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This paper provides a theoretical and empirical analysis of the effects of market competition and market expansion on firms' product line decisions. The theoretical model explicitly incorporates cost of management and firm heterogeneity in terms of managerial efficiency. Both the theoretical and empirical analyses show that the home country's final-goods tariff cut (which captures market competition) reduces all home firms' export product line, whereas in response to the foreign country's tariff cut (which represents market expansion), firms with high (low) managerial efficiency expand (reduce) export product lines. Our empirical analysis is based on data on Chinese firms from 2000 to 2006. The findings are robust to many specifications of the empirical model.

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1 Introduction

Firms compete in many dimensions and one for them is product lines. What determine product lines in equilibrium? The literature has emphasized the importance of competition in markets characterized by oligopolistic competition (e.g., Brander and Eaton, 1984). It is very challenging to empirically test those models and their predictions. In this study, we explore the product line issue based on monopolistic competition (to avoid strategic interaction) and Chinese data.

In response to changes in market conditions, different firms may adjust their product lines (or product scope) differently. In this study, we focus on firm heterogeneity in managerial efficiency because the literature already has extensive studies on firm heterogeneity in production productivity. We also focus on firms' export product scope because our data does not include information of product varieties sold in the domestic market (China). Specifically, we assume (in the theoretical model) that domestic firms are of two types, efficient ones with low management cost and inefficient ones with high management cost. Our model produces two predictions. First, a drastic domestic tariff cut reduces a firm's export product scope and total product scope (the number of products produced). Second, foreign tariff cuts exert two effects on each product exported by a Chinese firm. On the one hand, a reduction in foreign tariff lowers the "costs" of all Chinese exports. On the other hand, the foreign tariff cut induces all Chinese exporters to lower their prices, which in turn makes the foreign market competition tougher. Our analysis shows that under certain conditions, the positive cost effect outweighs the negative competition effect for the marginal products of efficient firms; however, the opposite is true for the marginal products of inefficient firms. Consequently, efficient firms expand their export product scope in response to foreign tariff cuts, whereas inefficient firms reduce theirs.

To test the hypotheses, we conduct an empirical analysis based on Chinese firms' export product scope data from 2000 to 2006. The key part of the analysis is to construct a measure of managerial efficiency and another measure of productive efficiency. The usual estimated TFP is a mixed of both. We use firm's general and administrative (G&A) expenses *residuals* as a proxy for managerial efficiency, with a higher residual representing lower efficiency. Another key explanatory variable is tariff reduction. Our main empirical analysis finds strong support for our theoretical prediction: in response to Chinese tariff cuts, all

Chinese firms reduce their export product scope; in response to foreign tariff cuts, Chinese firms with high managerial efficiency expand their export product scope, whereas those with low managerial efficiency reduce theirs. The estimation results are robust to different estimation approaches and measurements.

The present study is related to several strands of literatures. We introduce managerial efficiency as a source of firm heterogeneity and show that this heterogeneity, rather than the commonly-considered heterogeneity in production productivity, differentiates the responses of firms to trade liberalization. The importance of managerial efficiency and its difference from production productivity have been emphasized in management science literature. For example, Gort and Lee (2003) utilize American industrial data and found that managerial efficiency contributes substantially to TFP in American manufacturing sectors. They identify three sources of managerial efficiency, namely, superior initial managerial endowments, the accumulation of managerial knowledge through learning, and the impact of an effective market for managerial resources internal to the firm. These sources of managerial efficiency are different from a firm's production productivity. Bloom and van Reenen (2007) provide a method to measure firm's managerial efficiency. They use international survey data to score firms from one (poor management) to five (best management) based on 18 criteria. They find strong evidence that poor management practices are more likely when family-owned firms choose their Chief Executive Officers (CEO) by *primogeniture* (i.e., the eldest male child in the family). Without such survey data, most studies in the literature use a firm's selling, general and administrative (SG&A) expenses as a proxy for management costs (e.g., Fisher and Ittner, 1999; Eisfeldt and Papanikolaou, 2013). They assume that high management cost implies high organization capital, and thus, represent high managerial efficiency. Different from this approach, inspired by Bloom and van Reenen (2007), we *estimate* a firm's managerial efficiency using general and administrative (G&A) expenses, controlling for firm size, export status and markup. Low G&A expenses residual represents high managerial efficiency.

In the theoretical literature of multiproduct firms in international trade, all studies assume firm heterogeneity in production productivity and most, with the exception of Nocke and Yeaple (2014) and Qiu and Zhou (2013), predict that in response to *bilateral* trade liberalization, all firms (less productive and more productive) reduce their product scope (Arkolakis and Muendler, 2011; Baldwin and Gu, 2009;

Bernard et al., 2011; Dhingra, 2013; Eckel and Neary, 2010; Feenstra and Ma, 2008). Existing theoretical analyses have offered a clear picture and explanation (see Qiu and Zhou, 2013). On the one hand, domestic trade liberalization exerts a negative impact (the competition effect) on a firm's profit from each product. On the other hand, a foreign country's trade liberalization provides a positive opportunity (the market expansion effect) to a firm's profit from each product. The net effect is negative (resulting in product scope reduction) for low productivity firms, but may be positive (resulting in product scope expansion) for high productivity firms. In this paper, we argue that firms differ not only in production productivity, but also in many other aspects, such as managerial efficiency. Firm heterogeneity in management cost could generate results different from firm heterogeneity in production cost.[1]

Existing empirical studies on multiproduct firms generally find that trade liberalization has significant effects on firms' product scope choice. Despite the fact that most theoretical studies focus on bilateral trade liberalization, many empirical studies highlight *unilateral* trade liberalization. Iacovone and Javorcik (2010) document the phenomenon of product "churning" among Mexican firms as a result of improved access to foreign markets, that is, a substantial number of Mexican firms discontinue several existing products and simultaneously develop new products for export. Goldberg et al. (2010) show that from 1989 to 2003 when intensive trade and other reforms took place in India, Indian firms added more product lines than what they discontinued; the discontinuance was unrelated to tariff reduction. In contrast, Liu (2010) finds that increased import competition results in the US public firms shrinking the product scope through refocusing on the core competence products. In our study, Chinese exporters' data are utilized to examine the effects of tariff cut in China and that in foreign countries, respectively. Our results show that managerial efficiency is important in determining the extent to which firms adjust their export product scope.

The rest of this paper is organized as follows. In Section 2, Chinese data are utilized to conduct a preliminary empirical analysis on Chinese firms' response to trade liberalization without differentiating them by managerial efficiency. The theoretical model with firm heterogeneity in managerial efficiency is introduced and analyzed in Section 3. Chinese data are employed in Section 4 to test the main theoretical

[1] Nocke and Yeaple (2014) introduced two dimensions of firm heterogeneity: organizational capital and organizational efficiency. These two types of capability result in a trade-off between producing more products with lower productivity and producing less products with higher productivity. Managerial efficiency is very different from organizational capability.

predictions. Section 5 provides the concluding remarks.

2 Empirical Analysis without Managerial Efficiency

2.1 Estimation Framework and Measures

A firm's *total product scope* is defined in this study as the total number of products that the firm produces and sells to the markets (either domestic or foreign). *Export product scope* is defined as the total number of products that the firm sells to the foreign markets. A firm's export product scope is mainly determined by the profitability of a firm's products in the foreign market, which in turn is affected by many factors, including GDP, productivity, and trade costs. A firm's domestic market profitability affects its total product scope, but may or may not affect its export product scope.

We focus on two explanatory variables to determine how changes in trade costs affect Chinese firms' export product scope. The first variable is the home country's import tariffs (referred to as *home tariff* and denoted by HT hereafter), and the second one is the foreign countries' import tariffs (referred to as *foreign tariff* and denoted by FT hereafter). Accordingly, the following empirical equation is established:

$$e_{it} = \beta_0 + \beta_1 TFP_{it} + \beta_2 HT_{it} + \beta_3 FT_{it} + \boldsymbol{\theta}\boldsymbol{\Psi}_{it} + \epsilon_{it}, \tag{1}$$

where e_{it} is firm i's export product scope, TFP_{it} is firm i' total factor productivity,[2] HT_{it} is the home (Chinese) tariff level faced by firm i, and FT_{it} is the foreign tariff level faced by firm i, all in year t. $\boldsymbol{\Psi}_{it}$ is a vector of control variables, including export market size (foreign countries' GDP), ownership type (state-owned enterprise, foreign-invested enterprise, or others), and trade mode (processing or ordinary trade).

Although a country has many tariff lines, tariffs that are not relevant to a particular firm may not have an impact on the firm's export product scope. Inspired by Lileeva and Trefler (2010), we thus construct *firm-specific tariff* to better evaluate the effects of tariff changes on firms' export product scope. For home tariffs, suppose that a firm produces a set of products for the domestic market. The firm's profit will be affected directly by all tariff lines in this product set. A tariff line will have a more significant

[2] Given that Chinese product-level production data are unavailable, we assume that firms have a common productivity level and production function across goods Alternatively, we can view TFP_{it} as the average producitivy of all products.

effect if the firm has a larger share of the corresponding product in its total domestic sales. Thus, a firm-specific tariff should be the average of all relevant tariffs weighted by the share of each product's sales. However, data on product-level domestic sales are unavailable. Thus, we adopt a less satisfactory approach by using the share of a firm's export to substitute the share of its domestic sales, as in Yu (2015). Specifically, we introduce the following measure as firm i's home tariff:

$$HT_{it} = \sum\nolimits_{k \in E_{it}} \left(\frac{X^k_{i,initial\_year}}{\sum_{k \in E_{it}} X^k_{i,initial\_year}} \right) \tau^k_t, \tag{2}$$

where E_{it} is the set of firm i's export products in year t, $X^k_{i,initial\_year}$ is firm i's exports of product k in the first year the firm appears in the sample, and τ^k_t is the home country's ad valorem tariff on product k in year t. Inspired by Topalova and Khandelwal (2011), we fix exports for each product at the initial period to avoid possible reverse causality (endogeneity problem) in firm's export scope with respect to measured home tariffs. However, such a measure still faces some possible caveats which will be discussed later.

The construction of firm-specific foreign tariffs is more complicated than the construction of home tariffs because firms not only export multiple products, but also export them to multiple countries, with different subsets of products for different countries. The following measure of FT_{it} is proposed in this study to capture the relative importance of different tariffs of different foreign countries.

$$FT_{it} = \sum_{k \in E_{it}} \left[\frac{X^k_{i,initial\_year}}{\sum_{k \in E_{it}} X^k_{i,initial\_year}} \sum_{c \in C_{it}} \left(\frac{X^{kc}_{i,initial\_year}}{X^k_{i,initial\_year}} \right) \tau^{kc}_t \right], \tag{3}$$

where τ^{kc}_t is product k's ad valorem tariff imposed by country c in year t, $X^{kc}_{i,initial\_year}$ is the value of firm i's export of product k to country c in the first year the product appears in the sample, $X^k_{i,initial\_year} = \sum_{c \in C_{it}} X^c_{ik,initial\_year}$, and C_{it} is the set of countries where firm i has exports in year t. The ratio $\frac{X^{kc}_{i,initial\_year}}{X^k_{i,initial\_year}}$ represents the share of firm i's product k exported to country c in the first year the firm appears in the sample, which captures the relative importance of τ^{kc}_t in affecting firm i's product k export. Thus, $\sum_{c \in C_{it}} (\frac{X^{kc}_{i,initial\_year}}{X^k_{i,initial\_year}}) \tau^{kc}_t$ is the time-invariant weighted average of foreign tariffs on product k for firm i. Such a time-invariant weight can avoid the aforementioned endogeneity of weighted tariffs.

We next turn to TFP_{it}. Although many methods can be employed to measure a firm's TFP, we adopt the Olley-Pakes (1996) approach to estimate each Chinese firm's TFP (referred to as TFP1).[3] We modify the standard Olley-Pakes approach to better reflect the reality in China. First, following Feenstra et al. (2014), we use deflated output and input prices at the firm-product level to measure TFP. Second, we use real capital depreciation to construct a firm's real investment (the perpetual inventory method).[4] Third, we consider the effect of China's WTO accession in 2001 and the processing behavior of firms in TFP realization. A detailed description of the augmented Olley-Pakes TFP measures is provided in online Appendix C.

2.2 Data

Regression of model (1) and construction of *HT*, *FT* and *TFP* require extensive information. Thus, we employ three highly disaggregate panel datasets: product-level tariff data of every country, firm-level production data of Chinese firms, and firm and product-level trade data of Chinese firms. A brief description of these datasets is provided below, and detailed discussions are provided in online Appendix A.

Tariffs data. Tariff levels of all WTO members are provided at HS six-digit level on the WTO official webpage.[5]

Firm production data. China's National Bureau of Statistics maintains a rich database derived from

[3]The Levinsohn and Petrin (2003) approach is also a popular method to construct TFP. In this approach, materials (*i.e.*, intermediate inputs) are used as a proxy variable. Yu (2015) argues that this approach is appropriate for firms that do not utilize a large amount of imported intermediate inputs, and so it is less appropriate for our study because Chinese firms rely substantially on imported intermediate inputs whose prices are significantly different from those of domestic intermediate inputs (Halpern *et al.*, 2015). Nonetheless, our results do not change qualitatively when Levinsohn-Petrin (2003) TFP, System-GMM TFP, or Ackerberg et al.(2006) TFP is employed. Estimates that employ such TFP measures are not reported to save space but are available upon request.

[4]Firm-level data only provide the book value of each firm's capital stock. However, the original value of each firm's capital stock must be obtained for TFP estimation. To solve this problem, we assume $A_t = A_o \Pi_{s=o}^{t}(1 + r_s)$, where A_t is the book value of a firm's capital stock in year t, A_o is the original value of the firm's capital stock when it is purchased in year o, and r_s is the estimated province-industry-level growth rate of nominal capital stock in year s obtained from Brandt et al. (2012). If A_t and r_s are known for each firm, the firm's original nominal book value can be determined accordingly. Approximately 40% of observations have missing investment data, but this is not a problem because our estimation results do not change qualitatively when other measures of TFP are employed as shown later.

[5]Data can be accessed at http://tariffdata.wto.org/ReportersAndProducts.aspx. The data from Trade Analysis and Information System generally have missing values, particularly data on the tariffs imposed by other countries on Chinese exports. The product-destination-year combinations that have missing tariffs are thus dropped out.

annual surveys of large manufacturing enterprises in China. This database, called the Chinese Manufacturing Enterprises (CME) database, includes all state-owned enterprises (SOEs) and large non-SOEs whose annual sales are more than RMB five million (about US$604,600 at the exchange rate 8.27yuan/$, prevailing during most of the time in our sample period). Approximately $162,885$ firms are included in 2000 and $301,961$ in 2006. The CME database contains information of more than 100 financial variables obtained from each firm's accounting statement. The database has obvious omissions and errors. Following Feenstra et al. (2014), we clean the database as follows. We eliminate the observations (i.e., firms) wherein some key financial variables (such as total assets, net value of fixed assets, sales, and gross value of industrial output) are missing, or the number of employees is less than eight.[6] According to the basic rules of the generally accepted accounting principles, we also exclude the observations wherein (i) liquid assets are larger than total assets, (ii) total fixed assets are larger than total assets, (iii) the net value of fixed assets is larger than the total assets, (iv) the firm's identification number is missing, or (v) the firm's establishment time is invalid.

Export data. China's General Administration of Customs maintains a highly disaggregate trade database wherein each international trade transaction is recorded. The database contains a large variety of information about each trading firm, including each product's price, quantity, value, and destination. Product information is available at the HS eight-digit level. We use this database to calculate each Chinese firm's export product scope and construct the weights used in HT and FT of each firm. Some firms export products that belong to more than one industry. Considering that our focus is on within-industry multiproduct analysis, we assign a firm to an industry at HS 2-digit level, in which the firm has the most number of export products.

Our study requires the merging of the Customs database and CME database. Matching the two is challenging because they use completely different firm-identification systems. As in Yu (2015), by using the firms' Chinese names, zip codes, and telephone numbers, we are able to match 76,946 firms, which account for more than 40% of the manufacturing firms reported in the CME database and approximately

[6] The reason for selecting eight workers as the threshold is that firms with less than eight employees fall under a different legal regime, as pointed out by Brandt *et al.* (2012). We adopt this criterion also because a very small company may not have a good accounting/reporting system. However, our results are not sensitive to this critical level.

53% of the export value reported in the Customs database.[7] This representation is comparable to that of Bernard et al. (2009) for US data and Wang and Yu (2012) for Chinese data.

The summary statistics are reported in Table 1 which has three sub-tables. Tables 1A and 1B show that export product scope has a very large variation: The minimum of export product scope is 1 (i.e., a single product), whereas the maximum is 527, with the mean equal to 6.72. Approximately 79% of the Chinese firms (in our merged dataset) exported more than a single product from 2000 to 2006 and accounted for 91.4% of the total exports. Moreover, approximately two-thirds of the firms exported less than 5 products, 90% exported less than 15 products, and only 5% exported more than 25 products.

As shown in Table 1C, China's home tariffs (measured at both industry and firm levels) declined by approximately 50% from 2000 to 2006. Industry-level foreign tariffs (at 2-digit Chinese industrial classification level) also declined around 28% during the same period. By contrast, firm-level foreign tariffs FT decreased by only 3%. One possible reason for the slight decline of firm-level foreign tariffs is that most important export destinations for Chinese firms are developed countries which typically had low import tariffs in the beginning year (i.e., in 2000) of our sample [see Yu (2015) for a detailed discussion].

[Table 1]

2.3 Estimates

The estimation results from model (1) could differ both quantitatively and qualitatively depending on our assumption about the distribution of the dependent variable. We first assume a normal distribution. The OLS regression estimates are shown in column (1) of Table 2. Both home and foreign tariffs are positively associated with firms' export product scope. This result indicates that firms reduce their export product scope in response to both home and foreign tariff cuts.

[Table 2]

Our data clearly show that most of the firms export a small number of products, and only a few of them export a very large number of products. This observation suggests that the dependent variable does

[7] Our merged dataset has higher mean of sales than the full-sample CME database; this finding indicates that large firms are more likely to be matched. The same matching procedure is also used by Yu and Tian (2012).

not follow a normal distribution. Thus, the OLS result could be biased. Because our dependent variable is a non-negative count number, the use of count-data estimates would be more reliable (Cameron and Trivedi, 2005). Given that Poisson distribution is the most popular discrete distribution used to capture the characteristics of count data, we also calculate the Poisson estimate (with a clustered robust standard error). The regression results are shown in column (2) of Table 2. The result obtained from OLS remain valid qualitatively: Both home and foreign tariffs have positive and significant effects on export product scope.

Although Poisson distribution is the most popular approach for count data, it may not provide the best representation of our sample distribution. Poisson distribution requires that the mean and variance of a firm's export product scope be identical. However, our data reveal that the variance of the sample ($var(e) = 103.9$) is approximately 15 times larger than its mean ($\bar{e} = 6.72$), which indicates that Poisson distribution does not provide a good representation of our data. Moreover, our test of the goodness of fit for the Poisson model reports an extremely large χ^2 value (607,445), which again confirms the inappropriateness of Poisson distribution for our dependent variable.

We then resort to negative binomial distribution which allows the sample to exhibit a pattern of over-dispersion. In fact, when drawing a graph based on the proportion of firms with different export product scope, we notice that the negative binomial distribution approximates the observed distribution much better than the Poisson distribution. Since around 80% of the exporters have export product scope less than 10, we assume 10 as the maximum value of the discrete level. We report the negative binomial regression results in column (3) of Table 2. We find that the over-dispersion parameter α generated by the likelihood ratio test is significantly different from zero (we obtain $\alpha = .847$ from the regression), indicating that negative binomial distribution is a good probabilistic representative of our data.[8] The coefficients of both home and foreign tariffs are positive and statistically significant. We include year-specific fixed effects in the regressions because several other time-variant variables, such as exchange rate, may affect the firms' optimal export product scope. We also include firm-specific fixed effects to control for the

[8] We also perform regression based on gamma distribution and obtain results very similar to those from negative binomial distribution. These results are not presented in the table to save space but are available upon request.

effects of firm-invariant variables, such as firm location.[9] The fixed-effect negative binomial estimates are presented in column (4) of Table 2. The coefficients of home and foreign tariffs are again positive and highly significant. When year fixed effect is introduced, another control variable, China's GDP, is dropped out automatically.

All estimates in Table 2 show that more-productive firms have a larger export product scope, a prediction by all existing theoretical studies on multiproduct firms. Gravity models indicate that the GDP of two trading countries has positive effects on bilateral trade flows. We obtain some effects of gravity on export product scope. On the one hand, we find that the GDP of foreign countries raises the export product scope of Chinese firms. Note, to better evaluate the effects of foreign countries' GDP, we construct and use firm-specific GDP in our analysis by using the share of a firm's export to each country as the weight of the corresponding importing country's GDP. In addition, a firm's capital-labor ratio has a negative effect on its export product scope. SOEs have larger export product scopes than non-SOEs.

Six important caveats relate to the analysis and effects of home tariffs. First, two groups of firms are special. One group includes the pure domestic firms which do not have any exports; thus, their export product scope (zero) is insensitive to changes in home and foreign tariffs. In fact, our estimates do not include any pure domestic firms since, by construction, all firms in our sample are exporting firms. Another group consists of pure exporting firms which have no domestic sales; thus, home tariffs do not have any effect on their export product scope. We re-run the regression by omitting pure exporting firms from the sample. The regression results are shown in column (5) of Table 2. All the coefficients are very close to their counterparts in column (4). This result implies that omitting them from the sample does not change our estimation results.

Second, HT_{it} disregards tariffs on intermediate inputs. However, changes in the intermediate inputs' tariffs will affect the final goods' profits, which then affect firms' decisions on export product scopes. Moreover, trade liberalization in final goods is often accompanied by trade liberalization in intermediate goods. Hence, the cost effects associated with tariff changes in intermediate goods must be controlled. Accordingly, we include "home input tariffs" as an additional independent variable. Processing imports

[9] Firm-specific fixed effects in the negative binomial model apply to the distribution of the dispersion parameter (Hardin and Hilbe, 2003).

are duty-free in China; hence, even firms that import the same set of inputs may face different effective tariffs. This phenomenon makes it more difficult to construct firm-specific "home input tariffs." Given that a firm can engage in both processing and non-processing imports, we adopt the index of firm-specific input tariffs (FIT_{it}) suggested by Yu (2015) as our firm-level "home input tariffs". The index is

$$FIT_{it} = \sum_{k \in O_i} \frac{m^k_{i,initial\_year}}{\sum_{k \in M_i} m^k_{i,initial\_year}} \tau^k_t, \tag{4}$$

where $m^k_{i,initial\_year}$ is the value of firm i's imports of intermediate good k in the first year the firm appears in the sample, O_i is the set of firm i's non-processing imports, and M_i is the set of the firm's total imports. The set of processing imports does not appear in (4) because processing imports are duty free. FIT_{it} is constructed with time-invariant weights to avoid the aforementioned endogeneity of weighted tariffs, measuring the import weight of each product based on data on the firm's first year in the sample. Table 3 shows the negative binomial estimates when two new control variables–"home input tariffs" and "processing indicator"–are included. Trade liberalization in intermediate goods imports lowers export product scope. This result is counter-intuitive in the sense that exporters might increase their product scopes with the cost-saving effect from declining input trade costs. However, the result is reversed for firms that are less-integrated to processing trade to be shown later. In addition, firms that engage in processing trade are found to have smaller export product scopes than firms that only engage in non-processing trade.[10] In any case, the inclusion of such a control variable does not alter the effects and significance of the two key variables: home tariffs and foreign tariffs on the final goods.

We now turn to discuss the economic magnitudes of such two key variables. Since our estimates are negative binomial, it is inappropriate to interpret the coefficient as the marginal effect. We hence take a step forward to estimate the semi-elasticity, $dy/d(\ln \mathbf{X})$, where y denotes firm's export product scope and $\mathbf{X}$ denotes all regressors. The results are reported in column (2) of Table 3. The marginal effects of home and foreign tariffs are 1.149 and 0.182, respectively, suggesting that a 10 percentage point fall in home (or foreign) tariff leads to a cut of around 11 (or 2) export product varieties. Such effects are indeed sizable.

[10] Some firms change their types of ownership and trade mode. Hence, SOE, foreign, and processing indicators are not eliminated from the fixed-effects estimates. The transitional probability matrixes are not reported to save space but are available upon request.

[Table 3]

The third caveat is that input tariff reduction may have an impact on the cost of obtaining capital goods. The effect may be different from the intermediate input cost-saving effects that we have already controlled. To address such a concern, we drop capital goods in our analysis. To do that, we appeal to the classification of Broad Economic Categories (BEC). According to BEC, capital goods are mostly concentrated in Sectors 41 and 521, which broadly concord with products in Chinese Industrial Classification Sectors 36 and 37. We drop these two product categories and re-run the regression. The results are reported in column (3) of Table 3, which are similar as before.

The fourth caveat is that in constructing HT_{it}, we assume that the share of each product a firm sells in the domestic market is the same as that in the foreign markets. This is definitely untrue, but we would not be able to solve the problem directly because of data limitation. As mentioned before, we have tried to eliminate pure exporting firms from the sample to address this problem in part because such firms violate the aforementioned assumption to the largest degree. We have also performed the following auxiliary regressions to verify the robustness of the main results. China holds an important position in global supply chains (GSCs), and different firms engage in GSCs at different degrees (Yu, 2013). As a result, the differences between their sales distribution in the domestic market and that in foreign markets are also different. We classify all two-digit Chinese industries into two groups, namely, less integrated and more integrated, according to their "production depth" of engaging in GSCs, which is measured by the ratio of value-added to gross industrial output (OECD, 2010). The division line is the mean of the production depth ratio across industries. We then run the regressions separately for these two groups and obtain the estimates in columns (4) and (5) of Table 3. These two groups have different degrees of approximation to the "equal share" assumption; however, we find that for both the less-integrated group and more-integrated group, home tariffs have the same qualitative results (sign and significance) as in the main model and so do the foreign tariffs. Hence, our main findings are not sensitive to the "equal share" assumption.

The fifth caveat is related to the specific construction of the two tariffs. First, FT_{it} does not include tariffs on products that firm i does not produce and export in the initial year. An implicit assumption is that the firm should not respond to tariff changes in other products which it does not produce and export before. This is obviously not an innocuous assumption. For example, suppose that a firm produces and exports products x and y, but not product z. Suppose that there is a large tariff reduction in product z in the foreign countries. Producing and exporting z then becomes profitable for the firm. As shown by Kehoe and Ruhl (2013), this export extensive margin is very important, contributing to around a quarter of trade growth between the US and China, Chile, and Korea. Indeed, the missing extensive margin effect is also reflected from the small over-time variation of the index of FT_{it} as discussed in Table 1C. To capture such important extensive margin, we can adopt an industry-wide, as opposed to firm-specific, tariff to replace FT_{it} in the regression. Note that adding additional tariff lines to FT_{it}, i.e., using industry-wide tariff, does not necessarily mean a stronger positive effect because in the above hypothetical example, after producing z, its profit from existing products may decrease (e.g., drawing resources away from production of existing products). Thus, the total product scope may expand or shrink, depending on how the existing products' profits are affected. We leave this analysis to the robustness checks later.

Second, HT_{it} does not include tariffs on products that firm i does not produce in the initial year. However, given its distinct nature as compared to FT_{it}, the problem is less serious. To see this, let us go back to the previous example in which a firm produces products x and y, but not product z. It is quite clear when there is a large tariff reduction in product z in home country, the increased competition in this product market makes it even less profitable to produce z. Therefore, we probably will not miss out any important effects using our firm-specific home tariffs in the regression. Nevertheless, let us deal with this issue by adopting an industry-wide tariff to replace HT_{it} in the analysis. The regression results are presented in column (6) of Table 3. The coefficients of both home and foreign tariffs are positive and significant.

The sixth caveat is that tariff changes may induce a new entry. The export product scopes of new entrants may differ significantly from those of the incumbents. In this case, the estimate may not reflect the actual effects of tariff changes on existing firms' export product scope because it also includes the new entrants' export product scope. To address this issue, we run a balanced panel regression to separate these effects and report the results in the last column of Table 3. The sign and significance of the home tariff effects do not change.

2.4 Role of Firm Heterogeneity in Productivity

The general conclusion from Table 3 is that Chinese firms reduce their export product scope in response to home and foreign tariff cuts. As Qiu and Zhou (2013) point out, existing theoretical studies and empirical findings show that heterogeneous firms with different productivity levels may or may not respond to trade liberalization in the same manner with regard to their product scope adjustment. To investigate this issue with Chinese data, we divide all firms into two groups: low productivity and high productivity firms *within* each industry. We then combine all low (high) productivity firms from all industries as the low (high) productivity category. Columns (1) and (2) of Table 4 show the negative binomial estimates for the low productivity category and the high productivity category. The coefficients of home and foreign tariffs are again positive and significant. That is, the low productivity and high productivity Chinese firms adjust their export product scope in the same direction in response to tariff cuts. Firm heterogeneity in productivity does not matter in this regard.

[Table 4]

2.5 Endogeneity Issues

Our estimates in Tables 2-4 thus far may encounter the endogeneity issue. When firms are forced to reduce their export product scope because of the tough import competition induced by home tariff cuts, they may lobby the government for imposing temporary trade restrictions (Grossman and Helpman, 1994; Bown and Crowley, 2013). Thus, export product scope could reversely affect home tariffs (HT_{it}).[11] Evidence for such a phenomenon exists in developed countries, such as the U.S. (Goldberg and Maggi, 1999). This phenomenon may not occur in China because of China's special policy regime and strong regulations on labor unions. Nevertheless, we check whether our main results are sensitive to this potential problem. We control for such reverse causality by using an IV approach.

[11] However, it is not a worry for the reverse causality of foreign tariffs (FT_{it}) since Chinese firm's export product scope would not reversely affect the import tariffs imposed by *all* trading partners. This is especially true when foreign tariffs are already measured by time-invariant weight.

Inspired by Trefler (2004) and Amiti and Konings (2007), here we construct a one-year lag of home tariffs as the instrument by replacing τ_t^k in Eq. (2) with $\tau_{t-1.}^k$ The idea is that the government is generally hard to remove the high protection status quo from an industry with high tariffs, perhaps due to the pressure from domestic special interest groups. Thus, compared to other industries, sectors with high tariffs one year ago would still have relatively high tariffs in the current year.

We report the IV Poisson estimates in the rest of Table 4 in which column (3) reports the second-stage regression results and column (4) exhibits the first-stage estimation results. All variables in columns (3)-(4) are measured at their absolute levels with "home tariffs" as an endogenous variable whereas a "one-year lag of home tariffs" serves as the instrument. After controlling for such endogeneity, both home tariffs and foreign tariffs are still positive and significant. In the first-stage results shown in column (4), the coefficient of one-year lag of home tariffs is found to be highly statistically significant, which tends to confirm our suspicion mentioned above that high protection is persist. As reported in Table 4, the high Anderson canonical correlated LM χ^2 statistic suggests that our IV estimates are not under-estimated. Similarly, the Cragg-Donald F statistics is above the critical values suggested by Stock and Yogo (2005). This result indicates that our IV estimates are not weakly identified.

2.6 Summary and Issues

Two important results are obtained in the above empirical analysis and they deserve further investigation and understanding. First, we find that firms adjust their export product scope *similarly* in response to home and foreign tariff cuts. However, these two types of tariff reduction have opposite effects on the firms. As indicated in the literature (e.g., Qiu and Zhou, 2013), bilateral trade liberalization poses both a threat and an opportunity to every firm. A home tariff cut intensifies domestic competition; this situation is not good for the home firms. By contrast, a foreign tariff cut makes the domestic firms' export more profitable. This conventional wisdom does not clarify our finding on Chinese firms' export product scope adjustment.

Second, we find that firms with different levels of productivity adjust their export product scope in the *same* direction in response to tariff cuts. However, recent literature on heterogeneous firms suggests that high productivity firms normally behave differently from low productivity firms.

We explore the two issues by first developing a theoretical model (in Section 3) and then testing the predictions from the model (in Section 4).

3 Theoretical Model and Analysis: Heterogeneity in Managerial Efficiency

Our model consists of a world with two countries: China and Foreign. Each country has two industries, namely, the numeraire goods industry and the differentiated products industry. Differentiated products are produced by a continuum of firms with measure 1, and the numeraire goods is produced by atomic firms.

3.1 Technologies

In China, every firm in the differentiated goods industry can produce multiple products. All firms employ the same production technology but have different managerial capabilities. On the production side, we suppose that a firm produces a set of products with measure s. We index the firm's core competency as product 0 and the others in descending productivity in $[0, s]$; this indexing captures the situation wherein products further away from the core competency become less productive. We let the unit cost of producing the ith product be $c_i = c + \theta i$, where $\theta > 0$ captures the decline of productivity. The unit cost of producing the core competency is c. Introducing a product is costly. If a firm introduces s products, a fixed cost equal to ks will exist, where $k > 0$.

On the management side, we assume that each firm in *each* market incurs a cost of managing *each* product line. This management cost is a fixed cost with regard to the sales value/volume, but is increasing with regard to the number of products. This is justified by the fact that a firm needs to have different sales teams for different product lines which have different features, functions and target consumers.[12] Moreover, we further assume that firms are of two types: *efficient* firms that have lower management cost, denoted by m_l per product line per market, and *inefficient* firms that have higher management cost, denoted by m_h per product line per market, with $m_h > m_l$. Let σ denote the fraction of efficient firms

[12] Here we assume constant marginal fixed cost per good for simplicity. In a more general case, we should allow part of the fixed costs to be shared across goods. After going through the analysis below in this section, it is not difficult to see that our results and the mechanism, through which tariff affects export product scope, will remain valid.

in the industry.

Given that our focus is on Chinese firms, we simplify the situation for foreign firms. We assume that a continuum of symmetric foreign firms produce the differentiated goods. All of them have the same marginal cost of production, which is assumed to be zero. Each firm produces a single product. There is no managing cost and product introduction cost. The measure of foreign firms is also assumed to be 1.

3.2 Product Markets

Following Melitz and Ottaviano (2008), we assume that Z identical consumers exist in China, with each having a quasi-linear preference for the numeraire good and all varieties from the differentiated goods industry:

$$U = Q_0 + \alpha \int_{i\in\Omega} q_i di - \frac{1}{2}\beta \left(\int_{i\in\Omega} q_i di \right)^2 - \frac{1}{2}\gamma \int_{i\in\Omega} q_i^2 di,$$

where α, β, and γ are all positive constants; Q_0 is the consumption of the numeraire good; Ω is the set of all varieties sold in the Chinese market; and q_i is the consumption of variety i. A consumer maximizes her utility subject to a budget constraint. As a result, the market demand for variety i by all Z consumers is $p_i = \alpha - \frac{\beta}{Z} \int_{j\in\Omega} q_j dj - \frac{\gamma}{Z} q_i$, from which we obtain the demand function for variety i as

$$p_i = A - bq_i, \text{ where } A = \frac{\alpha\gamma + \beta P}{\beta M + \gamma} \text{ and } b = \frac{\gamma}{Z}. \tag{5}$$

In the above demand function, p_i is the price of variety i, M is the measure of Ω, and $P = \int_{i\in\Omega} p_i di$ is the aggregate price of all varieties. Slope b is exogenous, but the intercept A is endogenous, depending on the degree of product substitution (β) and the degree of product market competition (captured by the endogenous P and M).

The set of varieties, Ω, is large; thus, the seller of variety i regards himself as a small monopolist of variety i whose decision has no direct effect on other products. Competition in the market is captured completely by the vertical intercept of the demand function (A).

The foreign country also has Z consumers and the same demand structure as China. In particular, the demand function for variety i is

$$p_i^* = A^* - bq_i^*, \text{ where } A^* = \frac{\alpha\gamma + \beta P^*}{\beta M^* + \gamma} \ . \tag{6}$$

In this demand function, M^* is the measure of the set of varieties sold in the foreign market, which is denoted by Ω_F, and $P^* = \int_{i \in \Omega_F} p_i di$ is the aggregate price of all varieties in the foreign market.

We assume that tariffs take the form of iceberg transport cost. We let t (> 1) and $t^*(> 1)$ denote China's tariff and the foreign country's tariff. Then, t units of a product must be produced by a foreign firm to sell one unit in the Chinese market, and t^* units of a product must be produced by a Chinese firm to sell one unit in the foreign market. Free trade exists in the numeraire good industry.

3.3 Firms' Decision

We first analyze the Chinese firms' decisions. Each firm takes A and A^* as given when making its decisions. Because all Chinese firms have the same production productivity, without loss of generality, we set $c = 0$ to reduce notation. Suppose that firm j ($j = l$ for efficient firm and $j = h$ for inefficient firm) decides to introduce a range of products, $[0, s_j]$, which is called the firm's *total product scope*, and export a range of products $[0, e_j]$, which is called the firm's *export product scope*.[13] With consumer preference and market size (Z) in the two markets being the same, Chinese firms have a disadvantage in the foreign market because they face trade protection in the foreign market. Hence, in equilibrium, a Chinese firm will not introduce a product that is exported to the foreign market but not sold to the domestic market, that is, $e_j \leq s_j$. If $e_j < s_j$, then some products ($i \in (e_j, s_j]$) are sold in the domestic market but are not exported; the firm's export products are a subset of its total products. This is the case when the fixed cost of product introduction (k) is not too large. We focus on this case in this section and discuss the case of $e_j = s_j$ in online Appendix B. Under this circumstance, the firm's decision in the home market is expressed as

$$\max_{s_j, q_i} \int_0^{s_j} \left[(A - bq_i)q_i - \theta i q_i\right] di - m_j s_j - k s_j. \tag{7}$$

It is easy to derive the set of first order conditions, from which we obtain the optimal quantity, price, and profit of each product as

$$q_{ji} = \frac{A - \theta i}{2b}, \;\; p_{ji} = \frac{A + \theta i}{2}, \;\; \text{and} \;\; \pi_{ji} = \frac{1}{4b}\left(A - \theta i\right)^2, \;\; \text{for all } i \in [0, s_j]. \tag{8}$$

[13] If a firm produces product $i \in [0, s]$, it will produce all products $i' < i$ because of the decreasing efficiency in $[0, s]$. If it exports product $i \in [0, e]$, it will export all products $i' < i$.

A stronger demand (i.e., a larger A) leads to a larger output, a higher price and a larger profit. We can also obtain the optimal total product scope from the first order conditions as

$$s_j = \frac{A - 2\sqrt{b(m_j + k)}}{\theta}. \tag{9}$$

The total product scope is larger with stronger market demand (A), lower management cost (m_j), lower cost of product introduction (k), and slower decline of productivity (θ).

Given $e_j < s_j$, the firm's optimal decision in the foreign market is provided by

$$\max_{e_j, q_i} \int_0^{e_j} [(A^* - bq_i)q_i - t^* \theta i q_i] di - m_j e_j. \tag{10}$$

From the first order conditions of the above maximization, we obtain the optimal quantity, price and profit of each export product for $i \in [0, e_j]$ as

$$q^*_{ji} = \frac{A^* - \theta i t^*}{2b}, \quad p^*_{ji} = \frac{A^* + \theta i t^*}{2}, \quad \text{and} \quad \pi^*_{ji} = \frac{1}{4b}\left(A^* - \theta i t^*\right)^2, \tag{11}$$

and the optimal export product scope as

$$e_j = \frac{A^* - 2\sqrt{b m_j}}{\theta t^*}. \tag{12}$$

The export product scope is larger with stronger market demand (A^*), lower management cost (m_j), slower decline in productivity (θ), and lower foreign tariff (t^*). A decrease in foreign tariff increases output and profit, but reduces price. Tougher competition (smaller A^*) reduces output, price and profit.

Based on the above results, we also obtain

$$\frac{\partial \pi^*_{ji}}{\partial t^*} < 0 \quad \text{and} \quad \frac{\partial^2 \pi^*_{ji}}{\partial i \partial t^*} < 0. \tag{13}$$

That is, every product benefits from foreign country's tariff cut, and due to the iceberg-transportation nature of tariff, products with higher i benefit more from the foreign country's tariff cut.

We now analyze the foreign firms. In the Chinese market, a foreign firm chooses its quantity to maximize its profit $(A - bq_{fc})q_{fc} - tq_{fc}$, where subscript fc stands for a foreign firm in the Chinese market. Thus, the optimal quantity, price, and profit of a foreign firm in the Chinese market are, respectively,

$$q_{fc} = \frac{A - t}{2b}, \quad p_{fc} = \frac{A + t}{2}, \quad \text{and} \quad \pi_{fc} = \frac{1}{4b}(A - t)^2. \tag{14}$$

In the foreign market, the foreign firm chooses its output to maximize its profit $(A^* - bq_{ff})q_{ff}$, where subscript ff stands for a foreign firm in the foreign market. The optimal quantity, price, and profit of a foreign firm in the foreign market are, respectively,

$$q_{ff} = \frac{A^*}{2b}, \quad p_{ff} = \frac{A^*}{2}, \quad \text{and} \quad \pi_{ff} = \frac{1}{4b}A^{*2}. \tag{15}$$

3.4 Market Equilibrium

Lastly, we determine equilibrium A and A^*.

Given that $A = \frac{\alpha\gamma+\beta P}{\beta M+\gamma}$, we first calculate M and P. By definition, $M = s_l\sigma + s_h(1-\sigma) + 1$. From (8), we obtain the aggregate price of firm j in the Chinese market as follows:

$$p_j = \int_0^{s_j} p_{ji}di = \frac{1}{2}As_j + \frac{1}{4}\theta s_j^2.$$

Each foreign firm's price in the Chinese market is given in (14). Thus, the aggregate price in the Chinese market is

$$P = \frac{1}{4}\left[2A\sigma s_l + \theta\sigma s_l^2 + 2A(1-\sigma)s_h + \theta(1-\sigma)s_h^2 + 2(A+t)\right].$$

To simplify the notation, we let $\delta = \frac{2\gamma}{\beta}$. Using the results in $A = \frac{\alpha\gamma+\beta P}{\beta M+\gamma}$ yields

$$A = \frac{2\alpha\delta + \theta[\sigma s_l^2 + (1-\sigma)s_h^2] + 2t}{2[\sigma s_l + (1-\sigma)s_h + 1 + \delta]}. \tag{16}$$

In the foreign market, the total number of products sold is $M^* = \sigma e_l + (1-\sigma)e_h + 1$. The aggregate price of Chinese exporter j is

$$p_j^* = \int_0^{e_j} p_{li}^* di = \frac{1}{2}A^* e_l + \frac{1}{4}t^*\theta e_j^2.$$

Each foreign firm's price is provided in (15). Thus, the aggregate price in the foreign market is

$$P^* = \frac{1}{4}\left[2A^*\sigma e_l + t^*\theta\sigma e_l^2 + 2A^*(1-\sigma)e_h + \ t^*\theta(1-\sigma)e_h^2 + 2A^*\right].$$

Using the results in $A^* = \frac{\alpha\gamma+\beta P^*}{\beta M^*+\gamma}$ yields

$$A^* = \frac{2\alpha\delta + \theta t^*[\sigma e_l^2 + (1-\sigma)e_h^2]}{2[\sigma e_l + (1-\sigma)e_h + 1 + \delta]}. \tag{17}$$

Substituting A in (9), we obtain two equations jointly determining the optimal total product scopes s_l and s_h, which are functions of t. Substituting A^* in (12), we obtain two equations jointly determining the optimal export product scopes e_l and e_h, which are functions of t^*.

3.5 Trade Liberalization

We analyze the respective effects of two types of trade liberalization on Chinese firms' export product scope. The first type of liberalization is tariff reduction in China (t), and the second type is tariff reduction in the foreign country (t^*).

We first examine $\frac{de_l}{dt}$ and $\frac{de_h}{dt}$. Based on the expression of e_j from (12) and A^* from (17), we immediately know that t does not have any direct effect on e_l and e_h. However, the optimal export product scope given in (12) is obtained under the condition that $e_l < s_l$ and $e_h < s_h$. The Chinese tariff cut may eventually result in the violation of this condition. We prove in online Appendix B that $\frac{ds_l}{dt} > 0$ and $\frac{ds_h}{dt} > 0$. Hence, when a tariff cut is implemented in China, Chinese firms reduce their total product scope (s_l and s_h). When tariff cuts are implemented continuously, the total product scope is eventually reduced to the level of the export product scope (e_l and e_h). Once $e_l = s_l$, the optimal export product scope of efficient Chinese firms is no longer given in (12), and once $e_h = s_h$, the optimal export product scope of inefficient Chinese firms is no longer given in (12). Then, we have $\frac{de_j}{dt} = \frac{ds_j}{dt} > 0$.

We then discuss the effect of foreign tariff cuts on Chinese firms' export product scope. We prove in online Appendix B that

$$\text{(i)}\ \ \frac{de_l}{dt^*} < 0, \text{ and (ii) } \frac{de_h}{dt^*} > 0 \ \text{ iff } m_h \text{ is sufficiently large.} \tag{18}$$

The above analysis allows us to establish the following proposition.

Proposition 1. *(i) Suppose that there is a drastic cut of import tariffs in China. Then a further tariff cut reduces all Chinese firms' export product scope.*

(ii) In response to a tariff cut by the foreign country, Chinese firms with high-managerial efficiency expand their export product scope, whereas those with low-managerial efficiency reduce their export product scope if and only if their management cost is sufficiently high (i.e., m_h is sufficiently large).

The results of the proposition are surprising. On the one hand, one may ask why a domestic tariff cut affects export product scope. On the other hand, one may ask why some exporters are negatively affected by a foreign tariff cut such that they have to reduce their export product scope. The explanation is as follows. With regard to domestic tariff cut, each firm incurs a cost of introducing (or maintaining) every product it produces. By retaining a product, a firm obtains profit from the market; however, discontinuing a product results in saving from the fixed cost of production introduction (k) and the fixed cost of sales (m_j). When the domestic market is very profitable, the profit from the domestic market alone can cover the fixed costs. In that case, $e_l < s_l$ and lowering the Chinese tariff reduces a Chinese firm's domestic market profit, which results in a reduction in total product scope but not in export product scope because the latter is only affected by foreign market profitability. However, when a drastic tariff cut is implemented, the firm reduces its product scope to a large extent that the set of products available for export is likewise reduced. This is how domestic trade liberalization affects exports.

A foreign tariff cut has both direct and indirect effects on Chinese exporters. Every firm's marginal product earns zero profit from the foreign market. On the one hand, the foreign tariff cut lowers the "cost" of every exported product and thus increases profits, which induces all firms to expand their export product scope. This phenomenon is the cost effect, which is positive and direct. On the other hand, a low cost causes every firm to reduce the prices of all its products, which increases competition (lowering A^*). This is the competition effect, which is negative and indirect. It reduces the profits of all products (including the marginal products) and tends to reduce every firm's export product scope. The export product scope of a firm is reduced or expanded depending on the net effect on its marginal product. The competition effect is the same for all products as it shifts down the demand intercept (A^*). However, the cost effect is different for the efficient firms and the inefficient firms. An efficient firm's marginal product has a higher marginal cost of production ($e_l\theta$) than that of an inefficient firm ($e_h\theta$) because the former has a larger product scope. As discussed earlier right below (13), a reduction in foreign tariff (in the form of iceberg transport cost) reduces all products' cost of production by the same percentage; thus, an efficient firm's marginal product benefits more than an inefficient firm's because the former enjoys a larger cost reduction in the absolute term. We find that the direct cost effect dominates the indirect competition effect for all firms except for the inefficient firms when their marginal cost is very high. The intuition for the exceptional case is clear: when its management cost is very high, the firm does not benefit much from cost reduction but still faces the same loss from tougher competition as other firms.

3.6 Firm Heterogeneity in Production Productivity

The most interesting message from Proposition 1 is that when a tariff cut is implemented in the foreign country, Chinese firms with different managerial efficiency levels respond in opposite directions. In this section, we examine whether the heterogeneous response to foreign tariff cuts by firms with different managerial efficiency levels can be reinterpreted as by firms with different production productivity levels, namely, the usual Melitz (2003) type of firm heterogeneity. To this end, we make a few modifications to the main model. First, we assume that Chinese firms are homogeneous in managerial efficiency; for simplicity, we let $m_l = m_h = 0$. Second, Chinese firms differ in production productivity. We assume that the cost of core competency c is uniformly distributed in $[0, 1]$. Third, we merely focus on equilibrium analysis in the foreign market.

The derivation of optimal export product scope is similar to that in the main model except for one difference: all equilibrium variables are functions of c. Suppose that a firm has the cost of core competence equal to c, called firm c. Then, firm c's optimal export product scope is

$$e(c) = \frac{A^* - \ ct^*}{\theta t^*} = \frac{A^*}{\theta t^*} - \frac{c}{\theta}. \tag{19}$$

We assume that the foreign tariff is not too high or the foreign demand is sufficiently strong such that all Chinese firms export. This condition requires $A^* > t^*$ which we assume to hold below. The export quantity, price, and profit of firm c's ith product are

$$q_i^*(c) = \frac{A^* - (c + \theta i)t^*}{2b}, \quad p_i^*(c) = \frac{A^* + (c + \theta i)t^*}{2}, \quad \text{and} \quad \pi_i^*(c) = \frac{1}{4b}[A^* - (c + \theta i)t^*]^2.$$

Thus, the aggregate price of firm c is given by

$$p^*(c) = \int_0^{e(c)} p_i^*(c)di = \frac{1}{2}(\ A^* + ct^*)e(c) + \frac{1}{4}t^*\theta e(c)^2 = \frac{(A^* - ct^*)}{4\theta t^*}(3A^* + ct^*).$$

The aggregate price in the foreign market is given by

$$P^* = \int_0^1 p^*(c)dc + \frac{1}{2}A^* = \frac{9A^{*2} - 3A^*t^* + t^*}{12\theta t^*} + \frac{1}{2}A^*.$$

The number of products in the foreign market is given by

$$M^* = \int_0^1 \frac{A^* - \ ct^*}{\theta t^*} dc + 1 = \frac{2A^* - t^*}{2\theta t^{*2}} + 1.$$

The above expressions of P^* and M^*, together with $A^* = \frac{\alpha\gamma + \beta P^*}{\beta M^* + \gamma}$, allow us to solve for the equilibrium A^* as a function of t^*, expressed as $A^*(t^*)$. Substituting equilibrium A^* into the expression of optimal product scope (19), we obtain

$$e(t^*, c) = \frac{A^*(t^*)}{\theta t^*} - \frac{c}{\theta}.$$

$\frac{de(t^*,c)}{dt^*}$ is independent of c. That is, all firms respond to the foreign tariff cut in the same direction. Our numerical example shows that $\frac{de(t^*,c)}{dt^*} < 0$. That is, in response to the foreign tariff cut, all Chinese firms expand their export product scope.

One may ask why the result is different from Proposition 1, which is derived from the model with firm heterogeneity in managerial efficiency. In the main model, the two types of firms have different production productivity levels for their marginal products; thus, foreign tariff reduction affects them differently. However, with homogeneity in managerial efficiency and heterogeneity in production productivity, all firms have the same production productivity for their marginal products. This condition can be seen by substituting (19) into the cost of a firm's marginal product: $c + \theta e(c) = \frac{A^*(t^*)}{t^*}$, which is independent of c. Thus, all firms' marginal products will be affected similarly.

4 Empirical Analysis with Managerial Efficiency

Based on the preliminary empirical analysis in Section 2 and guided by our theoretical predictions in Section 3, we now conduct an empirical investigation with emphasis on the responses of heterogenous firms to foreign tariff cuts to examine the role of managerial efficiency. To this end, we need to first introduce two distinctive measures of efficiency, namely managerial efficiency and productive efficiency. These two aspects of efficiency form the TFP of a firm. We then conduct the empirical analysis with these two novel measures of efficiency.

4.1 Measure of Managerial Efficiency

By definition, if it costs a firm more to achieve the same outcome, then the firm is considered less efficient. Unlike productive efficiency which can be estimated from a production function, managerial efficiency cannot be directly estimated from production side. The mainstream literatures of management science and finance usually take a firm's selling, general and administrative (SG&A) as a proxy for management costs (e.g., Fisher and Ittner, 1999; Eisfeldt and Papanikolaou, 2013). We follow this idea to construct our managerial efficiency measure.

According to the generally accepted accounting principles (GAAP), SG&A expenses refer to a firm's expenses that occur apart from its actual production function.[14] Eisfeldt and Papanikolaou (2013) use firm's SG&A expenses to measure organizational capital by using the perpetual inventory approach. They show that firms with high organizational capital have higher managerial quality scores, implying that firms with higher SG&A expenses are more managerial efficient. However, Bloom and van Reenen (2007) point out that firms with more SG&A expenses are not necessarily having high managerial efficiency as such firms may also be larger, have higher exporter revenue, or even have higher markups. Their observation suggests that those variables need to be controlled.

In contrast to Eisfeldt and Papanikolaou (2013), we construct our managerial efficiency variable using G&A expenses residuals. First, we exclude selling expenses. Selling expenses refer to advertising, sales commissions, promotional materials distributed, rent of the sales showroom and sales offices, salaries and fringe benefits of sales personnel, utilities and telephone usage in the sales department.[15] These expenses may fit the organizational capital in Eisfeldt and Papanikolaou (2013) as they could be used as intermediate inputs to boost firm productive efficiency (Nocke and Yeaple, 2014). However, it is less relevant to the fixed-cost feature of the managerial efficiency in our model where managerial efficiency is independent of productive efficiency. Second, inspired by Bloom and van Reenen (2007), we control

[14] Examples include the occupancy expenses for nonmanufacturing facilities (rent, heat, light, property taxes, maintenance, etc.); compensation of nonmanufacturing personnel; expenses for automobiles and trucks used to sell and deliver products, depreciation of nonmanufacturing equipment; etc.

[15] In the Chinese firm-level dataset, we are able to breakdown the whole SG&A expenses to two categories: selling expenses and G&A expenses. In Chinese Pinyin, selling expenses refer to "xiao1shou4fei4yong4" whereas G&A expenses refer to "Guan3li3fei4yong4", respectively.

for firm size, export revenue and markup so that our managerial efficiency, i.e., the G&A residual, is independent of these factors. Third, given the above two features, low G&A residual indicates high managerial efficiency, and vice versa.

In particular, we consider the following specification:

$$\ln G\&A_{it} = \alpha_1 l_{it} + \alpha_2 \exp_{it} + \alpha_3 markup_{it} + \lambda_i + \eta_t + \epsilon_{it} \tag{20}$$

where $\ln G\&A$ is the log value of firm i's G&A expenses; l_{it} is the log value of labor; $\exp_{it}$ is the log value of export; and $markup_{it}$ denotes markup, all in year t. For simplicity, we measure markup as revenue divided by the difference between revenue and profit.[16] Measured managerial efficiency is defined as $\lambda_i + \eta_t + \epsilon_{it}$ since the sum reflects firm's G&A residuals which cannot be interpreted by firm size (proxied by log labor), firm export value, and firm profitability (proxied by firm markup).[17] Once these firm characteristics are controlled for, a firm has low managerial efficiency if it still has a large G&A residual. This managerial efficiency includes three components. The first component λ_i captures the time-invariant factors that affect the firm's G&A spending; the second component η_t captures the time trend of G&A spending which is common across all firms; and the third component ϵ_{it} represents the idiosyncratic unspecified factors that affect the firm's G&A expenses.

Once a firm's G&A residual is estimated, we construct two indicators of managerial efficiency for each firm in each year: the low managerial efficiency indicator and the high managerial efficiency indicator. Specifically, we rank all firms from the same industry according to their G&A *residuals* (in logarithm) in descending order. If a firm's G&A residual is *higher* than the top 10^{th} quantile of its industry, the firm has *low* managerial efficiency; and its low managerial efficiency indicator takes the value one, and zero otherwise. Similarly, if a firm's G&A residual is *lower* than the top 90^{th} quantile of its industry, the firm has high managerial efficiency; and its *high* managerial efficiency indicator takes the value one,

[16] As markup is just a control variable in our estimates, we take a shortcut to measure markup by presuming that marginal costs equal average costs, De Loecker and Warzynski (2012) use a more complicated way to estimate firm's markup using the product of firm's estimated input elasticity of the production function and the input share. Our estimation results would not change qualitatively using this alternative approach. However, it is worthwhile to note that such an alternative approach may be inappropriate to apply to our case given that the estimated input elasticity of the production function does not distinguish the difference between productive efficiency and managerial efficiency.

[17] In principle, this idea is in line with the measured TFP which is measured by the difference between firm's output and the fitted value of output, known as "Solow residuals".

and zero otherwise. If a firm's G&A residual is between the 10^{th} and 90^{th} quantiles, its low and high managerial efficiency indicators take the value zero. We then pool firms from all industries together while maintaining the value of their indicators.

Columns (1) and (2) of Table 5 present estimation results of Eq. (20). The positive and statistically significant signs of log labor and log exports suggest that firms with more G&A spending usually are larger and have more exports. By contrast, firms with smaller markup also have larger G&A expenses. By deducting such effects from the estimates, the bottom module of Table 5 reports the quantiles for the measured managerial index (in log). A higher value of the index indicates lower managerial efficiency.

[Table 5]

G&A expenses include 27 types of expenses with administrative expenses as the largest and most important one. In the robustness checks later in the paper, we will use an alternative measure of managerial efficiency based on administrative expenses. To obtain this alternative measure, we regress Eq. (20) again by replacing total G&A expenses with administrative expenses . Columns (3)-(4) of Table 5 report the estimation results using the new measure. The results are similar to those reported in columns (1) and (2).

4.2 Measure of Productive Efficiency

Note that the conventional measure of TFP, including TFP1 in the present study, is a Solow residual that includes both managerial efficiency and productive efficiency. We show this below. Since product-level production data are unavailable, we follow the convention to assume that firms have a common productivity level and production function across goods. The standard Cobb-Douglas gross production function yields

$$\ln Y_{it} = \alpha_k \ln K_{it} + \alpha_l \ln L_{it} + \alpha_m \ln M_{it} + x_{it} + \varpi_{it} + \varepsilon_{it}, \tag{21}$$

where Y_{it}, K_{it}, L_{it}, M_{it}, x_{it} and ϖ_{it} are firm i's sales, capital, labor, intermediate inputs, productive efficiency, and managerial efficiency in year t, respectively. The error term ε_{it} captures measurement error in output and unanticipated idiosyncratic shocks to production (De Loecker, 2011). The conventional

Olley-Pakes (OP) measure of productivity treat the difference between log output and log factor inputs times their estimated coefficients as the productivity:

$$TFP1_{it} = \ln Y_{it} - \hat{\alpha}_k \ln K_{it} - \hat{\alpha}_l \ln L_{it} - \hat{\alpha}_m \ln M_{it}. \tag{22}$$

Such a productivity measure (TFP1) is clearly correlated not only with productive efficiency (x_{it}) but also with managerial efficiency (ϖ_{it}).

Following Feenstra et al. (2014), we construct a *productive efficiency* measure, called TFP2. As in Olley and Pakes (1996), we suppose that investment V_{it} in the OP approach depends on productive efficiency x_{it} of the firm and the production innovation ς_{it+1} follows the following process: $\varsigma_{it+1} = x_{it+1} - x_{it}$. Then, we obtain the following function:

$$V_{it} = g_1(x_{it}, \ln K_{it}, HT_{it}, FT_{it}, EX_{it}, PE_{it}, WTO_t, SOE_{it}, FIE_{it}),$$

where EX_{it} is the export indicator that measures whether the firm exports in year t, PE_{it} is the processing export indicator, WTO_t is an indicator that equals one for every year after 2001 and zero before 2002, SOE_{it} indicates whether the firms is a SOE and FIE_{it} indicates whether the firm is a foreign-invested-enterprise, and more importantly, x_{it} is the productive efficiency TFP2. Inverting this relation yields the productive efficiency as

$$\begin{aligned} TFP2_{it} \quad &: \quad x_{it} = g_1^{-1}(V_{it}, \ln K_{it}, HT_{it}, FT_{it}, EX_{it}, PE_{it}, WTO_t, SOE_{it}, FIE_{it}) \\ &= \quad E((\ln Y_{it} - \hat{\alpha}_l \ln L_{it} - \hat{\alpha}_m \ln M_{it})|\mathbf{X}_{it}) - \hat{\alpha}_k \ln K_{it}, \end{aligned} \tag{23}$$

where $\mathbf{X}_{it}$ denotes all right-hand-side regressors used in the third-step OP estimation. The essential difference between the standard gross efficiency (TFP1) and pure productive efficiency (TFP2) is that the regressand of TFP1 uses the actual data on log output whereas that of TFP2 uses the fitted value of log output obtained in the third-step OP estimation. Online Appendix C provides a more detailed discussion on our TFP1 and TFP2 construction. Table A2 in online Appendix provides the industry-level estimates of the firms' TFP1 and TFP2 in each industry, together with the associated coefficients of labor, capital, and materials. Note that different industries have heterogenous variance between TFP1 and TFP2.[18]

A firm's productive efficiency could change when tariff changes. To address such a concern, inspired by De Loecker (2013), we consider that firm's productive efficiency reacts to changes in both home tariff and foreign tariff over time as follows:[19]

$$x_{it+1} = h(x_{it}, HT_{it}, FT_{it}) + \varsigma_{it+1},$$

where the production innovation, ς_{it+1}, is different from the step used to measure $TFP2_{it}$. With this modification, we have a new measure of productive efficiency as follows:

$$TFP2_{it}^{DL} : x_{it} = g_2^{-1}(V_{it}, \ln K_{it}, HT_{it}, FT_{it}, EX_{it}, PE_{it}, WTO_t, SOE_{it}, FIE_{it}).$$

The only difference between $g_1^{-1}(.)$ and $g_2^{-1}(.)$ is due to the different realization of production innovation. Note that the simple correlation between $TFP2_{it}^{DL}$ and G&A residuals is only (-0.02), suggesting that the measured productive efficiency is basically not correlated with the measured managerial efficiency.

4.3 Estimates with Heterogenous Managerial Efficiency

With the above two newly constructed measures of productive efficiency, we consider the following model which includes firm heterogeneity in managerial efficiency:

$$e_{it} = \beta_0 + \beta_1 TFP_{it} + \beta_2 HT_{it} + \beta_3 FT_{it} + \beta_4 FT_{it} \times LM_{it} + \beta_5 FT_{it} \times HM_{it} + \boldsymbol{\theta\Psi}_{it} + \epsilon. \qquad (24)$$

In this model, FT appears three times: as a separate term, interaction with the low managerial efficiency indicator (LM_{it}), and interaction with the high managerial efficiency indicator (HM_{it}). Our theory predicts that $\hat{\beta}_3 + \hat{\beta}_4 > 0$ and $\hat{\beta}_3 + \hat{\beta}_5 < 0$ because firms of low (high) managerial efficiency reduce (increase) their export product scope in response to foreign tariff cuts. The regression results are given in

[18] Recent literature (e.g., Ackerberg et al., 2006) points out that, in the first-stage estimation, there may not be any variation left to identify the labor coefficient by considering a nonparametric function of capital and material (or investment). However, De Loecker (2013) highlights that the essential point of the first-stage estimate is to generate an estimate of predicted output as a fuction of parameters of the production function. Our TFP2 measure thus derives such first-stage estimates in which the coefficient of capital and its interaction terms with home tariff, foreign tariff, export dummy, processing dummy, SOE dummy, foreign dummy, and WTO dummy are all included.

[19] Similar to De Loecker (2013), productive efficiency process adopts the fourth-order polynominal form $h(.) = \sum_{sm} \beta_{sm}(x_{it}^s \, HT_{it}^m + x_{it}^s \, FT_{it}^m)$ with $E(\varsigma_{it+1} HT_{it}) = 0$ and $E(\varsigma_{it+1} FT_{it}) = 0$.

Table 6. Note that TFP_{it} are measured by $TFP2_{it}$ and $TFP2_{it}^{DL}$, respectively. For comparison purpose, we also use $TFP1$ for TFP in column (1).

[Table 6]

In column (2) of Table 6, we find that both home and foreign tariffs have positive and statistically significant coefficients. More importantly, the interaction between foreign tariff and the high managerial efficiency dummy is negative and significant, with a larger economic magnitude than the own coefficient of foreign tariff. This result indicates that the effect of foreign tariff on export product scope is negative (i.e., $0.420 - 0.478 < 0$). The difference of such two coefficients is highly statistically significant (as shown by its p-value). Thus, a foreign tariff reduction increases the export product scope of high managerial efficiency firms. By contrast, the coefficient of the interaction between foreign tariffs and the low managerial efficiency indicator is positive and significant. Given that $0.420 + 0.146 > 0$, a foreign tariff reduction reduces the export product scope of low managerial efficiency firms. Middle managerial efficiency firms also reduce their export product scope (as indicated by the coefficient value 0.420). Note, the value of the TFP coefficient ($\hat{\beta}_1$) in column (2) drops by around 80% from that in column (1) using TFP1. This implies that results based on standard TFP measure overstates productive efficiency's contribution to export product scope.

We next see whether our results are sensitive to our firm-specific measures of tariffs. To this end, we replace firm-level home tariff with industry-level home tariff in column (3), replace firm-specific foreign tariff with industry-level foreign tariff in column (4), and replace both in column (5). We can see that the sign and significance of the key explanatory variables remain unchanged. However, the magnitudes of the coefficients are very different. First, for the home tariff, when we compare column (2) (firm specific HT) to column (3) (industry-level HT), and column (4) (firm specific HT) to column (5) (industry-level HT), respectively, it is clear that the coefficient of the firm specific HT is much larger than that of industry-level HT. This finding is expected. Suppose that an industry contains 3 products, x, y and z and a firm produces x and y only. When input tariffs of x and y drop (firm specific), the firm faces direct competition in its products, x and y, and thus respond accordingly (i.e., may stop producing x or y). However, when the industry-level tariff drops, it may be just because of the tariff cut in z, but not in x and y, and in that case, the firm will not be directly affected because it does not produce z. Product x and y are affected only due to the industry-wide competition change, but that effect is indirect and therefore weaker. Second, for the foreign tariff, the comparison is just the opposite, which is also expected. When we compare column (2) (firm specific FT) to column (4) (industry-level FT), we observe that the effect on high managerial-efficiency firms under firm specific FT ($0.420-0.478 = -0.058$) is much weaker than that under industry-level FT ($0.245 - 0.809 = -0.564$). When we compare column (3) (firm specific FT) to column (5) (industry-level FT), we observe that the effect on high managerial efficiency firms under firm specific FT ($0.465 - 0.727 = -0.262$) is much weaker than that under industry-level FT ($0.323 - 1.148 = -0.825$). The reason is as follows. Using the above example, when the foreign tariffs of product x and y drop (firm specific), the firm directly benefit in the products' exports, but its potential export profit in z does not increase, and so the firm may or may not start exporting z. By contrast, if the industry-level tariff drop is mainly or even partly due to tariff cut in z, the firm's potential export profit from z will go up and the firm may eventually induce the firm to export z. Similar comparison of the effects for low managerial efficiency firms is also observed can be understood following the same logic.

Finally, we check whether the results are sensitive to the 10^{th} and 90^{th} quantile G&A residual thresholds. In column (7) we re-define high managerial efficiency firms as those with G&A residuals lower than the bottom 25^{th} quantile and low managerial efficiency firms as those with G&A residuals higher than the 75^{th} quantile. We find that our results are insensitive to such alternative thresholds.

Thus far, firm productive efficiency is presumed not to change with tariff reduction. We now relax such an assumption and use $TFP2^{DL}$ as the measure of productive efficiency so that it can be changed in response to changes in home and foreign tariffs. The estimates are presented in columns (6) and (8) for the $10^{th}/90^{th}$ thresholds and $25^{th}/75^{th}$ thresholds, respectively. The results with regard to the key variables, i.e., HT_{it}, FT_{it} and their interaction terms, are qualitatively the same as the previous estimates above. In particular, the coefficient of productive efficiency ($TFP2^{DL}$) is positive an highly significant in both columns (6) and (8).

However, if a firm's managerial efficiency also changes in response to the changes in tariffs, it is possible that a firm is classified as a low managerial efficiency firm this year but switch to a high one next year;

and vice versa. To address such a concern, we use two alternative ways to classify managerial efficiency. First, we use a firm's *average* G&A residual during the entire sample period as the time-invariant measure of managerial efficiency. The average G&A residual is the simple average of all years' residuals obtained from Eq. (20). A variety of regressions in Table 7 with this new managerial efficiency measure show that our main findings stay robust by using different tariff measure (firm-level and industry-level), or by picking different cutoff (10% quantile and 25% quantile), or by adopting different measure of productive efficiency ($TFP2$ and $TFP2^{DL}$), as indicated in the note below the table. Second, inspired by Topalova and Khandelwal (2011), we fix a firm's G&A residual by using the firm's initial-year's G&A residual as a proxy. The results regarding the estimates of the key tariff variables are similar to our previous estimates.[20]

[Table 7]

4.4 Further Robustness Checks

As managerial efficiency is the key focus of this study, we will explore more alternative measures of this variable. We now propose to use administrative expenses residuals, instead of G&A residuals, to measure managerial efficiency. Since data on administrative expenses are only available for three years, 2004-2006, the size of our sample drops significantly. Despite of this, we run various regressions and report the results in Table 8. The negative binomial estimates in columns (1) and (2) have very similar results as those in Tables 6 and 7. As shown by column (3), replacing $TFP2$ with $TFP2^{DL}$ generates similar results as their counterparts in columns (1) and (2).

Furthermore, we run the IV Poisson regression by treating home tariff as endogenous. To this end, we use previous year's home tariff (with initial weight) as the instrument. The IV Poisson estimations, in columns (4)-(6), show that the coefficients of home tariff, foreign tariff and the interactions with low high managerial efficiency indicators are significant and have the anticipated signs. More importantly, the magnitude of the coefficient of the interaction term between foreign tariffs and high managerial efficiency indicator is larger than that of the foreign tariff in absolute value.

[20] The whole idea of these two alternative measures is to fix the value of a firm's managerial efficiency over the entire period. Such an approach also helps address another concern raised in Bloom et al. (2010) and Bloom et al. (2013): The estimates would be biased if managerial efficiency and productive efficiency affect each other.

[Table 8]

5 Concluding Remarks

In this paper, we conduct theoretical and empirical analyses on the effects of trade liberalization on firms' export product scope. The preliminary empirical analysis based on Chinese data shows that Chinese firms reduce their export product scope in response to a domestic tariff cut and a foreign tariff cut. Low productivity and high productivity firms behave similarly. We then build a theoretical model which explicitly incorporates a new dimension of firm heterogeneity, namely, managerial efficiency. Our model predicts that the home country's tariff cut reduces all home firms' export product scope; however, in response to a foreign country's tariff cut, a home firm's export product scope expands (shrinks) when the firm's managerial efficiency is high (low). We conduct another empirical analysis to test these predictions. In the empirical analysis, we use a firm's total G&A residuals and administrative expenses residuals, respectively, as a proxy for management cost to measure managerial efficiency. We find strong evidence to support our theoretical predictions.

Firm heterogeneity in managerial efficiency is the new element in our theoretical and empirical models. In our theoretical model, we model a firm's management cost as the cost of managing the set of products. It would be interesting to explore other modelling approaches.

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Table 1A: Distribution of Firms' Export Product Scope

Export Product Scope	Number of Obs.		Export Value	
	Percent	Cumulative	Percent	Cumulative
1	21.06	21.06	8.64	8.64
2	15.66	36.72	8.65	17.29
3	11.54	48.25	7.80	25.10
4	8.91	57.16	7.60	32.70
5	6.90	64.07	5.85	38.54
6-15	25.82	89.89	31.35	69.89
16-25	6.01	95.90	10.99	80.88
26-527	4.10	100.0	19.12	100.0

Table 1B: Summary Statistics (2000-2006)

Variable	Mean	Std. Dev.
Export Product Scope	6.72	10.19
Firm Sales (RMB1,000)	150,053	1,061,312
Number of Employees	479	1,687
Home Tariffs (Firm Level)	.085	.077
Home Tariffs (Industry Level)	.117	.056
Foreign Tariffs (Firm Level)	.075	.071
Home Input Tariffs (Firm Level)	.021	.038
Log China's GDP	28.29	.265
Log Importers' Weighted GDP	28.70	2.43
Log G&A Expenses	6.83	2.18
Log Administrative Expenses (after 2004)	4.73	1.46
Log Per-capita Administrative Expenses (after 2004)	1.11	3.16
SOE Indicator	.021	.141
Foreign Indicator	.589	.491
Processing Indicator	.286	.452

Note: Value is in Chinese yuan. US$1 was equivalent to approximately 8.20 yuan before July 2005.

Table 1C: Tariff Reductions (in percent)

Year	Ind. Home Tariffs		Firm Home Tariffs		Ind. Foreign Tariffs		Firm Foreign Tariffs	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2000	20.34	8.44	15.62	4.13	11.22	5.61	7.72	8.77
2006	10.11	4.15	7.69	1.60	8.07	4.17	7.61	8.35
Change (%)	50.29	–	50.77	–	28.07	–	2.43	–

Note: Columns (1)-(2) report the mean and standard deviation of 3-digit industry-level home import tariffs whereas columns (3)-(4) report firm-level home import tariffs as described in Eq. (2). Columns (5)-(6) report the mean and standard deviation of 2-digit Chinese-industry-classification(CIC) foreign tariffs opposed against Chinese firms. Columns (7)-(8) report the mean and standard deviation of firm-level foreign tariffs as described in Eq. (3).

Table 2: Baseline Estimates

Econometric Methods:	OLS	Poisson	Negative Binomial		
Regressand: Export Product Scope	(1)	(2)	(3)	(4)	(5)
Home Tariffs (Firm-Level)	13.438***	1.544***	1.565***	0.660***	0.793***
	(29.77)	(21.45)	(37.43)	(10.91)	(10.53)
Foreign Tariffs (Firm-Level)	10.347***	1.322***	1.283***	0.302***	0.263***
	(21.58)	(25.27)	(27.17)	(9.21)	(6.73)
Log Firm TFP (TFP1)	2.781***	0.273***	0.344***	0.035***	0.051***
	(22.92)	(19.85)	(40.59)	(4.19)	(4.77)
Log China's GDP	0.630***	0.093***	0.076***		
	(4.21)	(4.25)	(5.91)		
Log Weighted GDP of Importers	1.367***	0.223***	0.155***	0.123***	0.130***
	(60.91)	(43.74)	(131.14)	(54.57)	(46.28)
Log Capital-Labor Ratio	0.028	0.007	-0.011***	-0.001	0.002
	(1.01)	(1.29)	(-4.69)	(-0.28)	(0.32)
FIE Indicator	0.443***	0.015	0.082***	0.113***	0.113***
	(5.39)	(0.77)	(12.91)	(5.11)	(4.25)
SOE Indicator	1.062***	0.158***	0.118***	-0.059	-0.080*
	(3.28)	(2.64)	(5.03)	(-1.50)	(-1.89)
Firm-specific Fixed Effects	No	No	No	Yes	Yes
Year-specific Fixed Effects	No	No	No	Yes	Yes
Pure Exporting Firms Dropped	No	No	No	No	Yes
Prob.>χ^2	.000	.000	.000	.000	.000
Observations	87,763	87,763	87,763	63,844	43,191

Note: t-values in parentheses. * (**,***) indicates significance at the 10% (5%, 1%) level. 23,919 observations are dropped in columns (4) and (5) because of only one observation per group.

Table 3: Negative Binomial Estimates

Regressand: Export Product Scope	All Sample			GSCs Integrated		All Sample	
				Less	More		
Coefficients Reported:	b (t)	dy/dlnx	b (t)	b (t)	b (t)	b (t)	b (t)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Home Tariffs (Firm-Level)	1.425***	1.149	1.323***	1.861***	1.289***		2.406***
	(27.49)		(28.37)	(18.19)	(18.59)		(8.16)
Home Tariffs (Industry-Level)						0.686***	
						(13.65)	
Foreign Tariffs (Firm-Level)	0.310***	0.182	0.239***	0.443***	0.386***	0.280***	2.680***
	(9.98)		(8.82)	(5.75)	(10.24)	(12.23)	(7.76)
Home Input Tariffs	0.374***	0.065	0.477***	-0.668***	0.604***	0.337***	-0.920
	(4.87)		(6.96)	(-3.47)	(6.73)	(5.87)	(-1.44)
Log Firm TFP (TFP1)	0.081***	0.778	0.063***	0.234***	0.069***	0.059***	0.166***
	(11.42)		(10.28)	(13.27)	(7.74)	(11.73)	(3.52)
Log Weighted GDP of Importers	0.119***	28.49	0.116***	0.126***	0.116***	0.105***	0.157***
	(70.51)		(75.93)	(33.59)	(58.16)	(86.23)	(13.49)
Log Capital-Labor Ratio	-0.019***	-0.562	-0.015***	-0.066***	0.011**	-0.020***	-0.028*
	(-5.44)		(-4.76)	(-9.84)	(2.48)	(-7.74)	(-1.66)
FIE Indicator	-0.034**	-0.197	-0.029**	0.032	-0.115***	-0.008	-0.255***
	(-2.57)		(-2.22)	(1.31)	(-7.14)	(-0.74)	(-3.81)
SOE Indicator	0.032	0.003	0.011	-0.005	0.080**	0.020	0.071
	(1.06)		(0.38)	(-0.06)	(2.42)	(0.82)	(0.42)
Processing Indicator	-0.045***	-0.154	-0.043***	-0.048***	-0.055***	-0.051***	-0.120**
	(-9.76)		(-10.85)	(-4.15)	(-9.92)	(-14.33)	(-2.11)
Firm-specific Fixed Effects	Yes		Yes	Yes	Yes	Yes	Yes
Year-specific Fixed Effects	Yes		Yes	Yes	Yes	Yes	Yes
Pure Exporting Firms Dropped	Yes		Yes	Yes	Yes	No	Yes
Balanced Panel Considered	No		No	No	No	No	Yes
Prob.$>\chi^2$	.000		.000	.000	.000	.000	.000
Observations	40,925		37,565	14,823	26,102	52,176	1,798

Note: t-values corrected for clustering at the firm level in parentheses. *(**) indicates significance at the 10% (5%) level. 19 industries out of 30 are classified as more integrated in global supply chain (GSC). Coefficients in column (1) are in level whereas those in column (2) are the estimated semi-elasticity–dy/d(lnx), where y denotes export product scope. Columns (3)-(7) report the estimated coefficients and t-value (in parentheses). Column (3) drops samples in special machinery and transport equipment.

Table 4: Estimates with Heterogenous Productivity and Possible Endogeneity

Estimation Method:	Negative Binomial		IV Poisson	
Productivity Category:	Low Prod.	High Prod.	2^{nd} stage	1^{st} stage
Regressand: Export Product Scope	(1)	(2)	(3)	(4)
Home Tariffs (Firm-Level)	1.116***	1.280***	0.331**	–
	(17.73)	(20.23)	(2.56)	
Home Tariffs w/ One Lag (Firm-Level)				0.823***
				(269.4)
FIE Tariffs (Firm-Level)	0.548***	0.676***	0.654***	0.002
	(12.58)	(13.90)	(4.01)	(0.73)
Log Firm TFP (TFP1)	0.327***	0.080***	0.466***	-0.001
	(19.51)	(8.40)	(12.74)	(-0.34)
Log Weighted GDP of Importers	0.120***	0.168***	0.155***	-0.001
	(59.60)	(75.74)	(37.33)	(-0.77)
Foreign Indicator	0.155***	0.111***	0.045***	0.001
	(12.92)	(9.78)	(2.80)	(0.24)
SOE Indicator	0.052	0.091**	0.105*	0.002
	(1.36)	(2.40)	(1.78)	(1.12)
Industry-specific Fixed Effects	Yes	Yes	Yes	
Year-specific Fixed Effects	Yes	Yes	Yes	
Pure Processing Firms Dropped	No	No	Yes	
Anderson canon. corr. LM χ^2 statistic			17320†	
Cragg-Donald Wald F statistic			72600†	
Observations	30,947	25,311	22,735	

Note: t-values in parentheses. * (**,***) indicates significance at the 10% (5%, 1%) level. † indicates p<0.01. Pure processing firms are dropped in columns (3) and (4). Columns (1) and (2) are negative binomial estimates and include the sample in which firm TFP is lower than its industrial average in column (1) and higher in column (2). Columns (3)-(4) are IV Poisson estimates in which the endogenous variable is home tariff with initial year weight and the instrument is the previous year's home tariffs with initial year weight. Column (3) reports the second-stage estimation results whereas Column (4) reports the first-stage estimation results

Table 5: Estimates of Firm Managerial Efficiency

Measure of G&A Expenses:	Total G&A Expenses	Administrative Expenses
Regressand: Log G&A Expenses	Coefficient	Coefficient
	(1)	(3)
Log Labor	0.317***	0.249***
	(54.35)	(54.35)
Log Export	0.101***	0.071***
	(40.19)	(9.26)
Firm Markup	-0.019***	-0.005
	(-2.37)	(-0.26)
Year-specific Fixed Effects	Yes	Yes
Firm-specific Fixed Effects	Yes	Yes
R-squared	0.41	0.19
Number of Observations	97,776	59,494
Quantiles for Measured Managerial Efficiency Index (in Log)		
10% Quantile	-1.290	-1.711
25% Quantile	-0.711	-0.793
50% Quantile	-0.071	0.068
75% Quantile	0.649	0.853
90% Quantile	1.448	1.610

Note: t-values in parentheses. *** indicates significance at the 1% level. There are two regressions in this table. Estimation in column (1) regresses firm's log total G&A expenses on its log labor, log export, and firm markup. The residual which includes firm-specific dummies, year-specific dummies, and error term is firm's measured managerial efficiency. The lower module reports each quantile of firm's measured managerial efficiency. The higher the number, the lower the firm's managerial efficiency. The regressand in column (2) is firm's administrative expenses.

Table 6: Managerial Efficiency and Export Product Scope Using G&A Expenses

Cutoffs for G&A Residuals Indicators	10^{th}						25^{th}	
Measures of TFP	TFP1	TFP2				$TFP2^{DL}$	TFP2	$TFP2^{DL}$
Regressand: Export Product Scope	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Home Tariffs (Firm-Level: $\hat{\beta}_2$)	0.966***	0.968***		0.983***				
	(22.51)	(23.03)		(22.72)				
Home Tariffs (Industry-Level: $\hat{\beta}_2$)			0.265***		0.278***	0.486***	0.294***	0.497***
			(3.14)		(3.22)	(4.94)	(3.40)	(5.03)
Foreign Tariffs (Firm-Level: $\hat{\beta}_3$)	0.419***	0.420***	0.465***					
	(10.34)	(10.65)	(6.65)					
Foreign Tariffs (Industry-Level: $\hat{\beta}_3$)				0.245***	0.323***	0.527***	0.345***	0.566***
				(4.84)	(3.92)	(5.58)	(3.96)	(5.69)
Foreign Tariffs	0.125**	0.146***	0.593***	0.358***	1.036***	1.081***	0.786***	0.800***
× Low Managerial Efficiency Indicator ($\hat{\beta}_4$)	(2.17)	(2.61)	(6.42)	(4.45)	(8.30)	(8.05)	(9.15)	(8.60)
Foreign Tariffs	-0.459***	-0.478***	-0.727***	-0.809***	-1.148***	-1.226***	-1.044***	-1.093***
× High Managerial Efficiency Indicator ($\hat{\beta}_5$)	(-6.56)	(-7.01)	(-6.36)	(-11.64)	(-10.80)	(-10.59)	(-13.30)	(-12.73)
Log Firm TFP ($\hat{\beta}_1$)	0.126***	0.030***	0.057***	0.035***	0.070***	0.271***	0.078***	0.293***
	(19.97)	(3.26)	(4.10)	(3.71)	(4.91)	(8.18)	(5.47)	(8.81)
Log Weighted GDP of Importers	0.122***	0.122***	0.134***	0.122***	0.134***	0.135***	0.133***	0.134***
	(92.65)	(94.91)	(72.42)	(92.54)	(71.48)	(67.31)	(71.10)	(66.90)
Foreign Indicator	0.094***	0.099***	0.106***	0.100***	0.104***	0.105***	0.100***	0.101***
	(9.34)	(9.93)	(9.13)	(9.83)	(8.88)	(8.71)	(8.53)	(8.36)
SOE Indicator	0.034	0.031	0.034	0.030	0.026	0.020	0.022	0.016
	(1.52)	(1.42)	(1.07)	(1.32)	(0.80)	(0.60)	(0.70)	(0.48)
P-value of Difference between $\hat{\beta}_3$ and $\hat{\beta}_5$	[.000]	[.000]	[.000]	[.000]	[.000]	[.000]	[.000]	[.000]
Firm-specific Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-specific Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	57,385	57,416	53,197	57,416	53,197	49,569	53,197	49,569

Note: t-values in parentheses. * (**) indicates significance at the 10% (5%) level. Columns (1)-(6) use top and bottom 10^{th} quantiles of the estimated residuals of firm's G&A expenses within its industry as the cutoffs to define the low and high managerial efficiency indicators whereas columns (7) and (8) use the top and bottom 25^{th} quantiles as the cutoffs. All pure processing firms and pure exporters are dropped in all estimates. Foreign tariffs and their interaction terms with high/low managerial efficiency indicators in columns (1) and (2) are measured at the firm-level whereas those in columns (3)-(8) are measured at the industry-level. Firm productivity in column (1) is measured by the conventional Olley-Pakes TFP (TFP1) whereas those in columns (2)-(5), and (7) are measured by pure productive efficiency (TFP2). By contrast, firm productivity in columns (6) and (8) are measured by the De Loecker-type TFP2 which allows tariffs to react to the realizations of pure productive efficiency.

Table 7: Further Estimates of Export Product Scope Using G&A Expenses

Firm's G&A Measure:	Average					Initial-Year		
Firm's G&A Residuals Cutoffs:	10^{th}			25^{th}		10^{th}		25^{th}
Regressand: Export Product Scope	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Home Tariffs (Firm-level: $\hat{\beta}_2$)	0.953***	0.832***	0.554***	0.218**	0.556***	0.191**	0.531***	0.234**
	(21.71)	(12.03)	(5.47)	(2.36)	(5.50)	(2.06)	(5.27)	(2.56)
Foreign Tariffs (Firm-level: $\hat{\beta}_3$)	0.408***	0.850***	0.562***	0.333***	0.579***	0.330***	0.555***	0.344***
	(9.95)	(12.50)	(5.68)	(3.31)	(5.29)	(3.66)	(5.67)	(3.52)
Foreign Tariffs	0.272***	0.512***	1.690***	1.224***	1.195***	1.906***	1.778***	1.274***
× Low Managerial Efficiency Indicator ($\hat{\beta}_4$)	(4.45)	(3.94)	(10.44)	(10.77)	(10.02)	(11.49)	(10.32)	-10.7
Foreign Tariffs	-0.409***	-1.420***	-2.026***	-1.441***	-1.482***	-2.068***	-2.054***	-1.506***
× High Managerial Efficiency Indicator ($\hat{\beta}_5$)	(-4.89)	(-10.32)	(-13.01)	(-12.87)	(-12.60)	(-12.88)	(-12.32)	(-12.97)
Log Firm TFP2 ($\hat{\beta}_1$)	0.021**	0.031***		0.095***		0.084***		0.093***
	(2.14)	(2.63)		(6.39)		(5.58)		(6.25)
Log Firm TFP2^{DL} ($\hat{\beta}_1$)			0.283***		0.307***		0.275***	
			(8.28)		(8.98)		(8.13)	
Log Weighted GDP of Importers	0.123***	0.128***	0.136***	0.135***	0.135***	0.136***	0.135***	0.135***
	(93.75)	(78.45)	(66.40)	(70.41)	(66.22)	(70.37)	(66.50)	(70.88)
FIE Indicator	0.101***	0.111***	0.102***	0.098***	0.099***	0.102***	0.103***	0.098***
	(9.97)	(9.90)	(8.38)	(8.38)	(8.16)	(8.68)	(8.46)	(8.31)
SOE Indicator	0.033	0.027	0.005	0.015	0.004	0.015	0.006	0.014
	(1.45)	(0.98)	(0.14)	(0.47)	(0.11)	(0.47)	(0.18)	(0.42)
P-value of Difference between $\hat{\beta}_3$ and $\hat{\beta}_5$	[.000]	[.000]	[.000]	[.000]	[.000]	[.000]	[.000]	[.000]
Firm-specific Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-specific Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	57,416	53,197	49,569	53,197	49,569	53,197	49,569	53,197

Note: T-values in parentheses. * (**,***) indicates significance at the 10% (5%, 1%) level. Measure of firm G&A expenses in columns (1)-(5) use firm's average G&A expenses whereas those in columns (6)-(8) use initial-year G&A expenses. Columns (1)-(3), (6) and (7) use top and bottom 10^{th} quantiles of firm's G&A residuals as cutoffs to define the low (high) managerial efficiency indicators whereas columns (4), (5) and (8) use the top and bottom 25^{th} quantiles as cutoffs. Foreign tariffs and their interaction terms with high/low G&A indicators in columns (1) are measured at the firm-level whereas all others are at industry-level. Firm TFP measures in columns (3), (5) and (7) are TFP2^{DL} whereas the rest are TFP2.

Table 8: Managerial Efficiency and Export Product Scope using Administrative Expenses

Measure of Log Administrative Residuals:	10^{th}					25^{th}
Econometric Method:	Negative Binomial			IV Poisson		
Firm's TFP Measures:	TFP2	TFP	$TFP2^{DL}$	TFP2	TFP2	$TFP2^{DL}$
Regressand: Export Product Scope	(1)	(2)	(3)	(4)	(5)	(6)
Home Tariffs (Firm-Level: $\hat{\beta}_2$)	1.095***	1.215***		0.808***	0.798***	0.949***
	(14.29)	(15.12)		(5.61)	(5.53)	(6.24)
Home Tariffs (Industry-Level: $\hat{\beta}_2$)			0.209*			
			(1.64)			
Foreign Tariffs (Firm-Level: $\hat{\beta}_3$)	0.513***	0.390***	0.468***	0.581**	0.396**	0.374**
	(7.03)	(8.45)	(8.14)	(2.57)	(2.48)	(2.31)
Foreign Tariffs	0.567***	0.514***	0.793***	2.822***	2.087***	2.077***
× Low Managerial Efficiency Indicator ($\hat{\beta}_4$)	(5.23)	(4.68)	(6.09)	(9.17)	(7.70)	(7.92)
Foreign Tariffs	-0.578***	-0.462***	-0.622***	-1.669***	-1.149***	-1.035***
× High Managerial Efficiency Indicator ($\hat{\beta}_5$)	(-4.66)	(-3.62)	(-3.94)	(-6.13)	(-6.22)	(-5.40)
Log Firm TFP ($\hat{\beta}_1$)	0.074***	0.365***	0.449***	0.100***	0.095***	0.422***
	(4.65)	(21.35)	(24.83)	(3.82)	(3.56)	(18.47)
Log Weighted GDP of Importers	0.134***	0.132***	0.140***	0.162***	0.163***	0.165***
	(63.65)	(61.21)	(57.91)	(31.09)	(31.58)	(32.28)
FIE Indicator	0.143***	0.151***	0.145***	0.089***	0.085***	0.088***
	(11.48)	(11.77)	(10.82)	(4.79)	(4.83)	(4.93)
SOE Indicator	0.167***	0.166***	0.144***	-0.017	-0.066	-0.066
	(3.38)	(3.34)	(2.61)	(-0.20)	(-0.84)	(-0.86)
P-value of Difference between $\hat{\beta}_3$ and $\hat{\beta}_5$	[.000]	[.000]	[.000]	[.000]	[.008]	[.008]
Firm-specific Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-specific Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	41,492	38,681	36,081	17,533	17,533	16,842

Note: t-values in parentheses. * (**) indicates significance at the 10% (5%) level. Measures of firm managerial efficiency indicator use the estimation residuals of firm annual-average log firm's administrative expenses on firm's characteristics. Columns (1)-(4) use top and bottom 10^{th} quantiles of annual average log firm's administrative expenses within its industry as the cutoffs to define the low and high managerial efficiency indicators whereas columns (5) and (6) use the top and bottom 25^{th} quantiles as the cutoffs. All pure exporters and pure processing firms are dropped in all estimations. Columns (1)-(3) are negative binomial fixed-effect estimates whereas columns (4)-(6) are IV Poisson estimates in which the endogenous variable is home tariff with initial year weight and the instrument is the previous year's home tariffs with initial year weight. TFP measures in Columns (3) and (6) are $TFP2^{DL}$ whereas the rest are TFP2.