142)	(0.049)	(0.120)	(0.144)	(0.052)	(0.123)
$\ln(1+\tau_{jt}) * WTO_j$	–0.314***	–0.039**	–0.275***	–0.237***	–0.011	–0.226***
	(0.054)	(0.019)	(0.046)	(0.053)	(0.019)	(0.045)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	Yes	Yes	Yes
No. of observations	25,547	25,547	25,547	25,547	25,547	25,547
R^2	0.848	0.936	0.742	0.859	0.942	0.751

(a) Full sample

	Before WTO			After WTO		
	I	II	III	IV	V	VI
$\ln(1+\tau_{jt})$	0.113	0.053	0.060	0.215***	0.083*	0.132**
	(0.305)	(0.102)	(0.277)	(0.068)	(0.026)	(0.058)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	5,659	5,659	5,659	19,888	19,888	19,888
R^2	0.965	0.991	0.928	0.876	0.948	0.782

(b) Before/after WTO

TABLE A.4 – Tariffs and market thickness in China's processing input imports

$\ln(1+\tau_{jt})$	I	II	III	IV	V	VI	VII	VIII
HHI_{jt}	–0.173***	–0.189***						
	(0.030)	(0.030)						
$HHI_{jt} * WTO_j$	0.250***	0.235***						
	(0.030)	(0.030)						
SOE_{jt}			0.000	0.000				
			(0.000)	(0.000)				
$SOE_{jt} * WTO_j$			0.000***	0.000*				
			(0.000)	(0.000)				
$\widetilde{HHI}_{jt}$					–0.202***	–0.231***		
					(0.035)	(0.034)		
$\widetilde{HHI}_{jt} * WTO_j$					0.294***	0.267***		
					(0.037)	(0.037)		
$\widetilde{SOE}_{jt}$							–0.032	–0.082***
							(0.031)	(0.031)
$\widetilde{SOE}_{jt} * WTO_j$							0.181***	0.093***
							(0.030)	(0.030)
WTO_j	–0.525***	–0.589***	–0.458***	–0.522***	–0.510***	–0.573***	–0.476***	–0.533***
	(0.013)	(0.015)	(0.010)	(0.012)	(0.013)	(0.014)	(0.011)	(0.013)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	No	Yes	No	Yes
No. of observations	25,547	25,547	25,547	25,547	25,547	25,547	25,547	25,547
R^2	0.884	0.895	0.883	0.894	0.884	0.895	0.883	0.894

TABLE A.5 – Extensive and intensive margins in Japan's input imports

	I	II	III	IV	V
	$\ln Q_{jt}$	$\ln m_{jt}$	$\ln q_{jt}$	$\ln m^t_{jt}$	$\ln m^d_{jt}$
$\ln(1+\tau_{jt})$	0.193	0.024	0.169	–0.045	–0.119**
	(0.432)	(0.085)	(0.385)	(0.041)	(0.060)
WTO_j	0.484***	0.132***	0.352***	–0.022	–0.062*
	(0.117)	(0.031)	(0.103)	(0.025)	(0.036)
$\ln(1+\tau_{jt}) * WTO_j$	–0.275***	–0.095***	–0.181*	–0.014	0.000
	(0.120)	(0.025)	(0.100)	(0.011)	(0.015)
Product FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
No. of observations	459	459	459	459	459
R^2	0.945	0.984	0.923	0.991	0.985

TABLE A.6 – Tariffs and market thickness in Japan's input imports

$\ln(1+\tau_{jt})$	I	II	III
HHI_{jt}	0.127	0.508*	0.501*
	(0.131)	(0.282)	(0.277)
$HHI_{jt} * WTO_j$		–0.409*	–0.404*
		(0.239)	(0.238)
WTO_j		0.014	–0.019
		(0.023)	(0.030)
Product FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
No. of observations	459	459	459
R^2	0.990	0.990	0.990

Note: Standard errors in brackets ($^*p < 0.10,\ ^{**}p < 0.05,\ ^{***}p < 0.01$)

m^t_{jt} denotes the *total* number of Japanese firms

m^d_{jt} denotes the number of Japanese firms that are purely *domestic*

TABLE A.7 – Industry share in China's imports from the ROW, 2005

HS2 code	Industry	Intermediate inputs	Final goods
01–05	Animal products	1.1%	6.9%
06–15	Vegetable products	4.9%	6.7%
16–24	Food and beverage	1.6%	7.0%
25–27	Mineral	4.3%	0.0%
28–38	Chemical products	23.1%	2.9%
39–40	Plastic and rubber products	6.1%	1.2%
41–43	Leather products	1.7%	1.2%
44–49	Wood and pulp products	6.3%	1.9%
50–63	Textiles	16.9%	17.0%
64–67	Footwear and Headgear	0.3%	2.5%
68–71	Stone	5.0%	1.4%
72–83	Base metals	15.9%	4.4%
84–85	Machinery	8.2%	28.8%
86–89	Vehicles	1.4%	3.4%
90–98	Miscellaneous	3.2%	14.7%
	Total	100%	100%

TABLE B.1 – Structural change in China's ordinary input imports

	$\ln Q_{jt}$			$\ln m_{jt}$			$\ln q_{jt}$		
	Coef.	S.D.	t	Coef.	S.D.	t	Coef.	S.D.	t
$\ln(1+\tau_{jt})$	–0.981***	0.050	–19.71	–0.264***	0.030	–8.94	–0.717***	0.033	–21.57
WTO_j	1.405***	0.126	11.18	0.859***	0.075	11.51	0.546***	0.084	6.51
$(1+\tau_{jt}) * WTO_j$	–0.236***	0.058	–4.06	0.073***	0.034	2.12	–0.309***	0.039	–7.96
Constant	8.522***	0.105	80.94	3.394***	0.063	54.29	5.127***	0.070	72.93
No. of Obs. before WTO	5,739	5,739	5,739	5,739	5,739	5,739	5,739	5,739	5,739
No. of Obs. after WTO	20,239	20,239	20,239	20,239	20,239	20,239	20,239	20,239	20,239
Chow test		756.85			510.7			1062.32	
p-value		0.000			0.000			0.000	

Note: $^{*}p < 0.10,\ ^{**}p < 0.05,\ ^{***}p < 0.01$

Appendix B

In this Appendix, we examine whether China's accession into the WTO caused a structural break in the time series of intermediate imports, with a simple Chow test. In particular, we estimate the following regression:

$$\ln Y_{jt} = \alpha_0 + \alpha_1 \ln(1+\tau_{jt}) + \alpha_2 WTO_j + \alpha_3 (1+\tau_{jt}) * WTO_j + \epsilon_{jt},$$

where Y_{jt} is either China's total imports, extensive margin or intensive margin. As in the main analysis, τ_{jt} is the effectively applied tariff, WTO_j is a dummy variable, and ϵ_{jt} is the error term. To conduct the Chow test, we need to resort to time series analysis, rather than panel analysis used in the main text.

Table B.1 reports the estimation result of this test. The coefficients on the WTO dummy and the interaction term between the tariff variable and the WTO dummy are statistically significant at the 1% level. The t-tests on these two coefficients suggest that the WTO accession caused a significant structural change to the relationship between import tariffs and imports, especially total imports and the intensive margin. For total imports, the elasticity of tariffs is -0.980 before China's WTO accession, and $-1.215 (= -0.980 + (-0.235))$ after the WTO accession. At the same time, the estimates of the constant term increased from 8.521 to $9.926 (= 8.521 + 1.405)$. With regard to the intensive margin, the elasticity of tariffs is -0.716 before and $-1.024 (= -0.716 + (-0.308))$ after the WTO accession, and the corresponding value of the constant term is 5.127 before and $5.673 (= 5.127 + 0.546)$ after the WTO accession. The steeper slope and the greater intercept show that a structural change occurred after China's WTO accession. We also find that the Chow test rejects the null hypothesis of no structural change. Compared with the intensive margin, the structural change of the extensive margin is relatively weak. The elasticity of tariffs on the margin is -0.264 before and $-0.192 (= -0.264 + (0.072))$ after the WTO accession, which is consistent with the finding in Table 5 that tariffs have a smaller impact on the extensive margin than the intensive margin. These results provide a clear evidence of a structural break in inputs imports and intensive margin, occurred after China's accession into the WTO.