Received: 1 May 2019 | Accepted: 1 May 2019

DOI: 10.1111/roie.12410

SPECIAL ISSUE PAPER

WILEY

Input trade liberalization and import switching: Evidence from Chinese firms

Wei Tian[1] | **Miaojie Yu**[2]

[1]School of International Trade and Economics, University of International Business and Economics, Beijing, China

[2]National School of Development and CCER, Peking University, Beijing, China

Correspondence
Miaojie Yu, National School of Development, CCER, Peking University. Beijing, China. Tel: (+86)10-6275-3109. Email: mjyu@nsd.pku.edu.cn

Funding Information
We thank the financial support from the China's Natural Science Foundation (Nos. 71625007 and 71573006), the China Social Science Foundation (No. 16AZD003) and the University of International Business and Economics Young Scholars Project (No. 14QN02).

Abstract

This paper investigates how input liberalization affects firm import behavior. Using comprehensive production and trade data of Chinese firms, the paper shows that firms switch import sources from developing countries to developed countries as Chinese input tariffs fall. This finding is evident for import value and import scope. The observation holds after excluding the possible influence of reducing processing trade. The paper further demonstrates that the mechanism can be attributed to quality upgrading and innovation led by input cost reductions. The analysis handles the possible endogeneity problem, and the findings are robust and significant to different empirical methodologies and measurements.

JEL CLASSIFICATION
F1; F13; F14

1 | INTRODUCTION

Since entering the World Trade Organization (WTO) early this century, China has experienced remarkable trade opening. The country's simple average tariff dropped from 15.3% in 2001 to 7.5% in 2017. China's trade liberalization brought huge changes in foreign and domestic markets, including the rising quality and value added imbedded in exports and imports. China's exports have increased rapidly, as noted by many studies in the literature. Increasing imports, which take off later than exports, will be the next benefit of China's opening-up strategy. China is the second largest importing country, and its annual imports increased by more than four times between 2000 and 2016. The Chinese government has launched several policies and activities to promote imports, especially consumption goods, including holding the first China International Import Exposition and further reducing the simple average tariff to 7.5% in late 2018.[1]

Chinese firms have adjusted their strategies in response to the more liberalized circumstances. The firms are more active in importing and exporting, invest more in research and development (R&D), and are changing their importing and exporting decisions. For example, Liu and Qiu (2016) argue that input trade liberalization hampers firm R&D in China. Tian and Yu (2016, 2017) find that Chinese firms have increased export intensity (i.e., the ratio of exports to domestic sales) as a response to input liberalization.

Among the various changes, the change in import sources is rarely studied, although it may have an important impact on the map of international trade. Chinese firms that used to import a large proportion of inputs from developing countries are switching to imports from developed countries. This is happening not only because of the decline in processing trade in China, but also to meet the needs of firm innovation and product upgrading. Many studies have documented that input tariff reduction encourages import scope and import quality and lowers import prices, which further drives innovation and leads to productivity and welfare gains, but the link behind this process is complicated and controversial. In this paper, we shed some light on the first step of firms' reaction to reduced input tariffs, that is, how firms adjust their import sources and quality.

The paper shows that firms have engaged in import source switching and the importance of import quality a Fan, Li, and Yeaple (2015). We use a matched data set of comprehensive transaction-level trade and firm production data to generate a firm-level input tariff index, following Yu (2015). We further distinguish the tariff imposed on developing country import sources. We find that, instead of promoting imports from developing countries, the reduction in the tariff on developing country sources has enhanced the shift of import sources toward developed countries. This finding suggests a strong cost-saving effect of input trade liberalization. We further investigate the heterogeneous impacts on firms with different levels of productivity, and show that less productive firms are more largely influenced to switch import sources than more productive firms. This impact is also true for firms in high-technology industries and engaged in intensive innovation. To figure out the driving force of the switching, we examine the impacts on different types of importers and find that most switching has happened to new importers. This suggests that, as tariffs are reduced, more domestic firms are stimulated to start importing high-quality inputs from developed countries to replace domestic inputs.

An important alternative explanation for source switching might be the decline of processing trade in China since 2005. As Brandt and Morrow (2017) argue, to some extent, this decline can be attributed to the reduced input tariff, which decreases the opportunity cost of engaging in ordinary trade. This effect is unlikely to be important here, given that the sample ends in 2006, the starting year of the decline in import-processing trade. We also compare capital-intensive and labor-intensive industries, and processing firms and capital goods-intensive importers to exclude the effect of the decline in import-processing trade. We use the difference in the tariff as an instrumental variable to control for endogeneity in the first-difference regressions, following Trefler (2004). The switching happens not only in the intensive margin, but also in import scope. We show that input tariff reduction leads to greater import scope from developed countries, and this finding is robust to different measures of import variety and different types of firms.

To verify the mechanism of quality upgrading, we first generate a quality measure, following Khandelwal (2010), which handles the impact on market price of idiosyncratic demand shock. We take a further step to measure the quality function separately for ordinary firms and processing firms. The impact shows that firm profit and relative import quality from developed country origins increase as the input tariff decreases, suggesting that firms import higher quality goods from developed countries, outpacing imports from developing countries.

This paper is linked to the emerging literatures on imported intermediate inputs, innovation, and trade liberalization. The literature documents that imported intermediate inputs have a strong impact

on various dimensions of firm performance, including productivity (Amiti & Konings, 2007; Choi & Hahn, 2013; Kasahara & Rodrigue, 2008; Topalova & Khandelwal, 2011; Yu, 2015), exports (Bas & Strauss-Kahn, 2014; Kasahara & Lapham, 2013; Navas, Serti, & Tomasi, 2013), product scope (Goldberg, Khandelwal, Pavcnik, & Topalova, 2010), quality (Fan et al., 2015), and outcomes in downstream markets, like pricing and exchange rate pass-through (Bernini & Tomasi, 2015). Changes in these dimensions have had enormous effects in improving productivity. For example, a wide range of studies find that input trade liberalization is the strongest factor promoting productivity growth. Amiti and Konings (2007) and Topalova and Khandelwal (2011) show that, compared with output liberalization, input trade liberalization contributes two to 10 times more to productivity growth. Kasahara and Rodrigue (2008) find productivity gain for Chilean firms that import intermediate goods. Yu (2015) confirms this finding, using Chinese data and considering processing trade. Input liberalization boosts firm productivity through several channels, including enhancing input quality, augmenting competition, and increasing input varieties.

These findings have stimulated research on the mechanisms through which imported intermediate inputs boost productivity. A large volume of research finds that productivity and welfare gains can be explained by the increase in firm innovation, quality upgrading, and invention of new products, which are encouraged by increasing imported intermediate imports, especially new imported varieties (Arkolakis, Demidova, Klenow, & Rodriguez-Clare, 2008; Broda & Weinstein, 2006; Feenstra, 1994; Klenow & Rodriguez-Clare, 1997). Such mechanism may also act dynamically in the long run, through further expansion of domestic input scope led by more imported varieties. For example, Halpern, Koren, and Szeidl (2011) find that increased variety of intermediates generates productivity gain among Hungarian firms. Goldberg, Khandelwal, Pavcnik, and Topalova (2009), Goldberg et al. (2010) find that firms that are exposed to stronger input tariff reductions are more likely to introduce new products and invest in R&D because of the newly available imported inputs, and 31% of firms' product expansion could be attributed to the decline in input tariffs.

New imported inputs may promote innovation and productivity in several ways. The conventional argument is that production technology responds to variety, such that increasing input varieties reduces cost (Gopinath & Neiman, 2014; Kasahara & Lapham, 2013). Based on this assumption, Feenstra (1994) develops a measure of the welfare gain from more input varieties. Using data on 20 countries over 20 years, Broda and Weinstein (2004, 2006) show that the increase in imported varieties caused by input trade liberalization reduces import prices, which in turn generates welfare gain. Other literature highlights the spillover effect of the advanced technology and higher quality embedded in new imported inputs. Coe and Helpman (1995) and Keller (2002) verify the spillover effect empirically by using country-level data. Seker, Rodriguez-Delgado, and Mehmet (2015) illustrate the spillover effect theoretically. Our paper enriches understanding of the input quality channel, by demonstrating the resource changes and quality improvement that result from imported intermediate inputs. We find that firms switch from importing inputs from developing countries to importing inputs from developed countries as input tariffs are reduced. The effect is most pronounced for new importers, suggesting a higher probability of spillover from the increase in high-quality imported inputs.

Studies on how input cost reduction affects firm imports have drawn less attention than the research on output and exports, but studies on input cost reduction provide more direct evidence on how firms adjust and the effects on innovation and productivity. The change in import source is also the beginning of changes in all follow-up firm behaviors, and how firms react in imports is critical for understanding the impact of trade. Bas and Strauss-Kahn (2015) find a robust and significant increase in import and export prices among Chinese firms that experienced input tariff reduction, and the results are significant for firms sourcing imports from and selling output to developed countries. From the perspective of how import origin changes, our paper highlights the increasing use of high-quality inputs imported from

developed countries as a major approach of firms that exploit input tariff reduction to upgrade quality. Furthermore, we suggest that trade distribution might be reshaped as a consequence.

The paper also fits into the literature on quality upgrading and firm innovation in China. Liu and Qiu (2016) argue that input trade liberalization hampers firm R&D in China, while Tian and Yu (2017) find the opposite effect. Lim, Trefler, and Yu (2018) examine firm innovation in China and find that, overall, Chinese firms intensify their innovation once they are exposed to stronger competition and face larger market size. Feng, Li, and Swenson (2016) demonstrate that product upgrading in imported inputs helped Chinese firms to increase their presence in export markets. They estimate the benefit of increased use of imported inputs on firm exports, and find that firms benefit most when the intermediate inputs are purchased from higher-income countries, facilitating exports to the presumably more demanding developed markets. In contrast to these papers, our work studies the resulting changes in China's import structure, which is important for the country's all-around opening-up strategy since 2017.

The findings of this paper are also important for understanding the changes in global trade flows associated with liberalization. As the second largest importing country, China's opening-up not only affects China's trade, but also the distribution of trade flows across regions in the world. If trade liberalization in China boosts more trade between China and developed countries disproportionally, more unparalleled changes between developed and developing countries—such as in labor markets and welfare—can be expected to happen as a consequence.

The rest of the paper is organized as follows. Section 2 discusses the details of the data and data sources. Section 3 presents the empirical findings. Section 4 concludes.

2 | DATA AND MEASUREMENT

The data used in the paper are a combination of two disaggregated data sets: the annual survey of manufacturing firms in China and customs transaction-trade data. The two data sets provide rich information on firm production and trade. We take the data from 2000 to 2006, the period when Chinese input tariffs dropped most significantly. This section presents a brief introduction to the data.

2.1 | Chinese firm-level production data

The annual survey of manufacturing firms is carried out and maintained by China's National Bureau of Statistics. The survey includes all state-owned enterprises and non-state-owned enterprises whose annual sales exceed RMB 5 million (U.S.$830,000). The data cover complete information from three major accounting statements (i.e., balance sheet, profit and loss account, and cash flow statement), including firm output, profit, R&D, and inputs of labor, capital, intermediate inputs, and so on.

We started by applying stringent filters to clean the data, especially to exclude noisy and misleading data from the samples as a result of misreporting by some firms. We followed the criteria in Feenstra, Li, and Yu (2014) to omit outliers. First, we dropped observations where key financial variables were missing (such as total assets, net value of fixed assets, sales, and gross value of the firm's output productivity). Second, firms with fewer than eight workers were removed, since those firms fall below the legal regime, as mentioned in Brandt, Biesebroeck, and Zhang (2012).

Next, we screened the data according to the basic rules of the Generally Accepted Accounting Principles. Observations were excluded if any of the following were found: (1) liquid assets were greater than total assets, (2) total fixed assets were greater than total assets, (3) the net value of fixed assets was greater than total assets, (4) the firm's identification number was missing, or (5) the date

when the firm was established was invalid (e.g., the opening month was later than December or earlier than January). The data were reduced by about 50% for each year to guarantee quality under the strict cleaning.

We exclude trading companies from the sample in all estimations to ensure the preciseness of the estimations. In particular, firms named with any Chinese characters for a trading company and importing and exporting companies are excluded.

2.2 | Chinese production-level trade data

The transaction-trade data are extremely disaggregated, at the Harmonized System (HS) eight-digit product level, obtained from China's General Administration of Customs. The data set records rich information on each export or import transaction for all trading firms, including trading price, quantity, value, and trade mode, which distinguishes processing trade from ordinary trade. From these data, we know the import value of each product from each original country, which we further use to construct the firm average input tariff.

We merged the manufacturing firm data and customs data. We used the firms' name–year, zip code, and the last seven digits of the telephone number to merge the two data sets. The merged data skew toward large firms, as the matched sample has more exports, more sales, and more employees. The details of the approach are introduced in Yu and Tian (2012) and Yu (2015).

2.3 | Measurement of firm-level tariffs

Using the trade data, we measure the average intermediate input tariff faced by a single firm, as in Yu (2015). The firm-specific input tariff index is based only on nonprocessing imports (O), given that processing imports enjoy free duty in China, as follows:

$$FIT_{it} = \sum_{k \in O} \frac{m_{ik,initial\_year}}{\sum_{k \in M} m_{ik,initial\_year}} \tau_{kt},$$

where $m_{ik,initial\_year}$ is firm i's imports of product k in the first year the firm appears in the sample. M is the set of the firm's total import varieties. The import weight for each product in the index is fixed at the firm's initial year in the sample to avoid endogeneity, following Topalova and Khandelwal (2011). Because imports might be reduced to zero by prohibitive tariffs, using import weights measured in current period firm tariffs would generate a downward bias.

To capture precisely the impact of input trade liberalization on imports from developing countries, we decompose imports from developing countries and construct the import tariff based on developing country sources using a similar approach. The weight in the following index is the import share of each import from developing countries.

$$FIT^{poor}_{it} = \sum_{k \in O} \frac{m^{poor}_{ik,initial\_year}}{\sum_{k \in M} m_{ik,initial\_year}} \tau_{kt}.$$

To fit with the related empirical literature, we also consider two dimensions of trade liberalization other than input tariff reduction, following Goldberg et al. (2010) and Topalova and Khandelwal (2011): (i) home (i.e., China) tariff cuts on final products, such as textiles and garments, namely

output tariffs; and (ii) tariff cuts in the foreign destination country (i.e., the United States), namely, external tariffs. The first dimension increases competition in the home market, and the second dimension enlarges markets. The output and external tariffs are generated at the two-digit Chinese Industry Classification (CIC) industry level. We average the tariffs of the HS six-digit products within each CIC two-digit industry code according to Amiti and Konings (2007).

We begin by showing some stylized facts on input tariffs and the pattern of imports. Figure 1 shows the correlation between the import share from developing countries and the input tariff. A positive correlation implies that input tariff reduction is associated with lower import scope share and value share from developing countries, which is consistent with our finding that imports are switched to developed countries as input trade liberalization occurs. In Figure 2, we demonstrate the time trend of imports from developing and developed countries. Imports from both sources increased rapidly after China entered the WTO; however, as trade opens up, imports from developed countries are always greater than those from developing countries, and the gap is increasing as well.

Table 1 presents the summary of statistics for the major variables used in the empirical analysis. On average, firms import 28% of the imported inputs from developing countries and firms import greater product scope from developed countries than from developing countries.

3 | EMPIRICAL FINDINGS

Before we start the firm-level estimation, we first use the transaction-level customs-trade data to take a preliminary look. In Table 2, we regress import value on the product-level input tariff. We control for firm total factor productivity (TFP), using Olley and Pakes' (1996) approach, following

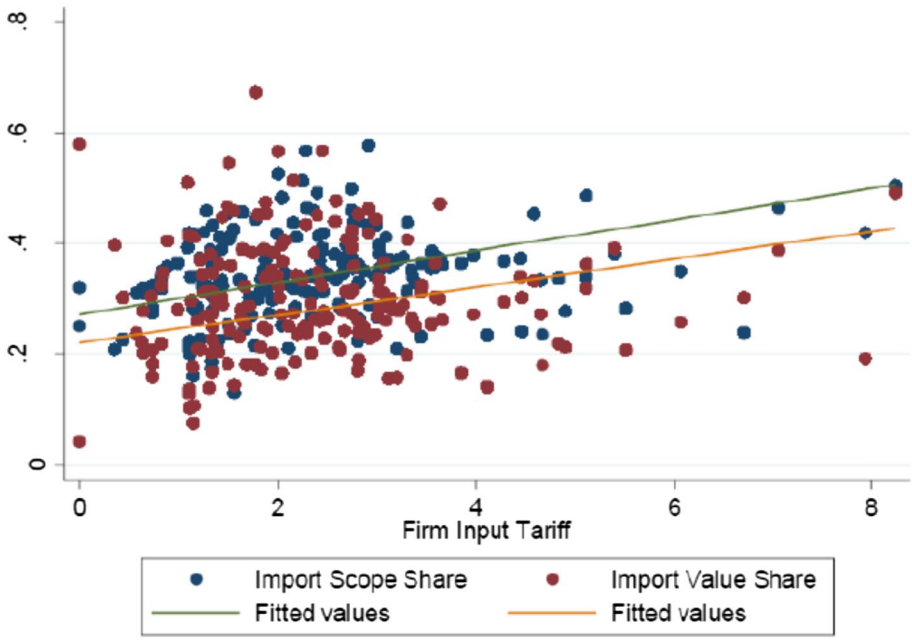

FIGURE 1 Firm input tariff, import scope, and import value

Note: Firm input tariffs are measured in percentage (horizontal axis). [Colour figure can be viewed at wileyonlinelibrary.com]

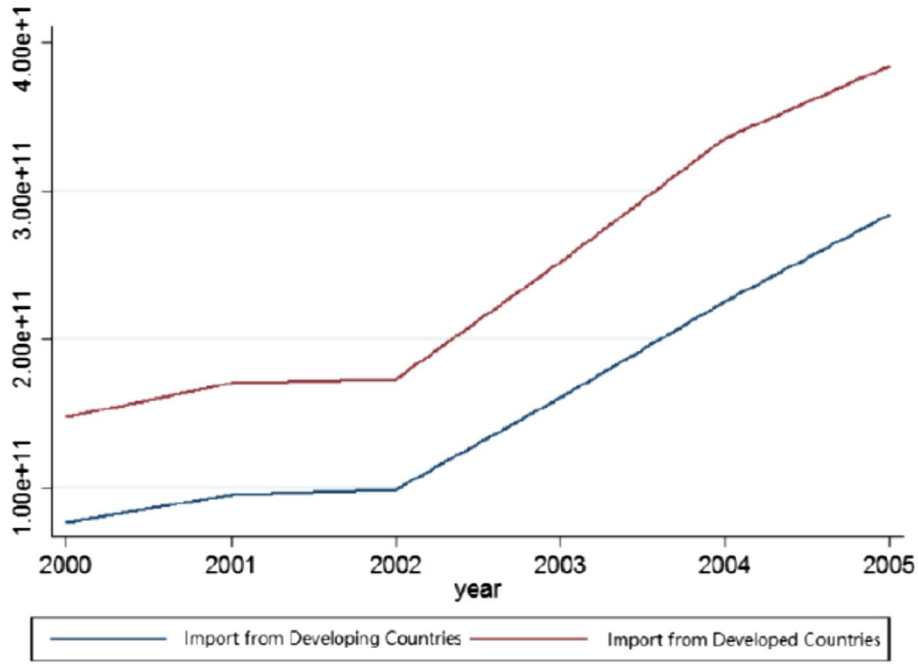

FIGURE 2 Imports from developed and developing countries

Note: Numbers in vertical axis are in dollar. [Colour figure can be viewed at wileyonlinelibrary.com]

Yu (2015), where we take into account firm export status and trade mode in the estimated productivity function. We use system generalized method of moments (GMM) and its normalization as an alternative measurement of TFP in the robustness checks later in the paper. In column (1) of Table 2, after controlling for industry-level output tariffs and tariffs charged by foreign countries, we show that a lower input tariff is associated with a higher import value. In columns (2) and (3), we separate the

TABLE 1 Summary statistics

Variable	Mean	Std. Dev.
Log firm labor	5.456	1.167
Firm TFP (Olley–Pakes)	1.122	0.382
Foreign indicator	0.569	0.495
SOE indicator	0.021	0.142
Log firm import	12.018	2.954
Import share from developing countries	0.281	0.378
Firm product–country import scope	17.664	44.532
Firm product–country import scope from developed countries	15.343	35.507
Firm product–country import scope from developing countries	8.372	21.024
Home input tariff (firm level)	3.24	5.922
Home input tariff from developing countries	1.379	3.724
Home output tariffs (industry level)	0.117	0.056
Foreign tariffs (industry level)	0.096	0.048

TABLE 2 Preliminary estimation

Regressand	(1)	(2)	(3)	(4)	(5)
Import value (HS6D Level)	**All**	**From developed countries**	**From developing countries**	**From developed countries**	**From developing countries**
Home input tariff (Product level)	−0.036*** (−135.82)	−0.037*** (−119.77)	−0.033*** (−64.31)	−0.031*** (−98.99)	−0.025*** (−47.57)
Home output tariffs (Industry level)	−1.483*** (−33.15)	−1.487*** (−27.98)	−1.181*** (−13.87)	1.274*** (12.60)	0.076 (0.4)
Foreign tariffs (Industry level)	0.837*** (14.89)	0.519*** (7.77)	1.554*** (14.72)	−0.135 (−1.43)	−0.411** (−2.46)
Firm TFP (Olley–Pakes)	0.376*** (85.89)	0.369*** (74.89)	0.405*** (42.05)	0.002 (0.24)	0.019 (0.81)
Foreign indicator	−0.479*** (−96.57)	−0.437*** (−70.75)	−0.541*** (−63.98)	0.051 (1.58)	0.139 ** (2.10)
SOE indicator	−0.143*** (−8.42)	−0.031 (−1.4)	−0.276*** (−10.47)	−0.145** (−2.03)	−0.067 (−0.66)
Log firm labor	0.187*** (181.64)	0.201*** (166.48)	0.147*** (71.41)	0.248***(29.33)	0.066 *** (3.4)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	No	Yes	Yes
R^2	0.0619	0.0603	0.0641	0.0174	0.0136
Observations	3,747,538	2,741,321	1,006,217	2,741,321	1,006,217

Note: Numbers in parentheses are robust *t* values. *,**,***Denote significance at the 10%, 5%, and 1% levels, respectively.

samples into two groups: imports from developed countries and developing countries, respectively. The results show that input tariff reduction favors imports from developed countries more than those from developing countries, suggesting that the import share from developed countries may be enhanced. In columns (4) and (5), we control for firm fixed effects, and the results are similar.

To explore firm behavior, we use firm-level data to examine how input tariff cuts affect import sourcing from developing and developed countries. We are interested in the resulting effect on the import share from developed countries. We also separate the tariff on developing country sources from the conventional average tariff, to compare the impacts of boosting imports from developed countries and developing countries. The following equation expresses our benchmark empirical specification, where $impshare_{it}^{rich}$ is the import share from developed countries of firm i in year t, FIT_{it}^{poor} is the average import tariff of firm i in year t for imports from developing countries (constructed earlier), φ_{it} is the productivity of firm i in year t, X_{jt} is the industry-level output tariff and external tariff of firm i in industry j and year t, ω_i and η_t are firm-level and year-level fixed effects, respectively, and μ_{it} is the firm-level idiosyncratic shock.

$$impshare_{it}^{rich} = \beta_0 + \beta_1 FIT_{it}^{poor} + \beta_2 FIT_{it}^{poor} \times \varphi_{it} + \beta_3 \varphi_{it} + \theta X_{jt} + \omega_i + \eta_t + \mu_{it}.$$

We report the results of the benchmark regressions in Table 3. In column (1), the import share from developed countries increases as the import tariff on developing country imports decreases. This suggests a switch of imports from developing countries to imports from developed countries, led by input tariff reduction on developing countries. In columns (2) and (3), we introduce firm productivity to control for its impact on firm imports. In column (2), we use the system GMM method to estimate TFP, and in column (3), we normalize the TFP to range from 0 to 1 to make it comparable across industries. The impact is still significant and robust. In column (4), we add the interaction term of input tariff and TFP, and we find the impact of tariff reduction is more pronounced for firms with lower productivity. The reason might be that firms with higher productivity were less financially constrained by the high level of input tariffs before the tariff reduction. In columns (5) and (6), we replace TFP measurement with a dummy indicating high TFP firms if their TFP measure is greater than the industry mean. We redo the regressions in columns (3) and (4), and the results are unchanged.

In Table 4, we investigate the mechanism behind the results. First, we check whether the impact exists for firms in all industries owing to cost saving, or whether the tariff cut only enables firms in high-skill industries to innovate and upgrade production. We examine the impact on skill-intensive firms in the first three columns in the table. In column (2), we use samples with positive R&D, and in column (3), we look at firms with a positive number of patents. The results show that the impact is similar for skill-intensive firms to the overall firms shown in column (1), indicating that upgrading exists universally.

Next, we regress by firm import status to find the strongest driving party. In columns (4) to (6), we regress for new importers, always importers, and importers who exit in the next year. The results show that the impact on new importers is more pronounced than on the other two types of firms. This finding provides a hint that input tariff reduction encourages more firms to start importing from developed countries than developing countries. This result is consistent with previous findings that highlight the effect on adjustment at the extensive margin under trade liberalization (Bernard, Jensen, Redding, & Schott, 2007).

TABLE 3 Benchmark regressions

Regressand: Rich import share	(1)	(2)	(3)	(4)	(5)	(6)
TFP measure	**System TFP**		**Relative TFP**		**High TFP indicator**	
Firm tariffs on poor inputs	−0.013*** (−24.98)	−0.013*** (−24.98)	−0.011*** (−15.19)	−0.018*** (−7.13)	−0.011*** (−15.18)	−0.013*** (−11.87)
Firm tariffs on poor inputs×Firm TFP				0.024*** (2.82)		0.003** (2.23)
Industry output tariff	−0.053 (−0.84)	−0.055 (−0.86)	−0.130 (−1.51)	−0.130 (−1.50)	−0.129 (−1.50)	−0.131 (−1.52)
Industry external tariff	−0.059 (−0.95)	−0.058 (−0.95)	−0.054 (−0.56)	−0.053 (−0.55)	−0.055 (−0.57)	−0.054 (−0.57)
Firm TFP		−0.014* (−1.73)	−0.044 (−0.60)	−0.076 (−1.03)	−0.002 (−0.34)	−0.007 (−1.02)
Observations	37,661	37,534	29,275	29,275	29,379	29,379
R^2	0.05	0.05	0.05	0.05	0.05	0.05
Number of party_id	23,194	23,132	22,338	22,338	22,405	22,405
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: Numbers in parentheses are robust *t*-values. *,**,***Denote significance at the 10%, 5%, and 1% levels, respectively.

TABLE 4 More specifications: By firm type

	(1)	(2)	(3)	(4)	(5)	(6)
				Type of importers		
Regressand: Rich import share	**All**	**Positive R&D**	**Positive patent**	**New**	**Always**	**Exiters**
Firm tariffs on poor inputs	−0.013*** (−24.98)	−0.011*** (−5.84)	−0.011*** (−4.87)	−0.018*** (−9.96)	−0.009*** (−12.58)	
Firm tariffs on poor inputs (one lag)						−0.016 (−1.43)
Industry output tariff	−0.055 (−0.86)	−0.097 (−0.36)	0.178 (0.56)	0.052 (0.21)	0.015 (0.18)	−1.235 (−0.72)
Industry external tariff	−0.058 (−0.95)	−0.071 (−0.31)	−0.510* (−1.66)	0.305 (1.00)	−0.195*** (−2.66)	−2.385 (−1.40)
Firm TFP	−0.014* (−1.73)	0.008 (0.23)	0.058 (1.14)	−0.004 (−0.13)	−0.019* (−1.78)	0.128 (0.59)
Observations	37,534	4,357	2,567	18,935	18,599	1,648
R^2	0.05	0.06	0.07	0.09	0.03	0.31
Number of party_id	23,132	3,331	1,933	17,499	11,286	1,580
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: Numbers in parentheses are robust *t*-values. *,**,***Denote significance at the 10%, 5%, and 1% levels, respectively.

However, the results could also be driven by the decline of processing trade. Brandt and Morrow (2017) argue that China's processing trade has declined since 2005, because input tariff reduction reduces the opportunity cost of doing ordinary trade. To nullify this channel, we separate the samples into labor-intensive and capital-intensive industries, given that processing trade is more concentrated in labor-intensive industries. The results in Table 5, columns (1) and (2), are significant, and the economic magnitudes are close. Furthermore, we check the effect on processing firms and capital goods importers separately in columns (3) and (4), where we still find a consistent and robust result, as in previous studies. All the findings suggest that the processing trade is not a challenge to our interpretation.

Next, we study the impact of input tariff reduction on firm imports from the extensive margin, namely, import scope. Product variety is defined at the product–country level, and the estimation results are shown in Table 6. In the first two columns, we regress, respectively, the import scope from poor countries on input tariffs by using negative binomial estimation to deal with the count data issue. We find that when input tariffs decrease, import scope from poor countries is squeezed out. This verifies our argument that input trade liberalization fosters firms to switch importing from developing countries to developed countries, from the extensive margin.

To show the negative nexus between firm tariffs on poor countries' inputs and firm's import share from rich countries more directly, in column (3) we regress the import share from rich countries on input tariffs, and in column 4 we use the Tobit method instead of ordinary least squares to correct the bias from sample truncation, and we also find a robust result. Moreover, most of the Chinese imports are from Asian countries, among which Association of Southeast Asian Nations (ASEAN) countries are the most important import-processing sources. ASEAN free trade agreement tariffs have dropped significantly, and trade was largely boosted. So, to exclude the impact through the decline in processing trade, we regress the import scope share from rich Asian countries in addition to that from ASEAN countries. Similar to our previous finding, we find that input tariff reduction for poorer countries promotes firms to import more from rich Asian countries relative to ASEAN countries.

Since the firm average input tariff is constructed by using the import weight of each input variety, the weight might be correlated to the import share from richer countries owing to time serial correlation of unobservable shock, although we fix the weight at the initial year in all the regressions. To handle the possible endogeneity problem, we use the one-year lag of tariffs as the instrument for the first difference in the tariff, following Trefler (2004). The results are shown in Table 7. In column (1), we show that the more the input tariff is reduced, the more the import share from rich countries increases. In column (2), we control for firm TFP as well, where TFP is measured using the system GMM method, and the result does not change. In columns (3) and (4), we use normalized TFP, and in column (4), we add an interaction term for poor countries' input tariff and firm TFP, to test the heterogeneous effect. We find that a greater reduction in the input tariff leads to a greater increase in the share of imports from richer countries, and the effect is more pronounced for less productive firms. In the last two columns, we replace the TFP measure with a dummy for high-productivity firms, generated as in Table 3, and redo columns (3) and (4) and obtain robust results.

Next, we investigate the mechanism of innovation. Import quality from developed countries, compared with that from developing countries, should be disproportionally boosted by lower input tariffs, if the scenario is true that firms exploit input tariff reductions to innovate and upgrade quality. To test this, we first follow Khandelwal (2010) to construct a measure of import quality as follows:

$$\log s_{cht} = \lambda_{1,ch} + \lambda_{2,t} + a_1 \log p_{cht} + a_2 \log ns_{cht} + \lambda_{3,cht},$$

TABLE 5 More specifications: By sector

	(1)	(2)	(3)	(4)
	Intensive sector			
Regressand: Rich import share	**Labor**	**Capital**	**Processing**	**Capital goods**
Firm tariffs on poor inputs	−0.011*** (−13.85)	−0.014*** (−20.95)	−0.013*** (−18.49)	−0.013*** (−8.05)
Industry output tariff	−0.145 (−1.14)	−0.035 (−0.45)	−0.008 (−0.09)	−0.171 (−0.82)
Industry external tariff	−0.162 (−1.22)	−0.050 (−0.70)	−0.020 (−0.23)	−0.302 (−1.02)
Firm TFP	−0.005 (−0.35)	−0.019* (−1.80)	−0.011 (−0.91)	−0.083** (−2.32)
Observations	11,325	26,209	26,449	3,358
R^2	0.06	0.05	0.05	0.06
Number of firms	7,002	16,223	18,136	2,155
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes

Note: Numbers in parentheses are robust *t*-values. *,**,***Denote significance at the 10%, 5%, and 1% levels, respectively.

TABLE 6 Estimation on import scope

	(1)	(3)	(4)	(6)	(7)
Regressand: Firm import scope (product–country)	**Poor only**	**Poor only**	**Import scope share from rich**		**Import scope share from East Asian Rich to East Asian Rich & ASEAN**
Method	**OLS**	**OLS**	**OLS**	**Tobit**	**OLS**
Firm tariffs on poor inputs	0.010** (2.26)	0.014*** (4.16)	−0.005*** (−4.87)	−0.003*** (−5.27)	−0.002*** (−2.71)
Industry output tariff	−2.227*** (−5.78)	−0.057 (−0.19)	0.313*** (3.26)	0.144*** (2.77)	−0.079 (−1.21)
Industry external tariff	−0.010 (−0.02)	0.274 (1.05)	−0.034 (−0.27)	0.014 (0.24)	−0.049 (−0.85)
Other controls	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	No	No	Yes
Observations	12,902	6,315	11,693	11,693	8,251

Note: Numbers in parentheses are robust *t*-values. *,**,***Denotes significance at the 10%, 5%, and 1% levels, respectively.

TABLE 7 IV Estimates with firm heterogeneity

Regressand: ΔRich import share	(1)	(2)	(3)	(4)	(5)	(6)
TFP measures	**System TFP**		**Relative system TFP**		**High TFP indicator**	
ΔFirm tariffs on poor inputs	−0.012*** (−10.10)	−0.012*** (−10.10)	−0.013*** (−4.45)	−0.021** (−2.21)	−0.012*** (−4.41)	−0.013*** (−3.48)
ΔIndustry output tariffs	0.192 (1.44)	0.188 (1.40)	−0.363 (−1.21)	−0.350 (−1.17)	−0.372 (−1.25)	−0.373 (−1.25)
ΔIndustry external tariffs	−0.078 (−1.13)	−0.079 (−1.15)	−0.042 (−0.29)	−0.034 (−0.23)	−0.043 (−0.30)	−0.043 (−0.31)
ΔFirm TFP		−0.012 (−1.24)	−0.079 (−0.59)	−0.123 (−0.88)	0.012 (0.99)	0.011 (0.80)
ΔFirm tariffs on poor inputs×Firm TFP				0.029 (0.96)		0.001 (0.14)
Observations	10,520	10,461	2,139	2,139	2,151	2,151
R^2	0.04	0.04	0.06	0.06	0.06	0.06
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: Numbers in parentheses are robust *t* values. *,**,***Denotes significance at the 10%, 5%, and 1% levels, respectively.

TABLE 8 Channels of input trade liberalization

	(1)	(2)	(3)	(4)	(5)
Regressand	**ROA**	**Import quality**		**Developed import quality ratio to developing**	
Firm input tariff	−0.048*** (−3.42)	−0.835*** (−2.80)			
Firm tariffs on poor inputs			−0.009** (−2.06)	−0.051*** (−3.31)	−0.058** (−1.97)
Firm return on assets (ROA)			−0.451 (−1.28)		−2.806 (−1.02)
Firm tariffs on poor inputs×Firm ROA			0.051 (0.76)		0.159 (0.36)
Industry output tariffs	0.036*** (2.82)	−0.558** (−2.06)	−0.631* (−1.73)	0.484 (0.30)	1.315 (0.59)
Industry external tariffs	0.007 (0.59)	1.225*** (4.66)	0.818** (2.23)	−1.911 (−1.25)	−2.599 (−1.20)
Firm TFP				−0.182 (−0.78)	−0.122 (−0.41)
Observations	21,984	36,644	22,551	11,200	6,746
R^2	0.01	0.06	0.07	0.01	0.01
Number of firms	14,663	22,926	14,843	7,481	4,708
Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes

Note: Numbers in parentheses are robust *t*-values. *,**,***Denotes significance at the 10%, 5%, and 1% levels, respectively.

$s_{cht} = q_{cht}/market_{it}$ is the import share of product h in industry i from country c in year t. $market_{it} = \sum_{ch \in i} q_{cht}/impen_{it}$ is the market size, where $impen_{it}$ refers to industry i's import penetration. $ns_{cht} = q_{cht}/\sum_{ch \in h} q_{cht}$ is the net share of product h from country c in total imports of product h. The estimated residual is considered as the product–country–year import quality, as follows:

$$\widehat{\lambda_{cht}} = \widehat{\lambda_{1,ch}} + \widehat{\lambda_{2,ch}} + \widehat{\lambda_{3,ch}}.$$

We estimated import quality for each CIC two-digit industry, separating for processing and ordinary imports, respectively.

Next, we examine the input tariff reduction and import quality in Table 8. In column (1), we find that reduced input tariffs generate greater returns on assets, implying that input tariff reduction saves cost and generates higher profit. We also control for other tariffs, including output tariffs and industry-level external tariffs charged by other countries. In columns (2) and (3), we regress firm input quality on input tariff and poor countries' input tariff, respectively, and the results show that import quality is improved as the input tariff decreases. In column (4), we further examine the impact on the quality ratio of imports from developed countries over developing countries. In column (5), we add the return on assets (ROA) and its interaction with tariffs, to control for the impact of firm productivity and profit. The results show that poor countries' input tariff reduction boosts the ratio of relative import quality from developed countries to developing countries. We also find that the impact is the same for firms with different ROAs, suggesting that there might be other channels to improve import quality other than profit.

4 | CONCLUSIONS

In this paper, we used comprehensive firm-level production and trade data of Chinese manufacturing firms to examine how input tariff reduction changes firm import behavior. We find that importing firms switch sources from developing countries to developed countries as the input tariff is reduced. This impact is prevalent among different types of firms, including processing firms and ordinary firms, and firms in labor-intensive and capital-intensive industries, but among the different importers, new importers benefit the most from tariff reduction.

We also show that the impact exists at the intensive margin and the extensive margin, that is, import value and scope shift toward developed countries as the input tariff decreases. We further explored the mechanism behind this result, which, consistent with the findings of the previous literature, can be attributed to the innovation and quality upgrading encouraged by lower input cost. Specifically, we find that there is a larger boost in import quality from developed countries compared with that from developing countries. and after taking care of the endogeneity problem and several robustness checks, we show that the findings are significant and robust.

This paper enriches the study of input liberalization and firm innovation and provides direct evidence of the change in import pattern. The results remind us that the distribution of the world trade flow may be affected by China's opening-up as well, in the sense that more trade within developing countries may be replaced with trade between developing and developed countries.

ACKNOWLEDGMENTS

We thank very helpful suggestions and comments from Guangzhong Li, Jie Li, Peter Egger, Zhenyu Wu, and other conference participants at International Workshop: China and the Global Economy 2018, which is co-organized by Institute of Industrial Economics of Jinan University, Institute of Industrial Organization and Regulation of Jinan University, and Business School of Sun Yat-Sen University. We thank the financial support from the China's Natural Science Foundation (Nos. 71625007 and 71573006), the China Social Science Foundation (No. 16AZD003) and the University of International Business and Economics Young Scholars Project (No. 14QN02). All Errors are ours.

ENDNOTE

[1] According to the executive meeting of the State Council on September 26, 2018, chaired by Premier Li Keqiang of the State Council.

REFERENCES

Amiti, M., & Konings, J. (2007). Trade liberalization, intermediate inputs, and productivity: Evidence from Indonesia. *American Economic Review*, *97*(5), 1611–1638. https://doi.org/10.1257/aer.97.5.1611

Arkolakis, C., Demidova, S., Klenow, P., & Rodriguez-Clare, A. (2008). Endogenous variety and the gains from trade. *American Economic Review: Papers and Proceedings*, *98(2)*, 444–450. https://doi.org/10.1257/aer.98.2.444

Bas, M., & Strauss-Kahn, V. (2014). Does importing more inputs raise exports? Firm level evidence from France. *Review of World Economics*, *150*(2), 241–275. https://doi.org/10.1007/s10290-013-0175-0

Bas, M., & Strauss-Kahn, V. (2015). Input-trade liberalization, export prices and quality upgrading. *Journal of International Economics*, *95*, 250–262. https://doi.org/10.1016/j.jinteco.2014.12.005

Bernard, A., Jensen, B., Redding, S., & Schott, P. (2007). Firms in international trade. *Journal of Economic Perspectives*, *21*(3), 105–130. https://doi.org/10.1257/jep.21.3.105

Bernini, M., & Tomasi, C. (2015). Exchange rate pass-through and product heterogeneity: Does quality matter on the import side? *European Economic Review*, *77*, 117–138. https://doi.org/10.1016/j.euroecorev.2015.04.005

Brandt, L., & Morrow, P. M. (2017). Tariffs and the organization of trade in China. *Journal of International Economics*, *104*, 85–103. https://doi.org/10.1016/j.jinteco.2016.10.010

Brandt, L., Van Biesebroeck, J., & Zhang, Y. (2012). Creative accounting or creative destruction? Firm-level productivity growth in Chinese manufacturing. *Journal of Development Economics*, *97*(2), 339–351.

Broda, C., & Weinstein, D. (2004). Variety growth and world welfare. *American Economic Review: Papers and Proceedings*, *94(2)*, 139–144. https://doi.org/10.1257/0002828041301443

Broda, C., & Weinstein, D. (2006). Globalization and the gains from variety. *Quarterly Journal of Economics*, *121(2)*, 541–585. https://doi.org/10.1162/qjec.2006.121.2.541

Choi, Y., & Hahn, C. (2013). Effects of imported intermediate varieties on plant total factor productivity and product switching: Evidence from Korean manufacturing. *Asian Economic Journal*, *27*(2), 125–143. https://doi.org/10.1111/asej.12006

Coe, D., & Helpman, E. (1995). International R&D spillovers. *European Economic Review*, *39(5)*, 859–887.

Fan, H., Li, Y., & Yeaple, S. (2015). Liberalization, quality, and export prices. *Review of Economics and Statistics*, *97*(5), 1033–1051.

Feenstra, R. (1994). New product varieties and the measurement of international prices. *American Economic Review*, *84(1)*, 157–177.

Feenstra, R., Li, Z., & Yu, M. (2014). Exports and credit constraints under incomplete information: Theory and application to China. *Review of Economics and Statistics*, *96*(4), 729–744.

Feng, L., Li, Z., & Swenson, D. (2016). The connection between imported intermediate inputs and exports: Evidence from Chinese firms. *Journal of International Economics*, *101*, 86–101.

Goldberg, P. K., Khandelwal, A. K., Pavcnik, N., & Topalova, P. (2009). Trade liberalization and new imported inputs. *American Economic Review*, *99*(2), 494–500. https://doi.org/10.1257/aer.99.2.494

Goldberg, P. K., Khandelwal, A. K., Pavcnik, N., & Topalova, P. (2010). Imported intermediate inputs and domestic product growth: Evidence from India. *Quarterly Journal of Economics*, *125*(4), 1727–1767. https://doi.org/10.1162/qjec.2010.125.4.1727

Gopinath, G., & Neiman, B. (2014). Trade adjustment and productivity in large crises. *American Economic Review*, *104*(3), 793–831. https://doi.org/10.1257/aer.104.3.793

Halpern, L., Koren, M., & Szeidl, A. (2011). *Imported inputs and productivity* (Working Paper 8). Budapest, Hungary: Center for Firms in the Global Economy.

Kasahara, H., & Lapham, B. (2013). Productivity and the decision to import and export: Theory and evidence. *Journal of International Economics*, *89*(2), 297–316. https://doi.org/10.1016/j.jinteco.2012.08.005

Kasahara, H., & Rodrigue, J. (2008). Does the use of imported intermediates increase productivity? Plant-level evidence. *Journal of Development Economics*, *87(1)*, 106–118. https://doi.org/10.1016/j.jdeveco.2007.12.008

Keller, W. (2002). Trade and the transmission of technology. *Journal of Economic Growth*, *7*(*1)*, 5–24.

Khandelwal, A. (2010). The long and short (of) quality ladders. *Review of Economic Studies*, *77*(4), 1450–1476. https://doi.org/10.1111/j.1467-937X.2010.00602.x

Klenow, P., & Rodriguez-Clare, A. (1997). *Quantifying variety gains from trade liberalization*. Chicago, IL: Graduate School of Business, University of Chicago.

Lim, K., Trefler, D., & Yu, M. (2018). *Trade and innovation: The role of scale and competition effects, Working Paper*. Toronto, Ontario, Canada: University of Toronto.

Liu, Q., & Qiu, L. (2016). Intermediate input imports and innovations: Evidence from Chinese firms' patent filings. *Journal of International Economics*, *103*, 166–183. https://doi.org/10.1016/j.jinteco.2016.09.009

Navas, A., Serti, F., & Tomasi, C. (2013). *Intermediate inputs and the export gravity equation* (Working Paper No. 2013-014). Sheffield, UK: Department of Economics, The University of Sheffield.

Olley, G. S., & Pakes, A. (1996). The dynamics of productivity in the telecommunications equipment industry. *Econometrica*, *64*(6), 1263–1297. https://doi.org/10.2307/2171831

Seker, M., Rodriguez-Delgado, D., & Mehmet, F. U. (2015). *Imported intermediate goods and product innovation: Evidence from India* (Working Paper). Ankara, Turkey: Central Bank of the Republic of Turkey.

Tian, W., & Yu, M. (2016). Processing trade, export intensity, and input trade liberalization: Evidence from Chinese firms. *Journal of the Asia Pacific Economy*, *20*(3), 444–464. https://doi.org/10.1080/13547860.2015.1054169

Tian, W., & Yu, M. (2017). Firm R&D, processing trade and input trade liberalisation: Evidence from Chinese firms. *World Economy*, *40*(2), 297–313.

Topalova, P., & Khandelwal, A. (2011). Trade liberalization and firm productivity: The case of India. *Review of Economics and Statistics*, *93*(3), 995–1009. https://doi.org/10.1162/REST_a_00095

Trefler, D. (2004). The long and short of the Canada–U.S. free trade agreement. *American Economic Review*, *94*(4), 870–895. https://doi.org/10.1257/0002828042002633

Yu, M. (2015). Processing trade, tariff reductions, and firm productivity: Evidence from Chinese firms. *Economic Journal*, *125*(585), 943–988. https://doi.org/10.1111/ecoj.12127

Yu, M., & Tian, W. (2012). China's processing trade: A firm-level analysis. In H. McMay & L. Song (Eds.), *Rebalancing and sustaining growth in China* (pp. 111–148). Canberra, ACT, Australia: Australian National University E-Press.

How to cite this article: Tian W, Yu M. Input trade liberalization and import switching: Evidence from Chinese firms. *Rev Int Econ*. 2019;27:1002–1020. https://doi.org/10.1111/roie.12410