Trade Liberalization, Market Structure, and Firm Markup: Evidence from China*

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Abstract

In an imperfectly competitive market, input tariff reduction may induce importers to partly pass-through the cost reductions and consequently increase markups. Such effect is heterogeneous across industries, depending on the market structure. We utilize an unprecedented liberalization episode in China, namely its WTO accession, to estimate such heterogeneous impact of trade reform on firm markup. The results show that input tariff reduction increases firm markup, but only for importers. Furthermore, market structure matters: importers' markup increases more due to input tariff reduction in less competitive industries.

Keywords: Trade liberalization, Input Tariff, Markup, Market Structure
JEL Classification: F12, F13.

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1 Introduction

Conventional wisdom emphasizes the "pro-competitive effect" of trade liberalization. That is, increased exposure to international competition forces domestic firms to reduce markup. See, for example, Levinsohn (1993) and Harrison (1994), or more recently de Blas and Russ (2015) and Feenstra and Weinstein (2010). This insight, however, is incomplete when trade in intermediate inputs is prevalent (Amiti and Konings, 2007).[1] In an imperfectly competitive market, when some firms import inputs for production whereas others do not, lowering tariffs on inputs will generate heterogeneous impact. In particular, firms that import inputs may only partly pass-through the reduction in their input costs and consequently increase their markups.

In this paper, we utilize an unprecedented liberalization episode in China, namely its WTO accession, to estimate such heterogeneous impact of trade reform on firm markup. Specifically, before it was approved WTO membership in December 2001, China had an average import tariff at around 17 % in 2000. According to its commitment to joining WTO, China substantially reduced its average tariff of manufacturing products, to around 9% within just a few years. Figure 1 illustrates the large and wide-spread drop in tariffs during 1997 to 2007 in China. In particular, both average tariff level and the standard deviation of tariffs across six-digit HS products dropped substantially in 2001, when China formally joined the WTO. Figure 2 highlights the importance of considering tariff reductions on inputs in the case of China, because around 75% of China's imports are intermediate inputs, while most of the remaining imports are capital goods.[2]

Such a large-scale trade reform implies profound impact on firms that go beyond the competitive effect. On the one hand, declines in output tariffs induce firms to reduce price for their products due to competition, whereas on the other hand, firms that import inputs may benefit from lower marginal costs due to input tariff reduction. When the price declines are small relative to the declines in marginal costs, we see an increase in firm markups. This is an insight highlighted in the influential study by De Loecker et al. (2014), which find incomplete cost pass-through to prices and rising markups for Indian firms responding to input tariff liberalization.

More specifically, this paper provides three novel empirical findings that have not been docu-

[1] Trade in intermediate inputs accounts for two thirds of international trade (Johnson and Noguera, 2012).

[2] One concern is that a large share of Chinese imports is for export processing (Feenstra and Hanson (2005), Yu (2014), Manova and Yu (2014)). However, considering only non-processing imports, input share is still around 75-80%, verifying the importance of trade in intermediate input.

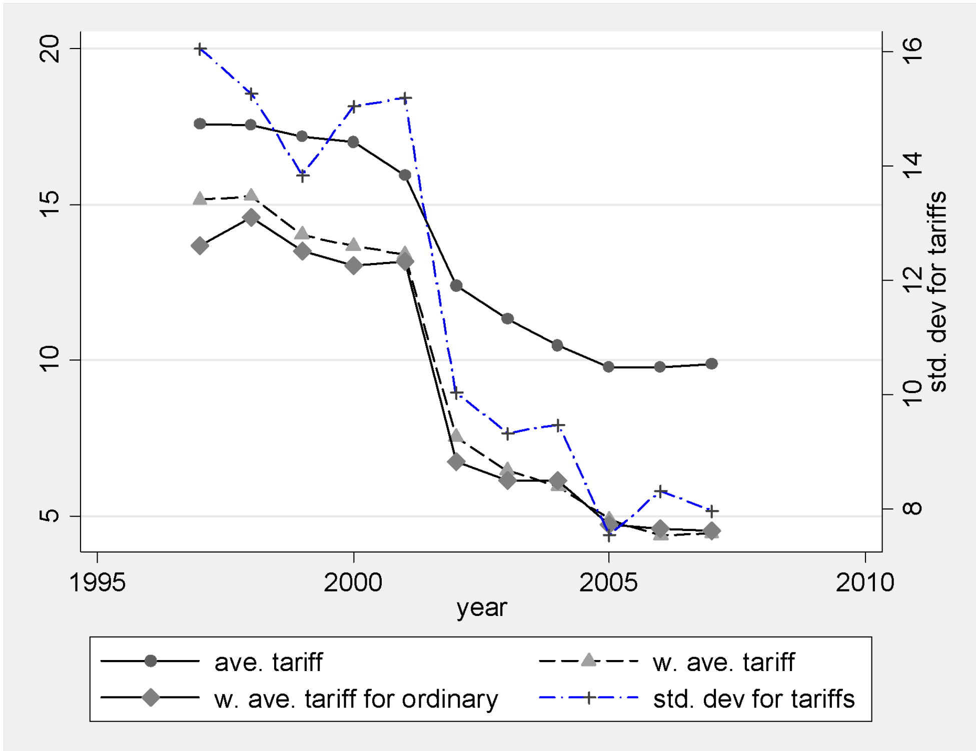

Figure 1: Tariff Reduction during 1997 - 2007

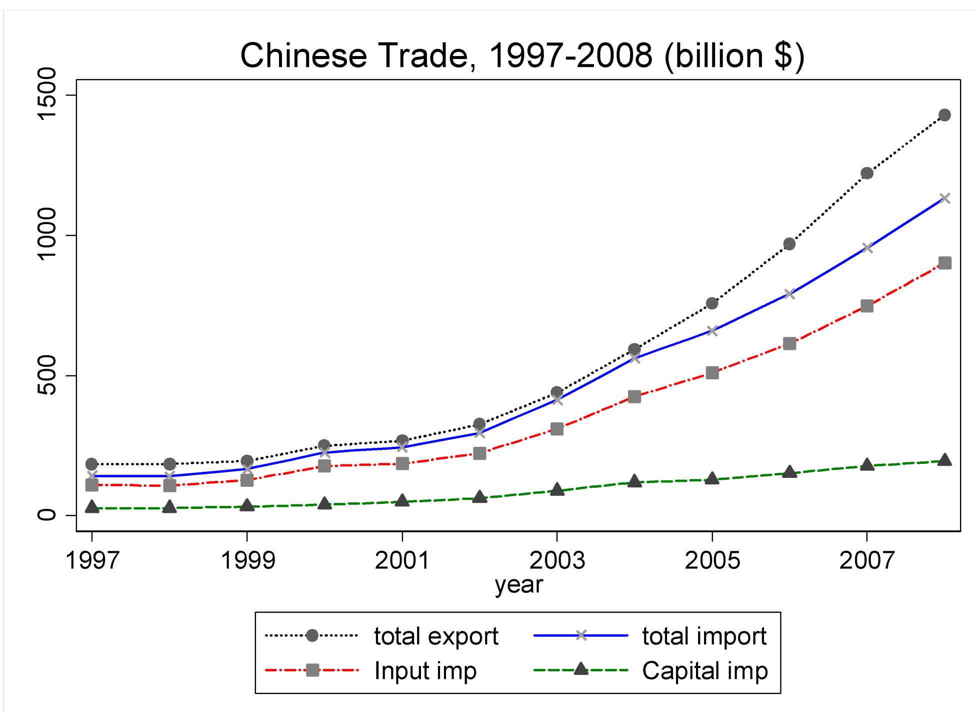

Figure 2: China's Import

mented in previous research. First, importers adjust their markups differently than non-importers in response to trade liberalization. To see this, we interact the input tariffs with an indicator for importing firms. We find that reduction in input tariffs exerts opposite impact on importers versus non-importers: it raises markup charged by importing firms whereas reduces it by non-importing firms. As a preview of our results, Figure 3 implies that after trade liberalization, the overall distribution of markups across manufacturing firms shifts rightwards from 2000 to 2007.[3] Figure 4 further shows the evolution of average markups between importers and non-importers during the same period. Compared with markups in 2000, apparently importers have relatively faster growth in markups over time. Put it more precisely, over our sample period, the average input tariff dropped by more than half, from 15% in 2000 to 6.2% in 2007, resulting in an increase in average markup of importers by about 1%, and a decrease in that for non-importers by about 0.1%.

Secondly, importers raise their markups because their imported inputs become cheaper after trade liberalization. Therefore consistent with the input-output linkage emphasized in Amiti and Konings (2007) and Amiti, Itskhoki, and Konings (2014), firms' import intensity serve as an important determinant of the markup increase. That is: firms with larger import share tend to experience higher increase in their markups.

At industry level, such heterogeneous impact could be viewed by comparing sectors which depend heavily on foreign inputs versus those that only have a small share of imported inputs. This is shown in Figure 5, where we show the evolution of markup distribution for two selected industries. Industry A (the left panel, production of fertilizer) has a relatively large import penetration rate, [4] but a relatively small share of imported inputs in total material inputs. While industry B (the right panel, Rubber) has the opposit pattern: a small share of import penetration but a large share of foreign inputs in total material use. Thus industry A is presumably subject to more import competition, while in contrast industry B depends on foreign inputs. The comparison is striking: the markup distribution of industry A actually shift left a bit from 2000 to 2007, while for industry B, the distribution shift substantially to the right, indicating substantial improvement in markups.

The third finding of this paper is: market structure matters. The cost advantage of importers compared with non-importers during liberalization episode is especially useful when the market is

[3] As we will discuss in more details in the estimation section, firm markups are estimated following the method by De Loecker and Warzynski (2012), separately for each five-digit sector.

[4] Import penetration rate is imports divided by total domestic sales of fertilizer products.

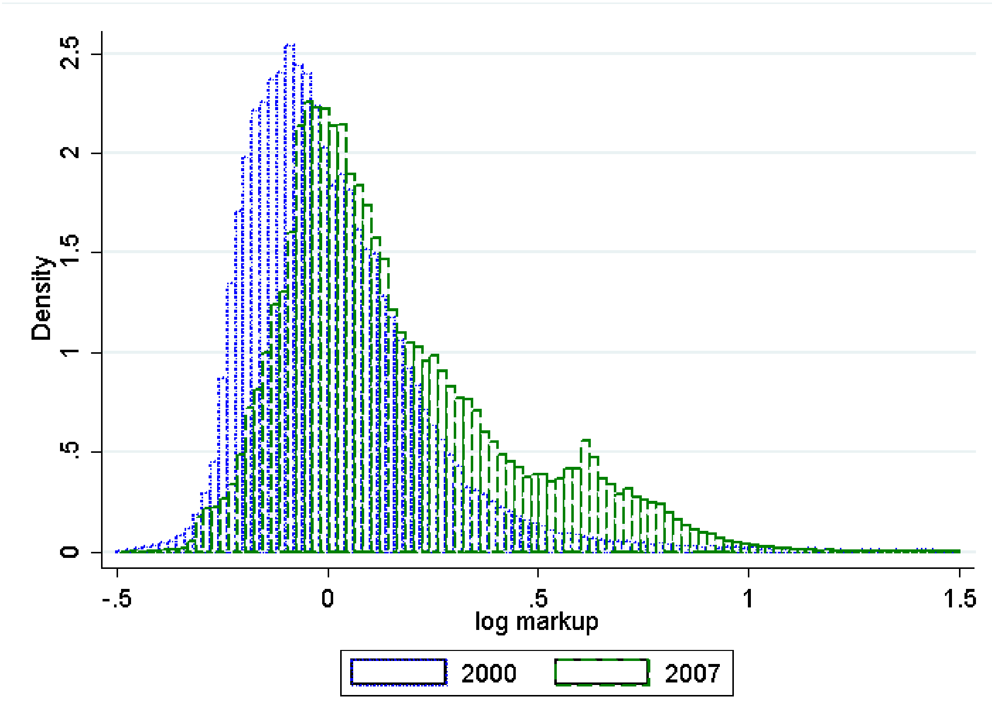

Figure 3: Markup Distribution: 2000 and 2007

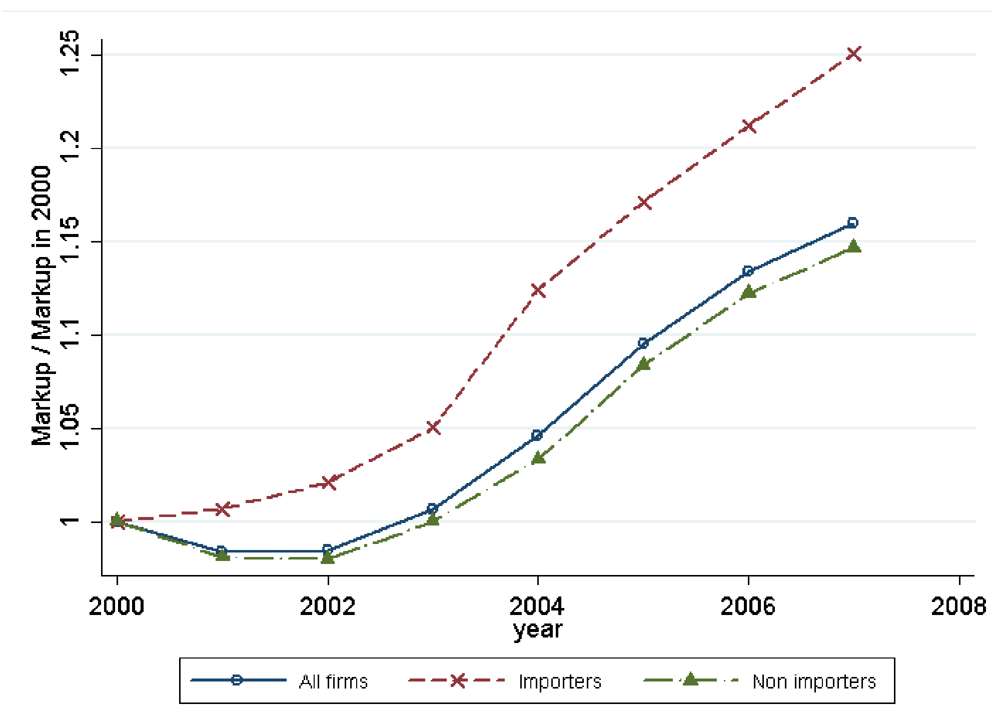

Figure 4: Markup Trend: Importers and Non-importers

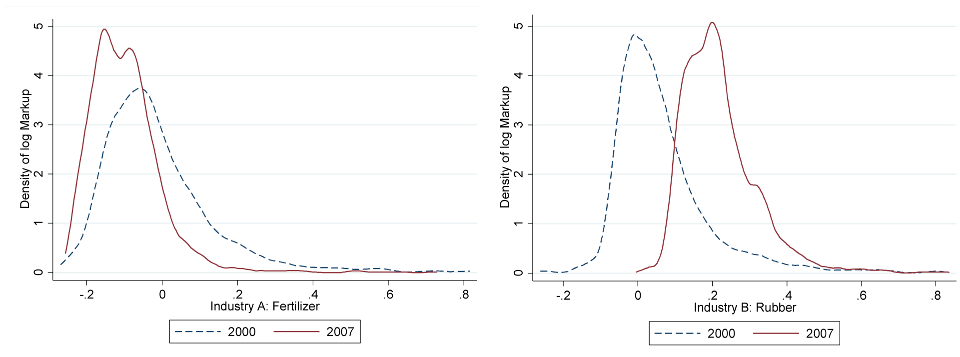

Figure 5: Markup Distribution of Two selected Industries

relatively concentrated. Intuitively, firm's ability to exert market power depends crucially on the market structure. When the market consists of a few large firms who also import inputs [5] and a number of small firms, cheaper access to imported inputs (due to input tariff reduction) gives those large importing firms more leverage not to "pass-through" the cost reduction to buyers, resulting in an increase in their markups.

In the empirical model, this heterogeneity across sectors in importer's markup response is captured by a three-way interaction among the importer indicator, the input tariff, and the market competitiveness. The negative coefficient for this interaction term implies that importers tend to have larger increase in markups compared with non-importers in less competitive markets/sectors. In the benchmark result, when we use the market concentration ratio of the top 20 firms (i.e., CR20), importers' markup increases by nearly 0.43% in the 1st quartile industry (in CR20 value), while it increases by about 3.63% in the 3rd quartile industry, and nearly 7.13% in the 90 percentile industry.

The results are strikingly robust when we alternate with different measures of market competitiveness, or use import intensity to replace importer indicator. The differential impact of input tariff reduction on importers vs. non-importers is also present when we construct a firm-level tariff measure to replace the industry-level input tariff and control for industry-year specific effects. Furthermore, one potential concern is that processing importers are not subject to import tariffs and their products are sold abroad, therefore they may not exhibit the same pricing strategy as ordinary importers do. So we experiment with a placebo test using only processing importers, which confirms that processing importers are not affected. Finally, to deal with the endogeneity

[5] Empirical evidence shows that more productive (and large) firms tend to be importers at the same time (see Bernard et al. 2009; Amiti et al. 2014).

concern, we adopt an alternative empirical strategy by examine the first-difference between two periods and using instruments for tariff changes. Our main results survive those robustness check..

Our paper contributes to a growing body of research that highlights the importance of input tariff liberalization. Those studies show that input tariffs work in different channels than output tariffs, and often play a more important role than output tariffs in influencing firm performance such as productivity and new product creation (Amiti and Konings, 2007; Goldberg et al., 2010; Topalova and Khandelwal, 2011; Yu, 2014).[6] De Loecker et al. (2014) provide the first study that accounts for the different impacts of input and output tariffs on precisely-measured firm markups. They show that the pro-competitive effect of output tariff reduction is largely offset by the access to cheaper imported inputs. They find evidence for rising markups for Indian firms responding to input tariff liberalization.

We also contribute to understanding the impact of China's WTO accession using firm level data. Yu (2014) shows that input tariff reductions strongly improve the productivity of non-processing exporters in China, with attenuate effect when the share of processing import grows. In the same vein, Fan, Li, and Luong (2015) ask how input tariff reductions affect exporters' markup across different destination markets. In contrast, we focus on the local impact of input trade liberalization on the markup of importers versus non-importers. China's WTO accession has been widely viewed as creating external pressure on competition in the domestic market. Domestic market is also regarded as more important than exports. Brandt and Thun (2010), for example, document that 80% of China's manufacturing output was sold domestically. The pro-competitive view of WTO accession receives empirical support by Lu and Yu (2015), who shows that sector-level markup dispersion narrows due to reduction in output tariffs. Moreover, Brandt et al. (2012a) find import competition contributes to significant productivity growth, mainly through entry of productive private entrants. They also show that tariff cuts tend to reduce domestic prices. Our study is complementary to theirs because we estimate the heterogeneous effect of input tariff reductions on different types of individual firms, with an emphasis on the role of market structure.

The remainder of this paper is organized as follows. Section 2 provides background on China's trade reform episode, and describes the construction of data, in particular the measurement of input tariffs and the estimation of firm markup. Section 3 presents the benchmark results. Section

[6] De Loecker and Goldberg (2013) provide a good review on how firm performance is affected by trade liberalization.

4 discusses the role of market concentration and conducts robustness tests. Finally, we conclude in section 5.

2 Background and Data Preparation

2.1 China's WTO Accession and Tariff Reduction

China gradually embrace globalization since early 1980s. However, the progress was greatly accelerated by its accession to WTO in December, 2001 (Branstetter and Lardy, 2006). As shown in Figure 2, since its WTO accession, China achieved an annual average growth at as high as 25%, in both export and import value until 2008. Accompanied with the accelerated trade growth was a large-scale reduction in tariffs. By 2005, China has fulfilled most of its commitment to cutting tariffs and eliminate non-tariff measures. The import-weighted average tariff across all 6-digit HS goods was reduced from 15% in 1997 to lower than 5% in 2007. Clearly from Figure 1, most of the tariff reductions occurred at around 2001 and 2002. Equally remarkable was the decline in the standard deviation of tariffs across products over the same period, as shown by the blue dash line in the same figure (right axis). As a result, the post-reform import tariff rates are uniformly low, implying that products with higher initial tariffs have undergone larger tariff reduction after trade liberalization.

To capture the distinct effect of input tariff on intermediate goods in contrast with output tariff on final goods, we adopt the extended Chinese Input-Output Table for benchmark year 2002.[7] The coefficients for the IO matrix (a_{kj}) reflect the cost share of input k for producing output j, that is $a_{kj} = \frac{input_{kj}}{\sum_k input_{kj}}$. First, we map each of the six-digit HS product code to a five-digit IO sector category. Tariff data at six-digit HS level is downloaded from the trade analysis and information system (TRAINS). The output tariff for a sector k is then simply the import-weighted average across all 6-digit HS codes within sector k. Finally, input tariff for each IO sector j is computed as the weighted average of output tariff, where the weights are given by the IO coefficients:

$$\tau_{jt}^{input} = \sum_k a_{kj} \tau_{kt}^{output} \tag{1}$$

[7]Using 2002 IO table implicitly assumes that the input-output structure didn't change much over our sample period, which is reasonable for a medium time span and is therefore often adopted in the literature (Amiti and Konings, 2007; Khandelwal and Tapolova, 2011).

In Figures 5, we plot the change in tariffs over the sample period, 2000-2007, as a function of initial tariffs in 2000, for output and input tariffs respectively. Similar to what is described in Amiti and Konings (2007), the sectors with the highest initial tariffs experienced the largest tariff reductions. This fact, combined with the shrinking standard deviation of tariffs across 6-digit HS goods, implies that there was little policy discretion across sectors in the extent of trade liberalization (Brandt, et al, 2012b). This would partly alleviate the endogeneity concern of the tariff reduction. Furthermore, in the robustness checks we employ the fact that sectors with high initial tariffs experienced the largest tariff drop and construct an instrumental variable estimation following Amiti and Konings (2007). Our main results still hold.

Another concern is the use of tariffs at sector level. Even within a narrowly defined sector, firms may subject to trade liberalization to different extent. Some firms import input more intensively than others, therefore may in practice benefit more from tariff cuts. So we map each firm with its detailed import information using the Customs data containing the universe of importers. This mapping enables us to construct an index of firm-specific input tariff, following Yu (2014). Compared with sector-level input tariff, at firm level, each firm may import multiple intermediate inputs in different fractions. So a_{ki} is now the cost share of product k in the production of firm i.

2.2 Estimating Firm Markups

Our main variable of interest is firm markup, defined as the ratio of price over marginal cost. The main production data we use is the Annual Surveys of Industrial Production (ASIP) data, provided by the National Bureau of Statistics of China (NBSC) for the period 2000-2007. This dataset contains all state-owned enterprises (SOEs) and non-SOEs with annual sales of at least five million RMB (around 620 thousand US dollars). This dataset contains detailed firm level production and balance-sheet information such as gross output, value-added, employment, capital stock, etc. It forms the basis for major statistics published in China Statistical Yearbooks and has been widely used by economic research. Brandt et.al (2012a) provide a detailed description of the data.

Given the limited information on output prices, we adopt the methodology proposed by De Loecker and Warzynski (2012) to estimate firm-level markups. Their approach follows the insight of Hall et al. (1986) and relies on the standard cost minimization conditions, with at least one

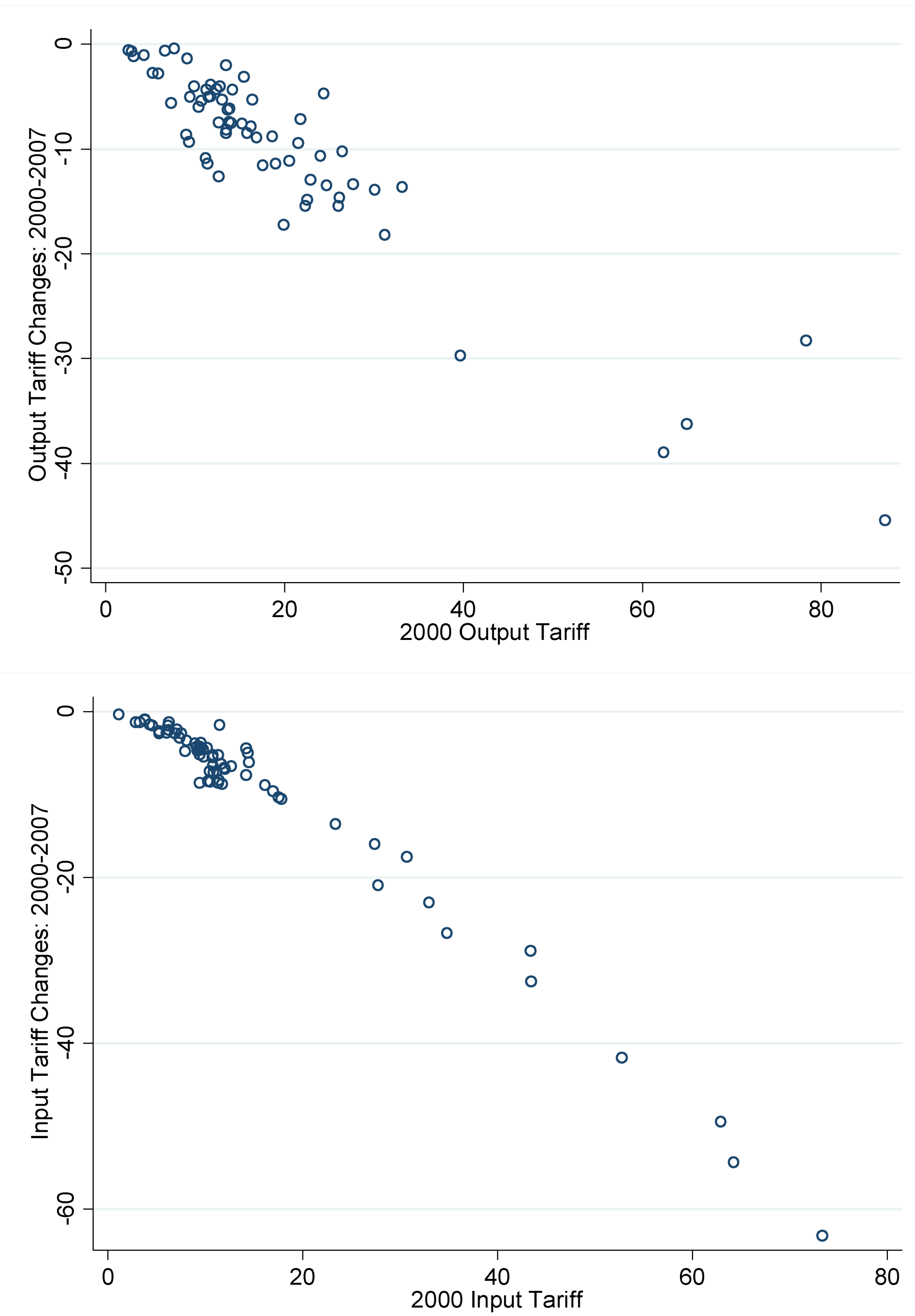

Figure 6: Output Tariff and Input Tariff Reduction

variable input free of adjustment frictions. One advantage of this method is that it does not depend on the settings of demand system and therefore could be conveniently applied to production data. Under any form of imperfect competition, the relevant markup is pinned down by the variable input's revenue share and its output elasticity.

We briefly describe the insight of De Loecker and Warzynski (2012) below. First, assume a continuous and twice-differentiable production function for firm i,

$$Q_{it} = f\left(K_{it}, L_{it}, M_{it}, \omega_{it}\right) \tag{2}$$

where K_{it}, L_{it}, and M_{it} denote capital, labor and material inputs respectively. ω_{it} stands for firm i's productivity.

Firms are cost-minimizers, their optimization problem could be captured by the following Lagrangian Function

$$L\left(K_{it}, L_{it}, M_{it}, \lambda_{it}\right) = P_{m,it}M_{it} + r_{it}K_{it} + w_{it}L_{it} + \lambda_{it}\left(Q_{it} - f\left(K_{it}, L_{it}, M_{it}, \omega_{it}\right)\right) \tag{3}$$

where w_{it}, r_{it} and $P_{m,it}$ denote respectively the wage rate, rental rate for capital, and price for intermediate inputs. As long as intermediate input remains free of adjustment costs, we could solve the first order condition for intermediate input as,

$$\frac{\partial L_{it}}{\partial M_{it}} = P_{it} - \lambda_{it}\frac{\partial f\left(K_{it}, L_{it}, M_{it}, \omega_{it}\right)}{\partial M_{it}} = 0 \tag{4}$$

where λ_{it} is exactly the marginal cost of production at a certain level of output, since $\frac{\partial L_{it}}{\partial Q_{it}} = \lambda_{it}$. Then defining markup as the ratio of price to marginal cost, $\mu_{it} = \frac{P_{it}}{\lambda_{it}}$, we could re-arrange equation (4) and get,

$$\begin{aligned} \mu_{it} &= \frac{P_{it}}{\lambda_{it}} = \frac{P_{it}}{P_{m,it}}\frac{\partial f\left(K_{it}, L_{it}, M_{it}, \omega_{it}\right)}{\partial M_{it}} \\ &= \frac{\frac{M_{it}}{Q_{it}}\frac{\partial f(K_{it}, L_{it}, M_{it}, \omega_{it})}{\partial M_{it}}}{\frac{M_{it}P_{m,it}}{Q_{it}P_{it}}} = \frac{\theta_{m,it}}{\alpha_{m,it}} \end{aligned} \tag{5}$$

where $\theta_{m,it}$ is the output elasticity of intermediate input and $\alpha_{m,it}$ is the revenue share of the expenditure on intermediate input.

The revenue share of input, $\alpha_{m,it}$, could be readily adopted from our firm level dataset. The output elasticity, $\theta_{m,it}$, needs to be estimated with the production function. Because our input tariffs are derived at sector level, we will also estimate the production function and firm markup for each sector separately. After matching the ASIP data with the IO sector code, we end up with 71 manufacturing sectors. To obtain reliable estimates of output elasticity, we keep firms who exist for no less than three years. After getting the parameter estimates, we apply them to the full sample to obtain firm markups for the full sample.[8]

De Loecker and Warzynski (2012) suggest a two-step estimation procedure, following the control function approach proposed by Olley and Pakes (1996), Levinsohn and Petrin (2003), and Ackerberg, Caves, and Frazier (2006). In the first step, we lay out the production function,

$$q_{it} = \theta_l l_{it} + \theta_k k_{it} + \theta_m m_{it} + \rho_{pt} + \omega_{it} + \varepsilon_{it} \tag{6}$$

where θ_l, θ_k and θ_m are the output elasticities of labor (l), capital (k) and inputs (m) respectively. ω_{it} is the total factor productivity (TFP). All variables are expressed in logarithm form, and the variables q_{it}, and m_{it} are deflated with industry-level output and input deflators from Brandt et al. (2012a). To account for regional differences in factor markets within China (Cheng et al. 2013), we also add province-year fixed effects ρ_{pt}. ε_{it} is an i.i.d error term.

Material input choice is affected monotonically by the productivity shocks that are observed by firms yet not by econometricians, thus we could represent material input as,

$$m_{it} = m_{it}\left(\omega_{it}, l_{it}, k_{it}, FX_{it}, FM_{it}\right) \tag{7}$$

Equation (7) indicates that firm's input choice is determined by its productivity and factor inputs. In addition, it is also affected by its export and import status. We include export status to acknowledge that exporters are faced with different final good demand and therefore they may have different input choices. Furthermore, we include the importer dummy to account for the fact that importers have different demand for intermediate inputs compared to non-importers.

Because more productive firms use more intermediate inputs, we could invert equation (7) and

[8] Firms who exist for less than three years may exhibit unrealistic input amount due to large fixed cost or negative profits, therefore we delete those sample to avoid bias in output elasticity w.r.t intermediate input. Excluding those firms may result in a downward biased coefficient estimate on capital. Nevertheless, coefficient on material input, which is our main interest, is unlikely to be affected. Our results are qualitatively robust if we keep those short-lived firms, or if we include firm exit probability in estimation to control for selection bias. These results are shown in the appendix Table A3.

express productivity as a function of inputs, export and import indicators,

$$\omega_{it} = h_t\left(m_{it}, l_{it}, k_{it}, FX_{it}, FM_{it}\right) \tag{8}$$

Then, combining equations (6) and (8), we could estimate the following equation non-parametrically,

$$q_{it} = \phi_{it}\left(m_{it}, l_{it}, k_{it}, FX_{it}, FM_{it}\right) + \rho_{pt} + \varepsilon_{it} \tag{9}$$

Estimating equation (9) yields predicted output $\hat{\phi}_{it}$ and error term $\hat{\varepsilon}_{it}$. Then we could recover productivity as,

$$\omega_{it}\left(\Theta\right) = \hat{\phi}_{it} - \theta_l l_{it} - \theta_k k_{it} - \theta_m m_{it} \tag{10}$$

where $\Theta = (\theta_l, \theta_k, \theta_m)$ is the set of output elasticities. In the second step, we estimate Θ by a GMM approach. We assume productivity follows a first order Markov process.

$$\omega_{it} = g\left(\omega_{it-1}\right) + \gamma_x FX_{it-1} + \gamma_m FM_{it-1} + \xi_{it} \tag{11}$$

where ξ_{it} is an i.i.d productivity shock. $g_t\left(.\right)$ is a third order polynomial of ω_{it-1} .We include lagged export and import status to allow for channels of productivity improvement through exporting or importing. A non-parametric regression of equation (11) obtains the innovation to productivity $\xi_{it}\left(\Theta\right)$. Because $\xi_{it}\left(\Theta\right)$ is not correlated with the lagged flexible inputs (labor and material) and current capital stock is pre-determined, we could then use the moment conditions

$$E\left[\xi_{it}\left(\Theta\right)\begin{pmatrix} l_{it-1} \\ m_{it-1} \\ k_{it} \end{pmatrix}\right] = 0 \tag{12}$$

to identify Θ. With Θ estimated, we could readily compute firm-level markup as

$$\hat{\mu}_{it} = \frac{\hat{\theta}_m}{\hat{\alpha}_{m,it}} \tag{13}$$

where $\hat{\alpha}_{m,it} = \frac{M_{it}P_{m,it}}{Q_{it}P_{it}/exp(\hat{\varepsilon}_{it})}$.

The distribution of firm markups (in logarithm value) is shown in Figure 3, for years 2000 and

2007. It shows a rightward shift of markup distribution from 2000 to 2007, a result consistent with what De Loecker et al. (2014) found for India. Over time, the distribution also becomes more dispersed. For brevity, we present the complete set of estimation parameters in the Appendix, including basis statistics on output elasticity, markup level, and the dispersion.

2.3 Descriptive statistics

As described above, our main firm-level variables are drawn from the Annual Surveys of Industrial Production (ASIP), 2000-2007. We follow Cai and Liu (2009) and use the General Accepted Accounting Principles as the guidance to clean the data. We then match this dataset with the firm-level trade data from the Customs Administration to get information on firms' import status and import intensity. We drop the top and bottom 1% extreme value for markups, as well as mis-reported observations. The data cleaning results in an unbalanced panel of 1,575,162 observations with 227,963 importers, distributed across 71 industries (126,718 firms in 2000 and 280,296 firms in 2007).

Table 1 presents the summary statistics of key variables used in our empirical investigation. Our major interest is firm level markup, which, after delete the bottom and top 1% sample, ranges from 0.76 to 2.34. Importers are in minority compared with non-importers, however, they exhibit higher markup than non-importers, on average. We also summarize all control variables we used in later empirical estimations, such as firm import (FM) / export (FX) status, firm tenure, productivity, as well as ownership. In addition to firm characteristics, summary of firm level input tariffs (which only applies for importers) are also presented. There is substantial variations across firms in tariff burdens that they receive.

The middle panel of Table 1 shows industry features, mainly about the competitiveness and tariff levels at industry level. As we will detail later, we use several measures of market competitiveness, including the market share of the top 20 firms (CR20), the (inverse of) log number of firms, the Herfindahl index (HHI), and two size measures (average capital stock, and average firm revenue). There are substantial variations in the level of competitiveness across industries. In the most competitive market (Cement), the largest 20 firms take only 7 percent of domestic market, while in the least competitive market (Tobacco), there are only 294 firms. The bottom panel summarizes firm output and inputs which are used for markup estimation.

[Table 1 about here]

3 Benchmark Results

3.1 Markup and Tariff Reduction

In this section, we examine the possible link between trade liberalization and firm-level markup. Importers who have access to foreign inputs may benefit from reductions in input tariffs, because they could partially pass-through the cost saving to buyers. Thus the first testable hypothesis is that input tariff reduction increases importers' markup. We estimate the equation

$$\begin{aligned} ln\left(m_{ijt}\right) =& \alpha\tau_{jt}^{o} + \beta_1\tau_{jt}^{m} + \beta_2\tau_{jt}^{m} \times FM_{it} + \beta_3 FM_{it} \\ &+ \Gamma X_{it} + \delta_t + \xi_i + \varepsilon_{it} \end{aligned} \tag{14}$$

where i, j and t stand for firm, sector and year respectively. Equation (14) is estimated using OLS. We use firm fixed effect to control for unobserved firm-specific time-invariant characteristics, and use year dummies to control for macro shocks. All estimations are clustered at firm level. τ_{jt}^{o} represents the output tariff, an average tariff across all 6-digit HS products within sector j. Since a fall in τ_{jt}^{o} will likely intensify competition in sector j, firms may see a drop in their markups. Therefore we expect $\alpha > 0$. τ_{jt}^{m} represents the input tariff, calculated as the weighted average of output tariffs of upstream sectors, using equation (1). FM_{it} is an indicator for direct importers of intermediate inputs. $FM_{it} = 1$ if firm i imports any foreign inputs, and $= 0$ otherwise. We expect the impact of input tariff reduction to be different between importers and non-importers, thus we interact the importer indicator FM_{it} with the input tariff τ_{jt}^{m}. Importers will benefit from cheaper access to foreign inputs. Thus the coefficient of this interaction, β_2, is expected to be negative. Besides key explanatory variables, we also include other control variables X_{it} that could affect markup, such as firm age, TFP, and firm ownership.

Table 2 presents the benchmark results. In column 1, we include only output tariff. The pro-competitive effect of output tariff is positive and statistically significant: a 10% reduction in output tariff leads to a drop in firm markup by around 0.4%. Column 2 considers the impact of input tariff reduction. The inclusion of input tariff only slightly reduces the estimated impact of output tariffs. However, lowering input tariffs has exerted heterogeneous impact on importers and non-importers.

The input tariff reduction decreases markup of non-importers ($\beta_1 > 0$), while it substantially raises markup of importers ($\beta_1 + \beta_2 < 0$). More specifically, on average a 10% decrease in input tariff raises importers' markup by nearly 1%, while it reduces non-importers' markup by 0.12%.

[Table 2 about here]

In an imperfectly competitive market, importers enjoy larger markups when they get cheaper access to foreign inputs. In contrast, those firms who do not use imported inputs are put in a cost disadvantage. While importers may reduce prices and increase markups at the same time, non-importers have to reduce both prices and markups due to competition. Recent literature has emphasized the importance of input tariff reduction in raising firm productivity. This paper points out an additional channel through which input tariffs may affect firms. That is: importers increase their markup after input trade liberalization. Besides cheaper foreign inputs, there are other channels that input tariff reduction may enhance importers' market power. For instance, it may encourage transfer of foreign technology embedded in imported inputs. Moreover, lower input tariff may also induce importers to source inputs with higher quality, which in turn increase firm's market power and markup.

Starting from Column (3), we include a set of control variables that may also affect firm markups. Column (3) includes an exporter dummy and the firm age. Consistent with De Loecker and Warzynski (2012), exporters have higher markups. In addition, older firms tend to have lower markups. Column (4) further includes measured TFP for each firm. Consistent with the theoretical predictions by Melitz and Ottaviano (2008), Atkeson and Burstein (2012), more productive firms tend to charge higher markups. Column (5) further adds firm ownership (i.e., foreign or state owned) as controls. The result suggests that state-owned enterprises (SOEs) have higher markups and foreign invested enterprises (FIEs) have lower markups compared with private firms.

In all regressions, the coefficients on two types of tariffs remain robust. In particular, input tariff reduction substantially increases markups of importers. Such impact is also robust when we replace the importer dummy with a continuous measure of import intensity in Column (6). Importers with higher import share tend to experience larger increase in their markups.

3.2 Firm Level Input Tariff and Processing Trade

There are concerns on sector level input tariff. Even within a narrowly defined industry, importers may be exposed to trade liberalization to different extent, as shown by a wide range of import intensity across importers. Furthermore, there may exist other confounding factors such as sector-level policy changes that may bias the estimation above. In this section, we utilize detailed firm-level import information to construct the firm specific input tariffs.

Table 3 shows the results. Column (1) retains the same econometric specification as in Table 2, except that here we replace the sector level input tariff with firm level input tariff. [9] Again, all estimations are clustered at firm level. The results confirm findings in Table 2. Sector-level output tariff reduction decreases markups while input tariff reduction decreases non-importing firms' markups but increases importers' markups. In column (2), we further include industry-year fixed effects to control any time-variant sector-specific factors. Note in this specification the effect of sector-level output tariffs has been suppressed by the industry-year fixed effect. The same pattern remains, although the magnitude falls.

[Table 3 about here]

A phenomenal observation in Chinese trade is that a large share of imports are imported components for export processing. Processing exporters usually import foreign intermediate input duty free and export the processed final goods abroad (Yu, 2014). Given the feature of processing trade, input trade liberalization may affect such firms differently. As a robustness check, in columns (3) we delete all processing firms in the sample. The results are robust.

Columns (4)-(6) focus on the sample of importers. In Column (4) we keep all importers. The results show that input tariff reduction raises importers' markups. Since processing imports are not subject to tariffs, we could use processing firms as a placebo test. In columns (5) and (6), we divide all importers into two subsamples: ordinary importers and processing importers. Column (5) shows that for ordinary importers, input tariff reduction raises firm level markup. While column (6) shows that for processing importers, input tariff has no significant impact.

[9] To compute firm level input tariff, we must obtain detailed firm inputs of each sector. Therefore firm level input tariff is only applicable to importers. For non-importers, we still use employ industry level input tariff to represent the general impact.

4 Market Structure Matters

4.1 Markup, Input Tariff and Market Concentration

In the previous section, we show important difference between output and input tariff reductions in their effects on firm markups. In particular, we show that importers respond to input tariff reductions by increasing their markup, while non-importing firms cut their markup. Intuitively, cheaper access to imported intermediate inputs grants importers a cost advantage, with which they could exert market power. However, such ability for importers to exert market power depends crucially on the market structure. In a very competitive market with many importing and non-importing firms, input trade liberalization would reduce input costs for a large number of firms, therefore their markups could not be increased. In a concentrated market where a few large firms import, input tariff reduction would help those firms to cut costs but still keep price high, leading to increased markups.

Thus we hypothesize that importers tend to have larger increase in their markups compared with non-importers in a less competitive sector. To test this hypothesis, we construct a three-way interaction among the importer indicator, input tariff, and a measure of market concentration, and specify the empirical model as,

$$\begin{aligned} ln\left(m_{it}\right) = & \beta_1 \tau_{jt}^m \times FM_{it} \times CR_j + \beta_2 \tau_{jt}^m \times FM_{it} + \beta_3 \tau_{jt}^m \times CR_j + \beta_4 \tau_{jt}^m \\ & + \alpha_1 \tau_{jt}^o + \alpha_2 \tau_{jt}^o \times CR_j + \Gamma \mathrm{X_{it}} + \delta_\mathrm{t} + \xi_\mathrm{i} + \varepsilon_\mathrm{it} \end{aligned} \tag{15}$$

where i, j and t stand for firm, sector and year respectively. CR_j stands for the market concentration measure of industry j. To be specific, we use the domestic sales share of top 20 firms to measure market concentration (hereafter, CR20). We use the CR20 in 2000 as a constant measure of sector-level concentration. Assumingly the market concentration rate does not change much over time, and using a constant measure also helps to avoid potential endogeneity of market concentration. The results are robust if we instead use a time-variant CR20. All equations include firm fixed effects and year dummy, and are clustered at firm level.

The variable that we are most interested in is the interaction term among the importer indicator, input tariff, and a measure of market concentration. We expect its coefficient, β_1, to be negative, implying importers have larger market power to charge high markup in less competitive markets.

However, it is also important to quantify the difference between importers and non-importers in their ability to adjust markup. To understand this, it is straightforward to separately compute the elasticity of markup with respect to the input tariff for importers and non-importers. The elasticity for importers is

$$\frac{\partial ln\,(m_{it})}{\partial \tau_{jt}^{m}} |\,(FM_{it}=1) = (\beta_1+\beta_3)\times CR_j + (\beta_2+\beta_4) \tag{16}$$

and that for non-importers is

$$\frac{\partial ln\,(m_{it})}{\partial \tau_{jt}^{m}} |\,(FM_{it}=0) = \beta_3\times CR_j + \beta_4 \tag{17}$$

First, importers see more chances to charge higher markup in more concentrated markets, thus we expect $\beta_1 + \beta_3 < 0$. Furthermore, the gap between importers and non-importers in their markups after liberalization is given by $\beta_1 \times CR_j + \beta_2$. We expect this gap to be increasing in market concentration, thus $\beta_1 < 0$.

In Table 4, Column (1) presents the basic results, while Column (2) further adds a set of additional controls including exporter dummy, age, ownership, and TFP. In both columns, our hypothesis is confirmed. Less competitive markets tend to have larger elasticity of markup with respect to input tariff. Interestingly, we find β_3 is negative, suggesting that in a very concentrated market it may be strategically optimal for even non-importing firms to charge higher markup. Finally, the interaction between output tariff and market concentration has a positive coefficient ($\alpha_2 < 0$), reflecting more drastic competition effect in more concentrated markets that are pushing down firms' markup.

[Table 4 about here]

Columns (3) and (4) replicate the first two columns but replace the importer dummy using an indicator for incumbent importers. The estimates hold similar when we focus on incumbent importers, suggesting the results are not driven by new entries of importers. Columns (5) and (6) replace the discrete importer dummy with the continuous measure of import intensity. The results still hold.

To quantify the impact of input tariff reduction, in Table 5, we report the elasticity of markup with respect to input tariff at different percentile of market concentration. Column (1) lists the value of CR20 for each sector, and column (2) the corresponding percentile. Equation (16) gives the formula to compute the elasticity. Column (3) shows the corresponding elasticity. In a very competitive market, such as plastic products ($CR20 = 0.1$), even importers experience falling markups due to trade liberalization. As CR20 increases, the importer's markup elasticity becomes negative and grows larger in magnitude. In the industry with median concentration level (0.306, fireproof products), a 10% reduction in input tariff raises importers' markup by 1.9%. Moreover, in a very concentrated industry (95 percentile), petroleum refining, where CR20 is 0.82, the corresponding rise in markup is 9%. Finally, we report the corresponding markup elasticity to input tariff for incumbent importers, or for import intensity (using mean value), in Columns (4) and (5) respectively.

[Table 5 about here]

Figure 6 presents more straightforward illustration of the quantitative effects of input tariff reduction. First, the top panel shows the scatterplot of input tariff reduction (in absolute value) across the 71 manufacturing sectors.[10] As shown, there is no systematic relation between input tariff reduction and the CR rate across sectors. The upward-sloping solid line gives the markup elasticity for importers, while the dashed line for non-importers. The two line diverge as market becomes more concentrated.

The middle panel then plots the multiplication between input tariff reduction and the markup elasticity, resulting in actual markup changes (in percentage) for importers (circle) and non-importers (x) respectively. The fitted lines clearly depict the pattern we have shown in Tables 3 and 4: moving from low CR sector to high CR sector, importers enjoy larger increase in markup compared with non-importers within the same sector.

The bottom panel considers difference among firms with different import intensity. In particular, we plot markup changes in each sector for firms who do not import, who import 50% of inputs, and who import all inputs. Consistently, firms with higher import intensity experience larger increase in markups in more concentrated markets. For example, in the industry with 25% percentile concentration level (0.20, pottery, china and earthware), input tariff drops 7.64% from 2000 to 2007, with a markup elasticity w.r.t input tariff as -0.05 for importers, the corresponding markup

[10] Two sectors (IO 17024 and 13017) are dropped in Figures 6, their input tariffs increased during the sample period.

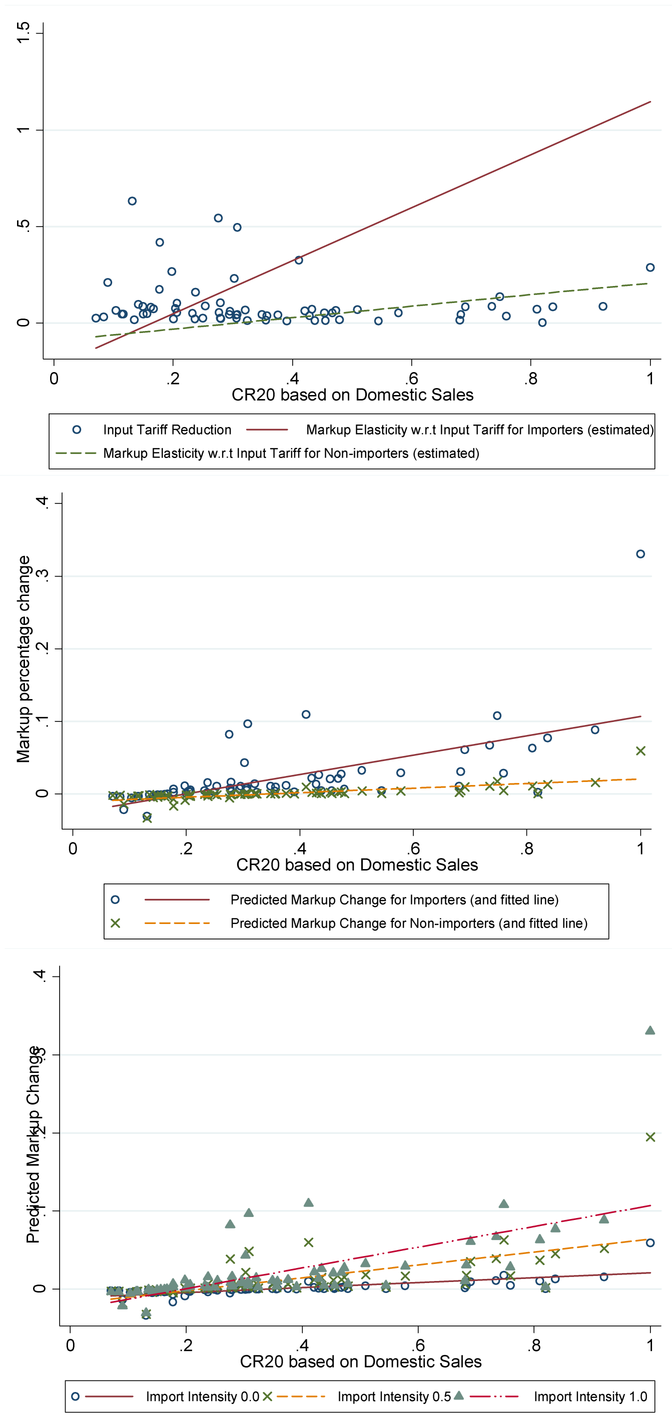

Figure 7: Predicted Markup Changes due to Input Tariff Reduction

growth (due to input tariff reduction) is 0.40%. As a contrast, in the sector of household electric appliances, (90% percentile concentration level, 0.735), input tariff reduction is 13.5% and the markup elasticity for importers is -0.78, therefore the corresponding rise in markup is strikingly around 10%.

4.2 Alternative measures for Market Competitiveness

Our results are robust across different measures of market competitiveness. In particular, Table 6 reports the results when we use number of firms (column (1)), the Herfindahl-Hirschman Index (HHI, column (2)). Furthermore, average firm size may indicate the barrier for firm to enter (Bain, 1956), thus columns (3) and (4) use average capital stock, and average domestic sales to measure the degree of competition. All results are consistent with previous ones, $(\beta_1 + \beta_3)$ is significantly negative, so input tariff reduction increase importers' markups by more in less competitive sectors. Finally, as in Table 5, for interested reader, we report the computed elasticities using alternative measures of market concentration in the appendix Table A.3.

[Table 6 about here]

4.3 Robustness checks on markup estimation

There are also concerns on the robustness of our markup estimations. We explore these issues in the appendix Table A3. Columns (1)-(2) consider the inconsistency when we estimate the impact of tariff reduction on firm markup. While tariff levels are known to firms, in the Markov process of productivity estimation, it is assumed that the current productivity realization is a surprise conditional on lagged productivity. We correct for this inconsistency by incorporating the tariffs in productivity estimation process, following the "direct approach" as in Fernandes (2007) and Topalova and Khandelwal (2011). Because tariffs that we use are at industry level, in this "direct approach" estimation, we assume a common production function across all industries. Columns (3)-(4) corrects for the possible selection bias by considering firms' exit probability, following Olley and Pakes (1996). Our benchmark estimations are based on the sample of firms who operate for at least three years, because short-lived firms may exhibit unrealistic input due to large fixed costs or negative profits. Nonetheless, in Columns (5)-(6), we use the complete sample of firms in markup estimation, regardless of the duration of their operation. After all corrections, our benchmark regression results in Table 4 still hold, with similar magnitude.

4.4 First Difference Estimations

So far, all previous estimations are based on panel regressions with firm fixed effects and year dummies. In Table 7, we experiment with alternative specifications to investigate the medium to long run effect of input trade liberalization. More specifically, we take first-difference to wipe out the firm-specific characteristics. Columns (1)-(3) examine the heterogeneous response of importers vs. non-importers, analogous to Table 3. In column (1), we use the three-period first difference of log markup as the dependent variable, while all explanatory variables are also three-period first differenced. In columns (2)-(3), we take four-period and five-period difference respectively. And the magnitudes of the coefficients are similar as in column (1) but are larger compared with the level regressions. a 10% reduction of output tariff causes firm markup to drop 0.60%. While a 10% drop of input tariff raises importing firm markups by 1.15% percent but reduces non-importing firms' markups by 0.33%.

[Table 7 about here]

In Column (4)-(6), we add all interaction terms between tariffs and market competitiveness, in comparison with Table 4. The coefficient of the interaction term, of input tariff, importer dummy and the market concentration, is significantly negative, implying a similar pattern but larger magnitude compared with the level regression. The inferred markup elasticity w.r.t input tariff is -0.11 in 5% percentile CR industry and -0.27 in 95% percentile CR industry.

4.5 Instrumental Variable Estimation

There are also concerns about the potential endogeneity of tariffs. In general, the direction of the bias caused by the endogeneity is ambiguous. Certain industries may receive protection for various reasons, such as lobby from powerful interest group, or government's priority on maintaining employment. On the other hand, the authority may liberalize different industries to different extent according to its political agenda or economic calculation. During China's trade liberalization episode, however, both output tariff and input tariff have been cut drastically and uniformly. In particular, one well-cited motivation for China's WTO accession is to commit to market-oriented reforms on its domestic economic system. This commitment is also witnessed by the uniform reduction in tariffs across sectors, as shown by the sharp decrease in both tariff levels and variation in Figure 2. Furthermore, as shown in Figure 5 and Figure 6, a common feature of China's tariff reduction is that the higher the initial tariff level is before the liberalization, the larger is the drop in tariff after liberalization. This pattern lends support to the argument that over the liberalization episode, there was very little policy discretion in the extent of trade liberalization in each sector (Brandt et al, 2012b).

[Table 8 about here]

Based on this argument, in Table 8, we address the endogeneity concern by an instrumental variable approach following Amiti and Konings (2007). In particular, we instrument the input tariffs, output tariffs, and their respective interactions with importer dummy, and/or the market competitiveness measure, using the initial pre-WTO tariff levels (in 2000) and their corresponding interaction terms. The direct first stage results of initial tariff levels on tariff reductions, for both input tariff and output tariff, are provided in the lower panel. [11]

5 Conclusion

In this paper, we examine firms' markup response to trade liberalization using a large-scale firm-level data from China. Although a large body of trade literature, in both theory and empirics, emphasizes the "pro-competitive effect" due to declines in output tariffs, the impact of lower input tariffs on firm performance only receives attention recently. Our starting point in this paper is to account for both channels of trade liberalization and more specifically examine the impact of input tariff reduction on firm markup distribution. In an imperfectly competitive market, input tariff reduction gives importers a cost advantage, which importers may not easily pass-through to the consumers. Crucially, the magnitude of the "pass-through", therefore the markup elasticity with respect to input tariff, depends on the market structure. We utilize an unprecedented liberalization episode in China, namely its WTO accession, to estimate such heterogeneous impact of trade reform on firm markup. The results show that input tariff reduction increases firm markup, but only for

[11] The whole set of first stage results are available upon request.

importers. Furthermore, market structure matters: importers' markup increases more due to input tariff reduction in less competitive industries.

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Table 1: Data Summary

Variable	Obs	Mean	Std. Dev.	Min	Max
Firm Characteristics (2000-2007)					
Markup if FM=1	227,963	1.108	0.251	0.764	2.341
Markup if FM=0	1,347,199	1.102	0.271	0.764	2.342
FX	1,575,162	0.288	0.453	0	1
FM	1,575,162	0.145	0.352	0	1
Incum. FM	1,575,162	0.107	0.309	0	1
Import intensity if FM=1	227,963	0.288	0.333	0	1
Age (in log)	1,575,162	1.968	0.862	0	4.615
TFP (in log)	1,575,162	1.415	0.456	-1.482	4.839
SOE dummy	1,575,162	0.09	0.287	0	1
FIE dummy	1,575,162	0.217	0.412	0	1
Firm Input Tariff	227,963	0.055	0.062	0	1.21
Industrial Features in 2000					
CR20	71	0.364	0.221	0.071	0.999
1/log (# of firms)	71	0.147	0.033	0.112	0.353
HHI	71	0.024	0.058	0.001	0.458
Average Capital (in log)	71	10.305	0.931	8.73	13.688
Average Revenue (in log)	71	10.894	0.903	9.542	13.463
Tariff at IO2002 level (2000-2007)					
Input Tariff (t^m)	568	0.093	0.09	0	0.734
Output Tariff (t^o)	568	0.142	0.145	0	0.892
Production Variables (2000-2007)					
Output/1000	1,608,402	76157.82	657008.60	17.147	2.03E+08
Material Input/1000	1,608,402	53547.36	483408.10	10	1.68E+08
Employment	1,608,402	253.84	923.06	11	1.88E+05
Real Capital/1000	1,608,402	26869.85	326224.00	0.625	9.74E+07

Table 2: Tariffs and Markup

	(1)	(2)	(3)	(4)	(5)	(6)
$FM =$			Importer dummy			Import intensity
t^o	0.0367***	0.0351***	0.0346***	0.0386***	0.0388***	0.0390***
	(6.95)	(6.05)	(5.96)	(6.60)	(6.62)	(6.66)
t^m		0.0118***	0.0124***	0.0102**	0.00905**	0.00785*
		(2.73)	(2.88)	(2.36)	(2.10)	(1.82)
$t^m \times FM$		-0.108***	-0.113***	-0.116***	-0.114***	-0.408***
		(-10.39)	(-10.83)	(-11.15)	(-10.94)	(-12.25)
FM		0.0295***	0.0298***	0.0295***	0.0295***	0.126***
		(28.53)	(28.85)	(28.52)	(28.55)	(38.39)
Age			-0.00637***	-0.00643***	-0.00706***	-0.00693***
			(-16.32)	(-16.45)	(-18.11)	(-17.78)
FX			0.00230***	0.00208***	0.00213***	0.00254***
			(4.22)	(3.82)	(3.91)	(4.68)
TFP				0.0162***	0.0163***	0.0175***
				(13.62)	(13.70)	(14.69)
SOE					0.0149***	0.0149***
					(12.31)	(12.32)
FIE					-0.00632***	-0.00591***
					(-4.15)	(-3.88)
N	1575162	1575162	1575162	1575162	1575162	1575162
R^2	0.237	0.238	0.239	0.240	0.240	0.243

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. With firm fixed effects and year dummy.

Table 3: Firm Level Input Tariff and Processing Trade

	(1)	(2)	(3)	(4)	(5)	(6)
	Full Sample	Full Sample	Exclude Processing	Total Importers	Ordinary Importers	Processing Importers
t^o	0.0298***	-	-	-	-	-
	(5.19)					
t^m	0.0206***	0.0184***	0.0274***	-0.0241***	-0.0187***	-0.0289
	(5.03)	(2.69)	(3.68)	(-4.93)	(-2.96)	(-1.18)
$t^m \times FM$	-0.0735***	-0.0377***	-0.0463***	-	-	-
	(-10.55)	(-5.14)	(-6.00)			
FM	0.0252***	0.0267***	0.0274***	-	-	-
	(31.72)	(39.26)	(39.46)			
Age	-0.00700***	-0.00778***	-0.00765***	-0.0109***	-0.00887***	-0.0166***
	(-17.94)	(-29.44)	(-28.86)	(-11.31)	(-8.82)	(-5.72)
FX	0.00214***	-0.00110***	-0.000954**	-0.00707***	-0.00732***	-0.00592**
	-3.93	(-2.85)	(-2.45)	(-7.93)	(-7.73)	(-2.20)
TFP	0.0161***	-0.0443***	-0.0416***	-0.0322***	-0.00494	-0.173***
	-13.53	(-33.76)	(-31.56)	(-8.38)	(-1.20)	(-15.49)
SOE	0.0149***	0.00880***	0.00878***	0.00319	0.00306	0.0259
	(12.35)	(10.04)	(10.00)	(1.15)	(1.08)	(1.37)
FIE	-0.00636***	-0.00313***	-0.00366***	0.00459**	0.00189	0.00464
	(-4.17)	(-3.31)	(-3.82)	(2.06)	(0.77)	(0.78)
N	1575162	1575162	1528081	227963	180882	47081
Firm FE	YES	YES	YES	YES	YES	YES
Ind*Year	NO	YES	YES	YES	YES	YES
Year FE	YES	NO	NO	NO	NO	NO
R^2	0.240	0.576	0.575	0.645	0.658	0.644

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Processing firm definition: firms whose export goods are all processing.

Table 4: Market Concentration, Tariffs and Markup

	(1)	(2)	(3)	(4)	(5)	(6)
FM =	Importer		Incumbent Importer		Import Intensity	
$t^m \times FM \times CR$	-1.091***	-1.075***	-1.372***	-1.353***	-1.387***	-1.341***
	(-12.49)	(-12.34)	(-13.60)	(-13.50)	(-6.56)	(-6.29)
$t^m \times FM$	0.147***	0.136***	0.164***	0.152***	-0.0651	-0.0908
	(6.89)	(6.37)	(6.56)	(6.10)	(-1.09)	(-1.51)
$t^m \times CR$	-0.245***	-0.298***	-0.243***	-0.297***	-0.290***	-0.346***
	(-5.49)	(-6.61)	(-5.46)	(-6.61)	(-6.51)	(-7.68)
t^m	0.0811***	0.0918***	0.0817***	0.0926***	0.0910***	0.102***
	(8.09)	(9.06)	(8.18)	(9.16)	(9.09)	(10.06)
t^o	-0.139***	-0.162***	-0.139***	-0.163***	-0.143***	-0.168***
	(-13.54)	(-15.57)	(-13.60)	(-15.68)	(-13.95)	(-16.08)
$t^o \times CR$	0.570***	0.662***	0.571***	0.666***	0.581***	0.679***
	(17.91)	(20.42)	(17.99)	(20.58)	(18.15)	(20.79)
$FM \times CR$	0.0927***	0.0926***	0.129***	0.128***	0.0519***	0.0502***
	(12.30)	(12.28)	(18.44)	(18.38)	(3.04)	(2.93)
FM	0.00723***	0.00719***	-0.0100***	-0.00926***	0.111***	0.113***
	(3.65)	(3.64)	(-5.08)	(-4.69)	-20.59	-20.89
Age		-0.00712***		-0.00731***		-0.00698***
		(-18.27)		(-18.75)		(-17.93)
FX		0.00201***		0.00269***		0.00244***
		(3.69)		(4.96)		(4.49)
TFP		0.0212***		0.0217***		0.0224***
		(17.69)		(18.12)		(18.68)
SOE		0.0148***		0.0148***		0.0149***
		(12.29)		(12.24)		(12.34)
FIE		-0.00603***		-0.00485***		-0.00568***
		(-3.96)		(-3.19)		(-3.74)
N	1575162	1575162	1575162	1575162	1575162	1575162
R^2	0.239	0.242	0.239	0.242	0.242	0.244

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. With firm fixed effects and year dummy.

Table 5: Markup Elasticity w.r.t Input Tariff

		Elasticity: markup w.r.t input tariff		
CR20	Percentile	Importers	Incumbent Importers	Mean Import Intensity
0.104	0.05	0.085	0.073	0.027
0.135	0.10	0.043	0.022	0.005
0.200	0.25	-0.047	-0.085	-0.042
0.306	0.50	-0.193	-0.261	-0.119
0.456	0.75	-0.398	-0.508	-0.227
0.735	0.90	-0.781	-0.968	-0.428
0.820	0.95	-0.897	-1.108	-0.489

Table 6: Alternative Measure for Competitiveness

	(1)	(2)	(3)	(4)
Comp =	1/logN	HHI	log K	log R
$t^m \times FM \times Comp$	-3.900***	-2.101***	-0.0500***	-0.145***
	(-5.95)	(-4.73)	(-3.18)	(-7.28)
$t^m \times FM$	0.409***	-0.0888***	0.386**	1.411***
	(4.76)	(-8.27)	(2.48)	(6.75)
$t^m \times Comp$	-6.042***	-5.661***	-0.121***	-0.0705***
	(-14.67)	(-10.81)	(-17.65)	(-8.51)
t^m	0.833***	0.0447***	1.172***	0.753***
	(15.00)	(8.42)	(18.01)	(8.83)
t^o	-0.863***	-0.0263***	-1.121***	-1.223***
	(-15.34)	(-3.41)	(-20.55)	(-17.61)
$t^o \times Comp$	6.454***	5.234***	0.116***	0.118***
	(15.79)	(10.71)	(21.17)	(18.07)
$FM \times Comp$	0.823***	0.679***	0.000567	0.00124
	(12.09)	(10.54)	(0.35)	(0.63)
FM	-0.0787***	0.0231***	0.0232	0.0164
	(-8.89)	(20.29)	(1.45)	(0.79)
Age	-0.00710***	-0.00713***	-0.00701***	-0.00708***
	(-18.21)	(-18.30)	(-17.99)	(-18.17)
FX	0.00205***	0.00204***	0.00212***	0.00207***
	(3.76)	(3.75)	(3.90)	(3.80)
TFP	0.0195***	0.0196***	0.0186***	0.0190***
	(16.32)	(16.43)	(15.69)	(15.97)
SOE	0.0148***	0.0149***	0.0151***	0.0148***
	(12.28)	(12.30)	(12.47)	(12.25)
FIE	-0.00636***	-0.00625***	-0.00628***	-0.00613***
	(-4.18)	(-4.10)	(-4.12)	(-4.03)
N	1575162	1575162	1575162	1575162
R^2	0.241	0.241	0.241	0.241

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. With firm fixed effects and year dummy.

Table 7: First Difference Estimation

	(1)	(2)	(3)	(4)	(5)	(6)
	Δ3 m	Δ4 m	Δ5 m	Δ3 m	Δ4 m	Δ5 m
$\Delta t^m \times FM \times CR$				-0.825***	-1.375***	-1.964***
				(-9.52)	(-11.54)	(-14.06)
$\Delta t^m \times FM$	-0.148***	-0.212***	-0.184***	0.0364	0.0958***	0.254***
	(-12.78)	(-14.36)	(-11.60)	(1.63)	(3.25)	(7.67)
$\Delta t^m \times CR$				0.603***	0.697***	0.749***
				(17.80)	(15.42)	(14.38)
Δt^m	0.0331***	0.0754***	0.0694***	-0.0862***	-0.0611***	-0.0790***
	(5.95)	(10.59)	(9.00)	(-10.39)	(-5.61)	(-6.33)
Δt^o	0.0599***	0.0480***	0.0341***	0.0428***	0.0317***	0.0198*
	(8.95)	(5.22)	(3.21)	(6.56)	(3.53)	(1.91)
$\Delta FM \times CR$				0.0788***	0.125***	0.192***
				(9.04)	(10.40)	(13.01)
ΔFM	0.0324***	0.0349***	0.0308***	0.0142***	0.00621**	-0.0133***
	(25.61)	(20.2)	(14.66)	(6.10)	(1.97)	(-3.43)
ΔFX	0.00285***	0.00395***	0.00274**	0.00290***	0.00391***	0.00252*
	(3.90)	(3.70)	(2.01)	(3.97)	(3.67)	(1.85)
ΔSOE	0.0123***	0.0151***	0.0195***	0.0124***	0.0151***	0.0195***
	(8.80)	(8.13)	(8.63)	(8.88)	(8.14)	(8.65)
ΔFIE	-0.00772***	-0.00886***	-0.00920***	-0.00763***	-0.00871***	-0.00898***
	(-4.45)	(-3.88)	(-3.31)	(-4.40)	(-3.81)	(-3.23)
ΔTFP	0.0232***	0.0494***	0.0658***	0.0259***	0.0523***	0.0686***
	(16.63)	(27.38)	(29.89)	(18.51)	(28.84)	(31.09)
ΔAge	-0.00610***	-0.00433***	-0.00281***	-0.00612***	-0.00433***	-0.00288***
	(-14.17)	(-7.47)	(-3.84)	(-14.24)	(-7.48)	(-3.94)
N	539543	336872	214355	539543	336872	214355
R^2	0.0287	0.0228	0.0216	0.0304	0.0254	0.0258

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. With year fixed effects.

Table 8: Instrumental Variable Estimation

	(1)	(2)	(3)	(4)	(5)	(6)
	Δ3 m	Δ4 m	Δ5 m	Δ3 m	Δ4 m	Δ5 m
$\Delta t^m \times FM \times CR$				-6.814***	-5.391***	-4.269***
				(-13.68)	(-10.69)	(-10.17)
$\Delta t^m \times FM$	-0.592***	-0.634***	-0.521***	0.895***	0.442***	0.361***
	(-20.75)	(-20.21)	(-17.41)	(9.12)	(4.32)	(4.27)
$\Delta t^m \times CR$				1.943***	0.963***	1.054***
				(5.94)	(2.79)	(3.72)
Δt^m	0.0932**	-0.176***	-0.0213	-0.480***	-0.945***	-0.530***
	(2.21)	(-3.81)	(-0.47)	(-3.71)	(-5.98)	(-3.92)
Δt^o	0.260***	0.297***	0.179***	0.411***	0.978***	0.522***
	(16.00)	(14.95)	(9.21)	(4.27)	(7.60)	(4.16)
$\Delta FM \times CR$				0.393***	0.358***	0.330***
				(16.73)	(14.26)	(13.75)
ΔFM	0.0290***	0.0299***	0.0287***	-0.0191***	-0.000631	-0.00802
	(31.91)	(22.88)	(16.90)	(-3.95)	(-0.12)	(-1.49)
ΔFX	0.00270***	0.00378***	0.00262*	0.00298***	0.00378***	0.00202
	(3.69)	(3.55)	(1.93)	(3.88)	(3.34)	(1.45)
ΔSOE	0.0112***	0.0153***	0.0188***	0.0119***	0.0168***	0.0201***
	(7.90)	(8.14)	(8.16)	(7.96)	(8.33)	(8.42)
ΔFIE	-0.00735***	-0.00815***	-0.00867***	-0.00639***	-0.00523**	-0.00663**
	(-4.24)	(-3.57)	(-3.11)	(-3.58)	(-2.15)	(-2.30)
ΔTFP	0.0248***	0.0527***	0.0679***	0.0329***	0.0617***	0.0740***
	(17.65)	(28.86)	(30.56)	(13.95)	(22.51)	(26.87)
ΔAge	-0.00637***	-0.00480***	-0.00348***	-0.00642***	-0.00451***	-0.00356***
	(-14.78)	(-8.27)	(-4.75)	(-14.50)	(-7.34)	(-4.79)
first. t^o	-0.174***	-0.226***	-0.311***	-0.190***	-0.238***	-0.335***
	(-79.72)	(-66.69)	(-66.97)	(-88.59)	(-68.08)	(-73.39)
first. t^m	-0.388***	-0.561***	-0.743***	-0.171***	-0.311***	-0.325***
	(-55.31)	(-55.82)	(-47.17)	(-20.18)	(-25.60)	(-18.76)
N	539543	336872	214355	539543	336872	214355
Under Ind.	451.4	253.4	209.7	500.4	371.6	356.4
Weak Ins.(F)	148.6	80.56	66.42	101.4	72.46	69.43

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. With year fixed effects.

Table A1: Output Elasticities

IO2002	bl	bm	bk	RTC	IO2002	bl	bm	bk	RTC
13013	0.271	0.649	0.051	0.971	31049	0.120	0.805	0.074	0.999
13014	0.285	0.739	0.040	1.064	31050	0.266	0.657	0.097	1.020
13015	0.269	0.674	0.086	1.029	31051	0.061	0.887	0.039	0.987
13016	0.060	0.911	0.033	1.003	31052	0.048	0.845	0.085	0.978
13017	0.279	0.711	0.027	1.017	31053	0.065	0.846	0.039	0.950
13018	0.235	0.721	0.039	0.996	32054	0.251	0.704	0.051	1.007
13019	0.230	0.774	0.043	1.047	32055	0.126	0.737	0.115	0.978
15020	0.227	0.712	0.056	0.996	32056	0.236	0.783	0.037	1.057
15021	0.123	0.713	0.093	0.930	32057	0.238	0.722	0.024	0.984
16022	0.297	0.692	0.204	1.194	33058	0.250	0.705	0.049	1.004
17023	0.244	0.689	0.037	0.970	33059	0.238	0.772	0.036	1.045
17024	0.233	0.738	0.033	1.004	34060	0.255	0.769	0.046	1.069
17025	0.214	0.709	0.032	0.956	35061	0.243	0.713	0.053	1.009
17026	0.250	0.766	0.039	1.054	35062	0.258	0.798	0.036	1.092
17027	0.287	0.686	0.056	1.029	35063	0.143	0.694	0.135	0.973
18028	0.301	0.670	0.049	1.020	36064	0.057	0.714	0.041	0.812
19029	0.286	0.662	0.052	1.001	36065	0.171	0.690	0.133	0.994
20030	0.071	0.686	0.113	0.870	37066	0.276	0.630	0.083	0.989
21031	0.108	0.877	0.037	1.022	37067	0.078	0.866	0.066	1.009
22032	0.064	0.710	0.134	0.907	37068	0.257	0.677	0.096	1.030
23033	0.074	0.867	0.089	1.030	37069	0.344	0.624	0.090	1.059
24034	0.109	0.836	0.047	0.991	37071	0.248	0.757	0.042	1.047
24035	0.296	0.652	0.045	0.993	39072	0.258	0.776	0.043	1.077
25036	0.248	0.658	0.147	1.053	39073	0.255	0.773	0.042	1.070
25037	0.219	0.918	0.031	1.168	39074	0.265	0.684	0.116	1.064
26038	0.208	0.700	0.051	0.959	40075	0.111	0.688	0.141	0.940
26039	0.243	0.706	0.045	0.993	40076	0.136	0.877	0.005	1.019
26040	0.252	0.694	0.049	0.995	40077	0.292	0.655	0.084	1.031
26041	0.226	0.784	0.047	1.057	40078	0.295	0.685	0.073	1.053
26042	0.230	0.768	0.065	1.063	40079	0.303	0.789	0.051	1.144
26043	0.252	0.697	0.046	0.994	40080	0.107	0.785	0.068	0.960
26044	0.246	0.741	0.050	1.037	41081	0.197	0.803	0.045	1.045
27045	0.250	0.694	0.066	1.010	41082	0.206	0.859	0.037	1.103
28046	0.149	0.735	0.087	0.972	42083	0.281	0.736	0.039	1.056
29047	0.261	0.773	0.041	1.075	42084	0.261	0.688	0.052	1.001
30048	0.267	0.668	0.072	1.007					

Table A2: Markup Summary

year	p25	p50	p75	mean	sd	p75-p25
2000	0.882	0.975	1.117	1.032	0.220	0.235
2001	0.882	0.968	1.094	1.016	0.199	0.212
2002	0.889	0.970	1.092	1.016	0.191	0.204
2003	0.907	0.989	1.126	1.039	0.195	0.219
2004	0.921	1.017	1.180	1.079	0.222	0.259
2005	0.939	1.047	1.243	1.130	0.271	0.304
2006	0.952	1.074	1.295	1.170	0.307	0.343
2007	0.966	1.086	1.327	1.197	0.330	0.361
Total	0.923	1.024	1.196	1.103	0.268	0.273

Table A3: Robustness Checks on Markup Estimation

	(1)	(2)	(3)	(4)	(5)	(6)
	Include input tariff		Include exit probability		Total sample	
$t^m \times FM \times CR$	-1.420***	-1.363***	-1.195***	-1.164***	-1.191***	-1.159***
	(-16.95)	(-16.12)	(-12.40)	(-12.28)	(-12.41)	(-12.28)
$t^m \times FM$	0.191***	0.148***	0.310***	0.287***	0.314***	0.291***
	(8.94)	(6.85)	(13.06)	(12.22)	(13.28)	(12.43)
$t^m \times CR$	-0.159***	-0.391***	-0.00895	-0.122***	0.0001	-0.114**
	(-3.03)	(-7.38)	(-0.19)	(-2.63)	(0.00)	(-2.48)
t^m	0.0480***	0.101***	0.0879***	0.112***	0.0926***	0.117***
	(3.84)	(7.93)	(8.65)	(10.94)	(9.12)	(11.44)
t^o	-0.100***	-0.216***	-0.0454***	-0.0942***	-0.0490***	-0.0985***
	(-7.29)	(-15.18)	(-4.36)	(-8.92)	(-4.70)	(-9.31)
$t^o \times CR$	0.525***	0.969***	-0.036	0.151***	-0.0415	0.148***
	(13.76)	(24.65)	(-1.15)	(4.71)	(-1.33)	(4.62)
$FM \times CR$	0.0968***	0.0960***	0.0737***	0.0732***	0.0798***	0.0792***
	(13.34)	(13.43)	(9.01)	(9.06)	(9.71)	(9.76)
FM	0.00858***	0.00760***	-0.00687***	-0.00676***	-0.00866***	-0.00859***
	(4.26)	(3.85)	(-3.01)	(-3.00)	(-3.79)	(-3.79)
Age		-0.00686***		-0.00789***		-0.00778***
		(-16.85)		(-18.84)		(-18.60)
FX		0.00106*		-0.00215***		-0.00209***
		(1.92)		(-3.36)		(-3.27)
TFP		0.0991***		0.0429***		0.0435***
		(75.42)		(35.73)		(36.12)
SOE		0.0193***		0.00900***		0.00932***
		(15.36)		(6.57)		(6.82)
FIE		-0.00529***		-0.00257		-0.00231
		(-3.40)		(-1.51)		(-1.35)
N	1575162	1575162	1575162	1575162	1575162	1575162
R^2	0.238	0.259	0.114	0.118	0.113	0.117

The above results differ by settings of equation (8) and equation (11) as well as sample size when estimating firm production function. Compared with our baseline results, we include input tariff in equation (11) for markups in Column 1 and 2. We control for firm exit probability (measured as a probit outcome of firm exit) in equation (8) in Column 3 to 6. Markup in Column 3 and 4 is estimated by firms that exist no less than three years, while markup in Column 5 and 6 is estimated by total sample from 2000 to 2007.

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. With firm fixed effects and year dummy.

Table A4: Markup Elasticities w.r.t Input Tariff: Alternative Measure for Competitiveness

	Percentiles				Input Tariff Elasticity			
Pecentile	1/log Firm #	HHI	Mean Capital (log)	Mean Revenue (log)	1/ log Firm #	HHI	Mean Capital (log)	Mean Revenue (log)
5%	0.115	0.001	9.037	9.916	0.101	-0.053	0.013	0.027
10%	0.119	0.002	9.265	10.084	0.057	-0.059	-0.026	-0.009
25%	0.129	0.004	9.644	10.278	-0.038	-0.073	-0.091	-0.051
50%	0.141	0.008	10.220	10.682	-0.156	-0.109	-0.190	-0.138
75%	0.159	0.022	10.784	11.046	-0.336	-0.218	-0.286	-0.216
90%	0.180	0.054	11.255	12.502	-0.547	-0.462	-0.367	-0.530
95%	0.189	0.067	12.201	12.947	-0.638	-0.563	-0.528	-0.626