# Markups and Quality Adjustments to Chinese Import Competition: Evidence from India

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**Abstract**

We estimate the effect of Chinese import competition on prices, costs, markups and quality growth of firm-products in the case of a large developing country, India. Our results suggest that firms were simultaneously able to reduce marginal costs and increase markups due to incomplete pass-through of costs to prices. Markup growth follows the same non-monotonic relationship that holds between competition and quality growth. Firms closer to the technology frontier are able to reduce costs and increase markups. These firms are also able to upgrade quality, plausibly by investing profits from increased markups in innovation related activities.

**Keywords: China, Import Competition, Quality, Markups**

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# 1 Introduction

The division of the gains from international trade between producers and consumers is a key question in international trade research. A voluminous literature has documented the gains to producers from increased productivity due to increased import competition (Pavcnik, 2002; Fernandes, 2007; Topalova and Khandelwal, 2011) and also access to imported inputs (Amiti and Konings, 2007; Topalova and Khandelwal, 2011). In the Indian trade liberalization context, De Loecker et al. (2016) find that trade liberalization resulted in lower marginal costs which translated into higher markups due to incomplete pass-through leading to only a modest reduction in prices. These findings raise important questions regarding the benefits to consumers from increased trade. Do gains from trade accrue disproportionately to producers as compared to consumers?

There may be additional gains to consumers if producers use the profits from increased markups to finance innovation activities leading to quality upgrading. An emerging literature on effects of trade on quality upgrading finds evidence of quality upgrading by exporting firms from tariff liberalization in China (Fan et al. (2015)) and a positive effect of reduction in import tariffs on rate of quality upgrading of country level export varieties to the US market (Amiti and Khandelwal (2013)). Bas and Strauss-Kahn (2015) find that input trade liberalization leads to increased export prices for Chinese firms that source inputs from developed countries. However, several issues related to the relation between trade and quality upgrading remain relatively unexplored. First, we have little understanding on the effects of trade on quality upgrading by domestic firms which do not export. To understand the overall impact of trade on quality in the domestic economy, we need to jointly study the effects on exporting as well as domestic firms. Secondly, we have less clarity on how firms finance their quality upgrading in response to increased trade. Thirdly, it is difficult to separate the effects of import competition from that of imported inputs in enabling quality upgrading of products. Trade liberalization episodes simultaneously increase import competition in the domestic market as well as increase access to high quality inputs from developed countries.

In this paper, we make the first attempt to tackle these issues by studying the effect of increased imports from China on the performance of Indian manufacturing firms during the period 1995-2007.

The rise in Chinese exports in the 2000s provides an ideal setting to study the effects of import competition on quality upgrading. Firstly, Chinese imported inputs are likely to be cheaper but not technologically advanced and hence are not expected to induce quality upgrading. Thus, while Chinese imported inputs are expected to affect prices, costs and markups because of lower costs, their effect on quality should be negligible. This enables us to study the effect of import competition on quality growth of firm-products without having to worry about the input channel. Secondly, the rise of China as a manufacturing superpower during the 2000s was primarily driven by economic reforms of the 1980s and 1990s leading to high productivity growth (Naughton (2007)), large scale rural-urban migration of nearly 150 million workers (Chen et al. (2010)), and capital accumulation in a relatively short period of time (Brandt et al. (2012)). Further, China's accession to the WTO in 2001 complemented the above internal reforms leading to unprecedented increase in Chinese manufacturing exports to the rest of the world, including both developed and developing economies.[1] This allows us to causally estimate the effect of increased imports from China. Following Autor et al. (2013), Autor et al. (2014) & Acemoglu et al. (2016), our identification strategy relies on instrumenting for Chinese exports to India by Chinese exports to a set of other developing countries. This strategy assumes there were no common technological shocks in industries which could drive the demand for Chinese imports.

Our analysis proceeds in three stages. We begin by studying the effect of Chinese import competition as well as imported inputs on prices, marginal costs and markups of firms in India. Then, we proceed to estimate the effect of Chinese import competition on the quality growth of firm-products. Finally, we link markup responses to quality growth.

To estimate markups and marginal costs, we follow the methodology proposed by De Loecker

[1] China's WTO accession gave most favored nation status to China among WTO member countries (Branstetter and Lardy (2006))

et al. (2016) to estimate production functions, which explicitly allows for multi-product production function, overcomes bias in revenue based production function estimates and accounts for bias resulting from unobserved input allocations across products and unobserved firm specific input prices.

The emphasis on quality upgrading by exporters in the literature is primarily driven by lack of data availability at the product level for firms which would enable computing appropriate measures of quality, as in Khandelwal et al. (2013). Export data lets researchers overcome this issue as trade data is classified at a very disaggregated level and hence can be used to construct reliable estimates of quality. Firm level data from Prowess for Indian firms enables us to overcome the data availability issues mentioned above and we are able to construct reliable estimates of quality as the database provides detailed firm product level data for over 3500 products. Our quality measure closely follows the measure proposed by Khandelwal et al. (2013) and is based on the intuition that conditional on price, a variety having a higher demand should be of a higher quality. Thus, we are able to study the effects of Chinese imports on quality of exporters as well as domestic firm. In our setting, each firm-product within a product is considered as a distinct variety.

Following Aghion et al. (2009), we allow for a non-monotonic relationship between competition and innovation. These models show that the relationship between competition and innovation is moderated by the distance to the world technology frontier. This occurs because the further the firm is from the frontier, lesser is the incentive to innovate as post-innovation rents reduce by more than pre-innovation rents. Exactly the opposite happens for firms closer to the frontier whose post innovation rents are reduced by much less than pre-innovation rents. Also, the effect would be strongest when the domestic firm-product is technologically similar to the imported product. Thus, the above framework is suitable to study import competition from developed countries whose products are close to the world technology frontier. We adapt the framework to allow for the relationship between competition and innovation to depend on the domestic technology frontier. Chinese imported products are technologically more likely to be closer to the domestic technology frontier for the Indian market than the world technology frontier. This enables us to study the effect of import competition on quality upgrading for all firms, both exporters and domestic.

Our results suggest that firms simultaneously reduced marginal costs and increased markups in response to Chinese import competition due to incomplete pass-through of costs to prices. The effects of increased imported inputs from China on costs and markups were much larger than that due to import competition. The effect on prices was positive but statistically insignificant. We find strong evidence for the non monotonic relationship between Chinese import competition and quality growth of firm-products. Chinese import competition led to positive growth in quality of firm-products which were closer to the domestic technology frontier while firm-products further away from the frontier had a negative effect on quality upgrading. Finally, we find a similar non monotonic relationship between Chinese import competition and growth in markups. Firm products which were initially closer to the frontier experienced positive growth in markups and the effect reduced as we moved away from the frontier. This provides a plausible link between markups and quality upgrading by firms due to increased import competition. The results are robust to the effect of outliers, exclusion of exporters and using unit prices as a measure of quality.

Our paper is closely related to Medina (2017), who studies the effect of Chinese import competition on quality in the apparel industry. The mechanism for quality upgrading works through shifting of resources from low to high quality products within a firm. Our paper focuses on within firm-product changes in quality in response to Chinese import competition. The mechanism highlighted in our paper suggests that within firm-product quality upgrading happens for firms closer to the technology frontier while firm-products away from the frontier are discouraged from innovating and do not upgrade quality. Thus, there are within firm-product changes in quality which cannot be solely explained by transfer of resources from low to high quality products within a firm. Finally, our empirical methodology is more suitable to study the overall effects on quality from import competition across a range of industries and products. The paper is organized as follows. Section 2 outlines the empirical strategy. Section 3 describes the data. Section 4 presents the results. Section 5 concludes.

# 2 Empirical Strategy

## 2.1 Chinese Import Competition and imported inputs

The main measure for Chinese import competition is the import penetration ratio for an industry $j$ (NIC 2004 revision) and is computed as:

$$IP_{jt}^{china} = \frac{M_{jt}^{IC}}{(Y_{j,94} + M_{j,94} - X_{j,94})} \tag{1}$$

where $M_{jt}^{IC}$ is the total import of Chinese goods in industry $j$ at time $t$; $Y_{j,94}$,$M_{j,94}$ and $X_{j,94}$ are total domestic production, imports and exports for industry $j$ during 1994. To overcome endogeneity concerns we follow Autor et al. (2013), Autor et al. (2014) & Acemoglu et al. (2016) in instrumenting for Chinese exports to India by Chinese exports to other developing countries. The instrument for (1) is computed as:

$$IV_{jt}^{china} = \frac{M_{j,t-1}^{IC,Others}}{(Y_{j,94} + M_{j,94} - X_{j,94})} \tag{2}$$

where $M_{j,t-1}^{IC,Others}$ is the lagged value of Chinese imports to an industry in Brazil, Indonesia, Malaysia and Mexico. This approach assumes that the rise in Chinese manufacturing exports to developing countries was primarily driven by internal supply shocks and reduced trade costs but not by unobserved import demand shocks in developing countries (Autor et al. (2013)). Consider a scenario where a technology shock in an industry increases the demand for Chinese imports in developing countries. Our estimates will then be capturing the effect of this technology shock and would erroneously attribute it to Chinese import competition.

To study the effect of imported inputs from China on firm performance we calculate the exposure of an industry $j$ to Chinese imported inputs in year $t$ as:

$$INP_{jt}^{china} = \sum_{s} \alpha_{js} \cdot IP_{st}^{china} \tag{3}$$

where $\alpha_{js}$ is the share of input $s$ in total output for industry $j$ and $IP_{st}^{china}$ is the import penetration ratio for input $s$. The instrument for $INP_{jt}^{china}$ is given by instrumenting for Chinese penetration ratio as given in (2) except the import penetration and its instrument is calculated for the input sector $s$ instead of the industry $j$:

$$IV_{INP_{jt}^{china}} = \sum_{s} \alpha_{js} \cdot IV_{st}^{china} \tag{4}$$

We also proxy for Chinese import competition in foreign markets by the import share of China in the US market given by:

$$IS_{j,t}^{China,US} = \frac{M_{j,t-1}^{China,US}}{M_{j,t-1}^{US}} \tag{5}$$

## 2.2 Markups and marginal cost estimation

We closely follow the methodology proposed by De Loecker et al. (2016) to estimate the coefficients of the production function and calculate markups and marginal costs at the firm-product level. De Loecker et al. (2016) improve upon the prevalent techniques in the literature on estimating production functions (Levinsohn and Petrin (2003);Olley and Pakes (1996)) by: (1) explicitly allowing for multi-product production function, (2) overcoming bias in revenue based production function estimates by using information on quantities of products, (3) accounting for unobserved input allocations across products within a multi-product firm, and (4) addressing bias arising from unobserved firm specific input prices. The methodology to estimate markups and marginal costs is briefly described below.

Let the production function for firm-product $ip$ in year $t$ be given by:

$$Q_{ipt} = F_{pt}(R_{ipt}, K_{ipt}, L_{ipt})\Omega_{pt} \tag{6}$$

where $Q$ is physical output, R is raw materials and is the freely adjustable input, $K$ and $L$ are capital stock and labor expenditures respectively and are fixed inputs, and $\Omega$ is firm level productivity. Product wise cost minimization subject to (5) and input costs results in the following expression for firm-product level markups:

$$\mu_{ipt} = (\frac{P_{ipt}Q_{ipt}}{W^{R}_{ipt}R_{ipt}})\frac{\partial Q_{ipt}}{\partial R_{ipt}}\frac{R_{ipt}}{Q_{ipt}} = \frac{\theta^{R}_{ipt}}{\alpha^{R}_{ipt}} \tag{7}$$

where $\mu_{ipt}$ is the firm-product level markup, $W_{ipt}$ is the input price for raw materials, $\alpha^{R}_{ipt}$ is the ratio of raw materials expenditure allocated to product $p$ to the total sales of product $p$, and $\theta^{R}_{ipt}$ is the output elasticity with respect to raw materials (variable input in our case). Firm-product level marginal costs can then be calculated using markups estimated above combined with data on firm-product level prices as:

$$cost_{ipt} = \frac{P_{ipt}}{\mu_{ipt}} \tag{8}$$

To estimate coefficients of production function, we take logs of equation (5) while allowing for an additive error term, $\epsilon_{ipt}$, to capture measurement error and/or unanticipated output shocks. Taking $\omega_{it} = \ln(\Omega_{it})$ and collecting log of physical inputs in the vector $\mathbf{x}_{ipt}$, the estimation equation is given by:

$$q_{ipt} = f_p(\mathbf{x}_{ipt}; \boldsymbol{\beta}) + \omega_{it} + \epsilon_{ipt} \tag{9}$$

As within firm allocation of inputs across products and physical quantities for inputs are unobserved by us [2], we substitute $x_{ipt} = \rho_{ipt} + \tilde{x}_{ipt} - w_{ipt}$ in equation (8) to obtain:

[2] We only observe deflated expenditures on each input by the firm using industry level deflators

$$q_{ipt} = f_p(\tilde{\mathbf{x}}_{ipt}; \boldsymbol{\beta}) + A(\rho_{ipt}, \tilde{\mathbf{x}}_{ipt}, \boldsymbol{\beta}) + B(\mathbf{w}_{ipt}, \rho_{ipt}, \tilde{\mathbf{x}}_{ipt}, \boldsymbol{\beta}) + \omega_{it} + \epsilon_{ipt} \tag{10}$$

where $\rho_{ipt}$ is the log of input share of product $p$, $\tilde{x}_{ipt}$ is the deflated input expenditure, $w_{ipt}$ captures the log difference of firm-product specific input price and the industry level input price index. $A(.)$ denotes the bias arising from unobserved product level input allocation while $B(.)$ denotes the bias due to unobserved input prices specific to a firm-product. We now need to estimate the production function coefficients , $\beta$, and the unobserved input allocation, $\rho_{ipt}$.

Under the assumption that a multi-product firm and single product firm producing the same product use the same production technology, observations on single product firms for each industry can be used to estimate the production function in (9). For single product firms, $A(.) = 0$, and hence we do not need to address the bias due to unobserved shares of inputs allocated to products within a firm. As we only use single product firm sample for production function estimation, subscript $p$ can be dropped. To account for input price bias, unobserved firm specific prices, $w_{it}$, is approximated by output prices ($p_{it}$, product dummies ($D_p$), market shares ($s_{it}$) and exporting status ($exp_{it}$). The input price control function is given by:

$$w^x_{it} = w_t(p_{it}, D_p, s_{it}, exp_{it}) \tag{11}$$

A static input demand function is used to control for unobserved productivity shocks following Olley and Pakes (1996) and Levinsohn and Petrin (2003). The demand for raw materials is assumed to be a function of productivity, other fixed inputs (capital and labor), and all variables that affect the demand for materials. The additional variables affecting material demand are output prices ($p_{it}$), product dummies ($D_p$), market shares ($s_{it}$), exporting status ($exp_{it}$), and output tariffs ($\tau^{output}_{it}$), input tariffs ($\tau^{input}_{it}$) and Chinese import penetration ratio ($IP^{china}_{it}$) on the product produced by the firm $i$. The material demand function is given by

$$\tilde{r}_{it} = r_t(\omega_{it}, \tilde{k}_{it}, \tilde{l}_{it}, p_{it}, D_p, s_{it}, exp_{it}, \tau_{it}^{output}, \tau_{it}^{input}, IP_{it}^{china}) \tag{12}$$

Inverting the material demand function gives the control function for productivity:

$$\begin{aligned} \omega_{it} &= h_t(\tilde{r}_{it}, \tilde{k}_{it}, \tilde{l}_{it}, p_{it}, D_p, s_{it}, exp_{it}, \tau_{it}^{output}, \tau_{it}^{input}, IP_{it}^{china}) \\ &= h_t(\mathbf{x}_{it}, \mathbf{z}_{it}) \end{aligned} \tag{13}$$

where $\mathbf{z}_{it}$ consists of all variables affecting input demand except other inputs and unobserved productivity.

The use of only single product firms to estimate the production function raises concerns regarding selection bias. This would be the case if number of products produced by a firm is a function of the unobserved productivity or the inputs. Similar to the correction for exit of firms proposed by Olley and Pakes (1996), the probability of a firm remaining a single product firm ($SP_{it}$) is modelled as a function of previous period productivity and a productivity cutoff.

The law of motion for productivity is given by:

$$\omega_{it} = g_t(\omega_{it-1}, \tau_{it-1}^{output}, \tau_{it-1}^{input}, IP_{it-1}^{china}, exp_{it}, SP_{it}) + \xi_{it} \tag{14}$$

We can express output as a function of observable variables and the error term by combining $f(.)$ and $B(.)$ into a function $\phi(.)$. Output can then be expressed as:

$$q_{it} = \phi_t(\tilde{\mathbf{x}}_{it}, \mathbf{z}_{it}) + \epsilon_{it} \tag{15}$$

where $\phi_t(.)$ identifies output net of measurement error, $\epsilon_{it}$. Estimation of (14) yields predicted values of output, $\widehat{\phi}$. Productivity can now be expressed as a function of observables and parameters and is given by:

$$\omega_{it} = \widehat{\phi}_{it} - f(\tilde{\mathbf{x}}_{it}; \boldsymbol{\beta}) - B((p_{it}, D_p, s_{it}, exp_{it}), (p_{it}, D_p, s_{it}, exp_{it}) \times \tilde{\mathbf{x}}_{it}; \delta) \tag{16}$$

where $\delta$ denotes the parameters of the input price control function.

To estimate the parameters, $\beta$ and $\delta$, we use equation (13) to construct moments based on the innovation in the productivity shock, $\xi_{it}$. The moments identifying the parameters are given by:

$$E(\xi_{it}(\boldsymbol{\beta}, \boldsymbol{\delta})\mathbf{Z}_{it}) = 0 \tag{17}$$

where $\mathbf{Z}_{it}$ consists of lagged materials, current capital and labor, with their higher orders and interaction terms, and also contains lagged output prices, Chinese import penetration ratio, lagged market shares, lagged tariffs and their interaction with inputs. The estimation procedure employed is the GMM procedure suggested by Wooldridge (2009). The estimation procedure yields estimates for $\beta$ and $\delta$ and hence all parameters of the production function as well as input price functions are identified. Input allocation between products within a multi-product firm can be recovered by dividing the production function into two separate functions, $f_1$ and $f_2$, with only $f_2$ depending on the input allocation across products. Predicted output can be expressed as:

$$\hat{q}_{ipt} = f(\tilde{\mathbf{x}}_{it}, \hat{\boldsymbol{\beta}}, \hat{w}_{ipt}, \rho_{ipt}) + \omega_{it} \tag{18}$$

The below system of equations can be solved to recover firm level productivity and input allocation between products within a firm.

$$\hat{q}_{ipt} = f_1(\tilde{\mathbf{x}}_{it}, \hat{\boldsymbol{\beta}}, \hat{w}_{ipt}) + f_2(\tilde{\mathbf{x}}_{it}, \hat{w}_{ipt}, \rho_{ipt}) + \omega_{it} \tag{19}$$

$$\sum_j exp(\rho_{ipt}) = 1 \tag{20}$$

Once we estimate the input allocation across products within a firm, we can use (6) and (7) to calculate firm-product level markups and marginal costs respectively.

## 2.3 Quality in domestic market

The evidence on effect of increased import competition on quality has mainly focused on exporting firms (Fan et al. (2015)) or country level exports (Amiti and Khandelwal (2013)). These studies find that import competition enables quality upgrading. However, there is much less clarity on effect of import competition on quality of products produced by domestic producers. Fernandes and Paunov (2009) study the effect of import competition on domestic as well as exporting Chilean firms. However their measure of quality is based on unit values which are an imperfect measure of quality and are often noisy (Amiti and Khandelwal (2013)). Our first measure of quality follows the methodology of Khandelwal et al. (2013) and is based on the intuition that conditional on price a firm-product having higher quantities has higher quality. We adapt their methodology for the domestic market setting of this paper. Within each product category, we treat each firm-product as a distinct variety and estimate its quality as outlined below. The first step involves estimating the residual from the following OLS regression:

$$q_{ipt} + \sigma_k p_{ipt} = \alpha_p + \alpha_t + \nu_{ipt} \tag{21}$$

where we assume specific values of $\sigma$ for product $p$, and $\alpha_p$ and $\alpha_t$ are product and time fixed effects respectively. Our primary measure for quality relies on industry wise estimates of $\sigma$ from Broda et al. (2006). We also set $\sigma$ to equal 5 and 10 for all industries for our secondary measures of quality, as in Fan et al. (2015). Estimated quality is then given by:

$$\hat{\gamma}_{ipt} = \frac{\hat{\nu}_{ipt}}{\sigma - 1} \tag{22}$$

We also estimate a second measure of quality based on Forlani et al. (2016) where quality is a function of estimated markups, unit prices and quantities and is given by:[3]

$$\hat{\gamma}_{ipt} = \mu_{ipt} p_{ipt} + (1 - \mu_{ipt}) q_{ipt} \tag{23}$$

Following insights from Aghion et al. (2005) and Aghion et al. (2009), we allow for the relationship between import competition from China and quality of firm-products to be moderated by the firm-product's distance from the technology frontier. In our setting of the domestic Indian economy, the technology frontier is defined for the domestic market. We define the distance from domestic frontier of a firm-product-year observation as:

$$PF_{ipt} = \frac{exp(\gamma_{ipt})}{\max_{i\epsilon pt}(exp(\gamma_{ipt}))} \tag{24}$$

where $PF_{ipt}$ denotes proximity to the domestic technology frontier and takes on value of 1 for firm-products at the domestic technology frontier, i.e., firm-products having highest quality within each product category.

## 2.4 Effect of Chinese import competition

We start by estimating the firm level effects of Chinese import competition by estimating the below specification:

$$\Delta X_{ijt} = \alpha_0 + \alpha_i + \alpha_{j(3),t} + \beta_1 IP^{china}_{ij,t-3} + \beta_2 IS^{China,US}_{ij,t-3} + \nu_{ijt} \tag{25}$$

where $X$ denotes three period growth in sales, exports, wages, capital and materials expenditure. $\alpha_i$ & $\alpha_{j(3),t}$ are firm and industry-year (NIC 3 digit) fixed effects to sweep out time invariant firm specific variables and yearly shocks to industries which may be correlated with Chinese imports. $IP^{china}_{ij,t-3}$ & $IS^{China,US}_{ij,t-3}$ are computed as a sales share weighted average of product level variables defined earlier.

[3] This measure has also been recently used in Stiebale and Vencappa (2018)

Next, we study the within firm product changes in prices, marginal costs, markups and quality in response to Chinese import competition by estimating the below specification:

$$\Delta X_{ipt} = \alpha_0 + \alpha_{ip} + \alpha_{j(3),t} + \beta_1 IP^{china}_{j,t-3} + \beta_2 INP^{china}_{j,t-3} + \beta_3 IS^{China,US}_{j,t-3} + \nu_{ipt} \tag{26}$$

where $X$ denotes three period growth in prices, marginal costs, markups and quality. We exploit within firm-product variation and control for industry-year specific shocks that may be correlated with Chinese imports.

Finally, we use the following specification to relate firm-product growth in quality, prices, marginal costs and markups to Chinese import competition, proximity to domestic technology frontier and the interaction between the two:

$$\Delta X_{ipt} = \alpha_0 + \alpha_{ip} + \alpha_{j(3),t} + \beta_1 IP^{china}_{j,t-3} + \beta_2 INP^{china}_{j,t-3} + \beta_3 (IP^{china}_{j,t-3} \text{x} PF_{ip,t-3}) + \beta_4 PF_{ip,t-3} + \nu_{ipt} \tag{27}$$

where $\Delta X_{ipt}$ is three period growth for a firm-product between time period $t$ and $t-3$ while all explanatory variables are in levels in period $t-3$. We study growth in dependent variables over three periods as this lets us optimally exploit China's import rise till the year 2007 which is just before the financial crisis period. Chinese imports to India and other developing countries increased exponentially from 2003 onward and hence we want to use as much of post 2003 data as possible in our estimation.

# 3 Data

Our primary source for firm level data is the Prowess database from the Centre for Monitoring the Indian Economy (CMIE). Prowess database has information on financial performance of over 45000 firms across manufacturing, services, financial and utility sectors. These firms account for a substantial fraction of output in the organized manufacturing sector and taxes collected by the governments. For this study we focus on firms in the manufacturing sector for the sample period 1995-2010. A unique feature of Prowess database is that it captures detailed information on firms' product level production including quantity,sales and capacity of each product manufactured by the firm. The 1956 Companies Act requires firms to report detailed production data for all products manufactured by the firm. The internal product classification of CMIE assigns a 20 digit unique code to each product. There are over 3500 unique products in our cleaned sample. These product codes were mapped to the National Industries Classification (NIC) 2004 revision.

The data on Chinese imports to India and other developing countries, namely Malaysia, Indonesia, Brazil and Mexico, was sourced from the UN-COMTRADE database. The HS six-digit products were mapped to the NIC 2004 revision. We combine the Chinese import data above with industry level production data from Annual Survey of Industries (ASI)[4] and National Sample Survey Office (NSSO) [5] and industry level data on total exports and imports for India from UN-COMTRADE database to calculate the import penetration ratio measure and its instrument in (1) and (2) respectively. Finally we proxy for elasticity of substitution between varieties in each industry by using industry specific elasticities for imports into India from Broda et al. (2006).

# 4 Results

## 4.1 Import competition and prices, costs and markups

We plot the distribution of prices (figure 7), marginal costs (figure 8) and markups (9) for firm-product pairs present at both the start and end of sample period. We compare prices, costs and markups by plotting residuals from regressing these on firm-product fixed effects to make them comparable across product categories.[6]. We plot the distributions for the time

[4]ASI data reports production data for registered manufacturing firms in the organized manufacturing sector.

[5]The NSSO surveys unregistered manufacturing units in the manufacturing sector.

[6]This approach is similar to that used in De Loecker et al. (2016)

period 1995-2007

These figures suggest that there was a considerable leftward shift (reduction) in factory gate prices. However, marginal costs moved only slightly leftward and there was no significant shift in the markups distribution for the period 1995-2007. However, these aggregate trends may be confounded by industry specific factors affecting firm-product level prices, costs and markups. Hence, we now report the results from estimating the main specification discussed in the earlier sections.

Table 6 reports the results from estimating equation (25) using instrumental variables estimation to causally identify the effect of Chinese import competition on firm level performance and production input variables. The results suggest that there was a positive effect of Chinese import competition on growth in firm sales and exports, however the effects are not statistically significant (columns (1) & (2)). Chinese import competition also led to negative growth in wages and capital inputs while there was no significant effect on growth in materials input (columns 3-5). These results are suggestive of substantial within firm adjustments in inputs which cannot be explained by within firm across product reallocation of input resources (Medina, 2017).

Next, we study the within firm-product changes in prices, costs and markups by estimating equation (26). Table 7 reports the results. We find that Chinese import competition resulted in significant reduction in prices (column 1) and marginal costs (column 4) and increase in markups for firm products (column 7). The coefficients on prices and markups equal costs as these variables are in logs. The results suggest that there was only partial pass-through of costs to prices. Firms are able to considerably reduce marginal costs plausibly due to reduction in X-inefficiencies. We do not observe a similar decline in prices as firms offset this reduction in costs by increasing markups. Thus, the effect on prices is lower than would have been expected in the case of constant markups. Our results are qualitatively similar to those of De Loecker et al. (2016) who study the effect of unilateral trade liberalization in India on prices, costs and markups. Columns 2,5 and 8 include a measure of Chinese imported inputs and we find that although the coefficients are much larger compared to that on the Chinese import competition measure, they are statistically insignificant.[7]

Finally, we test for heterogeneous response to Chinese import competition based on distance to technology frontier. If the overall effect on costs and markups reported above uniformly applied to all firms, we would not expect the markups increases to explain the hypothesized non-monotonic relationship between import competition and quality growth earlier. However, if firm-products closer to the technology frontier are differentially affected compared to those that are further away, markups increases could be a plausible channel linking import competition and quality growth. We estimate equation (27) with three period growth in prices, costs and markups as the dependent variable and the results are reported in columns 3,6 and 9 respectively. We find strong evidence that firm-products closer to the frontier saw differentially negative growth in prices and marginal costs, and positive growth in markups. Thus, the reduced overall prices of firm-products were driven by low quality firm-products which were away from the frontier. The overall effect on marginal costs and markups were driven mostly by firm-products closer to the quality frontier.

Thus, firms closer to the frontier would be better able to invest the additional profits from increased markups towards innovation activities as compared to firms away from the frontier.This differential effect of Chinese import competition on marginal costs and markups based on proximity to technology frontier provides a plausible link between import competition and quality upgrading for firm-products in India.

[7] Chinese import competition can lead to reduced costs for firms from increased efficiency which increases markups and simultaneously induce lowering of markups due to pro-competitive effects in the product market. The results in Table 7 suggest that the cost channel is more salient and hence there is an overall increase in markups. To isolate the pro-competitive effects of Chinese import competition, we follow De Loecker et al. (2016) and control for the effect of marginal costs by including a quadratic polynomial of marginal costs with markups as the dependent variable in equation (26):

$$\mu_{ipt} = \alpha_0 + \alpha_i p + \alpha_{j(3),t} + \beta_1 IP^{china}_{j,t-1} + \beta_2 cost_{ipt} + \beta_2 cost^2_{ipt} + \nu_{ipt} \tag{28}$$

The results from estimating (28) are reported in appendix table A1. The results suggest that conditional on cost effects, import competition from China indeed put downward pressure on markups.

## 4.2 Chinese import competition and quality growth

Our results on prices, marginal costs and markups in the above section suggest that the gains from increased Chinese import competition mainly accrued to producers, at least in the short run. Producers were able to reduced marginal costs considerably while simultaneously increasing markups. Next, we explore other potential gains to consumers in terms of quality upgrading, apart from the modest reduction in prices. The results from estimating equation (26) and (27) with three period growth in quality as the dependent variable is reported in table 8. We use our quality measure based on citetkhandelwal2013 in columns 1-6, based on Forlani et al. (2016) in columns 7-9 and use unit prices as proxy for quality in column 10. Columns 1-3 use $\sigma$ values from Broda et al. (2006) while we fix $\sigma = 5$ in columns 4-6. The results suggest that Chinese import competition led to no overall effect on quality upgrading (columns 1-2) or negative and significant degradation in overall quality (columns 4-5 & columns 7-8). Thus, our results suggest that import competition may not lead to overall quality upgrading and may even lead to lowering of overall quality in the domestic market once we include both exporters and non-exporting domestic firms in our sample. This finding is contrary to the unambiguous positive effect on quality upgrading reported in Amiti and Khandelwal (2013) who study the quality upgrading of exported varieties from various countries to the US market.

Columns 3, 6, 9 & 10 report the result from estimating specification (27), which is similar to that employed in Aghion et al. (2009) & Amiti and Khandelwal (2013). Firms away from the technology frontier are discouraged from investing in innovation as they would not survive the competition even after innovating successfully ($\beta_1 < 0$). On the other hand, firms closer to the technology frontier can escape losses from increased competition by investing in innovation ($\beta_3 > 0$). We find strong support for the hypothesized non monotonic relationship between import competition and quality upgrading. Firm-products closer to the technology frontier increased their quality ($\beta_3 > 0$), while firm-products away from the technology frontier ($PF_{ip,t-3} \approx 0$) reduced quality of their products in response to Chinese import competition. The results also provide suggestive evidence of convergence as we find $\beta_4 < 0$, implying that firm-products further from the frontier experience faster quality growth. The results are robust across different quality measures. These results are qualitatively similar to the findings of Amiti and Khandelwal (2013) who find that import competition result in quality upgrading of varieties closer to the world technology frontier.

## 4.3 Robustness

In this section, we check the robustness of our results to selection bias and alternative measures of Chinese import competition. One concern with our main results on the non-monotonic relationship between competition and quality upgrading is that it might be driven by re-allocation of resources from low quality to high quality products within firms and also if high (low) quality firm-products are more (less) likely to survive in the face of Chinese import competition. This would be problematic as the hypothesized relationship works primarily through within firm-product increases in quality based on proximity to quality frontier of the firm-product and not through re-allocation channel. To check the robustness of our results to selection issues, we report results from adding a triple interaction term between Chinese import competition, proximity to quality frontier and an indicator of switching (columns 1,4)/product addition (columns 2, 5) and product drop (columns 3, 6) in table 9. Our main results are robust to this specification and suggest that the non monotonic relationship between competition and quality upgrading holds even in firms which did not switch, add or drop products. These results hold for both our measures of quality. Thus, our results are not driven by within firm across product re-allocation of resources. In table 10, we report results from estimating equation (27) with different measures of Chinese import competition. The various alternate measures for Chinese import competition is given by: $\frac{\mathrm{M^{IC}}}{\mathrm{Y}}$ in columns 1 & 4; $\frac{\mathrm{M^{IC}}}{\mathrm{Y+M}}$ in columns 2 & 5; and $\mathrm{IP}^{china}$ x $WTO$ in columns 3 & 6. Here we have dropped subscript for brevity and $M^{IC}$ denotes Chinese imports to India, $M$ denotes total imports to India and $Y$ denotes domestic production in any given industry. $WTO$ is an indicator variable equal to 1 for years 2002 and later. Our main results are robust to these alternative measures of Chinese import competition and we continue to find strong evidence for non monotonic relation between competition and innovation.

# 5 Conclusion

In this paper, we estimate the effect of Chinese import competition on prices, costs, markups and quality growth of firm-products in the case of a large developing country like India. We were able to overcome data limitations regarding availability of detailed product level data for firms in the domestic market which enabled us to study the effect of Chinese import competition on quality upgrading for both domestic and exporting firms.

Our result suggest that firms closer to the technology frontier are able to reduce costs and increased markups. These firms are also able to upgrade quality, plausibly by investing profits from increased markups in innovation related activities. Thus, import competition increases profits which lead to increase in quality, but only for firms which are initially closer to the technology frontier.

In future work, we intend to expand our exploration of how Chinese import competition affects firms' investment in innovation activities other than quality like investment in research and development or patents.

# References


Acemoglu, D., Autor, D., Dorn, D., Hanson, G. H., and Price, B. (2016). Import competition and the great us employment sag of the 2000s. *Journal of Labor Economics*, 34(S1):S141–S198.

Aghion, P., Bloom, N., Blundell, R., Griffith, R., and Howitt, P. (2005). Competition and innovation: An inverted-u relationship. *The Quarterly Journal of Economics*, 120(2):701–728.

Aghion, P., Blundell, R., Griffith, R., Howitt, P., and Prantl, S. (2009). The effects of entry on incumbent innovation and productivity. *The Review of Economics and Statistics*, 91(1):20–32.

Amiti, M. and Khandelwal, A. K. (2013). Import competition and quality upgrading. *Review of Economics and Statistics*, 95(2):476–490.

Amiti, M. and Konings, J. (2007). Trade liberalization, intermediateinputs and productivity. *American Economic Review*, 97(5):1611–1638.

Autor, D. H., Dorn, D., and Hanson, G. H. (2013). The china syndrome: Local labor market effects of import competition in the united states. *American Economic Review*, 103(6):2121–68.

Autor, D. H., Dorn, D., Hanson, G. H., and Song, J. (2014). Trade adjustment: Worker-level evidence. *The Quarterly Journal of Economics*, 129(4):1799–1860.

Bas, M. and Strauss-Kahn, V. (2015). Input-trade liberalization, export prices and quality upgrading. *Journal of International Economics*, 95(2):250–262.

Brandt, L., Van Biesebroeck, J., and Zhang, Y. (2012). Creative accounting or creative destruction? firm-level productivity growth in chinese manufacturing. *Journal of development economics*, 97(2):339–351.

Branstetter, L. and Lardy, N. (2006). China's embrace of globalization. Technical report, National Bureau of Economic Research.

Broda, C., Greenfield, J., and Weinstein, D. (2006). From groundnuts to globalization: A structural estimate of trade and growth. Technical report, National Bureau of Economic Research.

Chen, Y., Jin, G. Z., and Yue, Y. (2010). Peer migration in china. Technical report, National Bureau of Economic Research.

De Loecker, J., Goldberg, P. K., Khandelwal, A. K., and Pavcnik, N. (2016). Prices, markups, and trade reform. *Econometrica*, 84(2):445–510.

Fan, H., Li, Y. A., and Yeaple, S. R. (2015). Trade liberalization, quality, and export prices. *Review of Economics and Statistics*, 97(5):1033–1051.

Fernandes, A. (2007). Trade policy, trade volumes and plant-level productivity in colombian manufacturing industries. *Journal of International Economics*, 71(1):52–71.

Fernandes, A. M. and Paunov, C. (2009). Does tougher import competition foster product quality upgrading?

Forlani, E., Martin, R., Mion, G., and Muûls, M. (2016). Unraveling firms: Demand, productivity and markups heterogeneity.

Khandelwal, A. K., Schott, P. K., and Wei, S.-J. (2013). Trade liberalization and embedded institutional reform: evidence from chinese exporters. *American Economic Review*, 103(6):2169–95.

Levinsohn, J. and Petrin, A. (2003). Estimating production functions using inputs to control for unobservables. *The Review of Economic Studies*, 70(2):317–341.

Medina, P. (2017). Import competition, quality upgrading and exporting: Evidence from the peruvian apparel industry. *University of Toronto mimeo.*

Naughton, B. (2007). *The Chinese economy: Transitions and growth*. MIT press.

Olley, G. S. and Pakes, A. (1996). the dynamics of productivity in the telecommunications equipment industry.. *Econometrica*, 64(6):263–97.

Pavcnik, N. (2002). Trade liberalization, exit and productivity improvements:evidence from chilean plants. *Review of Economic Studies*, 69(1):245–276.

Stiebale, J. and Vencappa, D. (2018). Acquisitions, markups, efficiency, and product quality: Evidence from india. *Journal of International Economics*, 112:70–87.

Topalova, P. and Khandelwal, A. (2011). Trade liberalization and firm productivity: The case of india. *Review of economics and statistics*, 93(3):995–1009.

Wooldridge, J. M. (2009). On estimating firm-level production functions using proxy variables to control for unobservables. *Economics Letters*, 104(3):112–114.

# Tables

Table 1: Chinese Imports and Exports in Developing Countries

| | Chinese Imports (in billions 2007 US$) | Chinese Import share | Exports to China (in billions 2007 US$) | Chinese Export share |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Panel A: India | | | | |
| 1995 | 1.102 | 0.022 | 0.452 | 0.01 |
| 2001 | 2.14 | 0.036 | 1.081 | 0.021 |
| 2007 | 24.58 | 0.122 | 9.49 | 0.065 |
| Panel B: Mexico | | | | |
| 1995 | 0.708 | 0.007 | 0.05 | 0 |
| 2001 | 4.715 | 0.024 | 0.451 | 0.002 |
| 2007 | 29.74 | 0.106 | 1.895 | 0.007 |

The table reports Chinese imports, import share, exports and export share for India (panel A) and Mexico (panel B) for years 1995,2001 and 2007.

Table 2: Chinese Imports and Exports in Developing Countries

| | India | Mexico | Indonesia | Malaysia | Brazil |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Panel A: Chinese Imports (in billions 2007 US$) | | | | | |
| 1995 | 1.102 | 0.708 | 2.034 | 2.334 | 0.569 |
| 2001 | 2.14 | 4.715 | 2.158 | 4.455 | 1.556 |
| 2007 | 24.58 | 29.74 | 8.558 | 18.842 | 12.621 |
| Panel B: Chinese Import Share | | | | | |
| 1995 | 0.022 | 0.007 | 0.037 | 0.022 | 0.008 |
| 2001 | 0.036 | 0.024 | 0.06 | 0.052 | 0.024 |
| 2007 | 0.112 | 0.106 | 0.115 | 0.129 | 0.105 |
| Panel C: Exports to China (in billions 2007 US$) | | | | | |
| 1995 | 0.452 | 0.05 | 2.37 | 2.662 | 1.638 |
| 2001 | 1.081 | 0.451 | 2.578 | 4.474 | 2.227 |
| 2007 | 9.49 | 1.895 | 9.675 | 15.444 | 10.749 |
| Panel D: Chinese Export Share | | | | | |
| 1995 | 0.01 | 0 | 0.038 | 0.027 | 0.026 |
| 2001 | 0.021 | 0.002 | 0.039 | 0.043 | 0.033 |
| 2007 | 0.065 | 0.007 | 0.085 | 0.088 | 0.067 |

The table reports Chinese imports, import share, exports and export share for India, Mexico, Indonesia, Malaysia and Brazil for years 1995,2001 and 2007 in panels A,B,C and D respectively.

Table 3: Markups, sector wise

| Sector | Markups Mean | Markups Median |
|---|---|---|
| Food and Beverages | 2.154625 | 1.144788 |
| Textile and Apparel | 2.052991 | 1.405984 |
| Paper and Paper Products | 2.443302 | 1.563417 |
| Chemical and Chemical Products | 3.955301 | 1.328957 |
| Rubber and Plastic Products | 2.162729 | 1.302694 |
| Non-metallic Products | 4.833217 | 2.298591 |
| Basic Metals | 2.230342 | 1.323997 |
| Fabricated metal products | 4.784414 | 1.451045 |
| Machinery and equipment | 2.714002 | 1.360666 |
| Electrical machinery | 3.495139 | 1.382335 |
| Motor vehicles and Transport Equipment | 1.754854 | 1.707909 |
| Furniture and Manufacturing n.e.c. | 2.065985 | 1.077042 |
| Average | 2.964918 | 1.362076 |

Table 4: Output Elasticities

| Sector | Observations | Labor | Material | Capital | Returns to scale |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Food and Beverages | 1129 | 0.14 | 0.81 | 0.03 | 0.98 |
| Textile and Apparel | 3114 | 0.13 | 0.80 | 0.10 | 1.03 |
| Paper and Paper Products | 1263 | 0.14 | 0.87 | 0.09 | 1.11 |
| Chemical and Chemical Products | 3023 | 0.28 | 0.73 | 0.02 | 1.03 |
| Rubber and Plastic Products | 1574 | 0.18 | 0.79 | 0.15 | 1.12 |
| Non-metallic Products | 694 | 0.18 | 0.66 | 0.14 | 0.98 |
| Basic Metals | 2180 | 0.14 | 0.84 | 0.11 | 1.09 |
| Fabricated metal products | 575 | 0.29 | 0.79 | 0.08 | 1.16 |
| Machinery and equipment | 1071 | 0.30 | 0.67 | 0.10 | 1.07 |
| Electrical machinery | 979 | 0.22 | 0.78 | 0.05 | 1.05 |
| Motor vehicles and Transport Equipment | 225 | -0.19 | 1.02 | 0.13 | 0.96 |
| Furniture and Manufacturing n.e.c. | 308 | 0.42 | 0.50 | -0.13 | 0.79 |

The table reports average output elasticities from estimation of the translog production function. Column 1 reports the number of observations for production function estimation. Columns 2-4 report average output elasticities for the factors of production while column 5 reports the average returns to scale.

Table 5: Summary Statistics

| variable | description | N | mean | sd |
|---|---|---|---|---|
| Panel A : industry level variables | | | | |
| $IP^{china}$ | Chinese import competition | 1083 | 0.04 | 0.15 |
| $INP^{china}$ | Chinese imported inputs | 1067 | 0.02 | 0.04 |
| $IS^{China,US}$ | Chinese import share(US) | 1083 | 0.12 | 0.15 |
| Panel B : firm level variables | | | | |
| l | Labor costs (log) | 45827 | 3.17 | 1.82 |
| k | Gross fixed assets (log) | 45827 | 5.66 | 1.72 |
| m | Material costs (log) | 45791 | -1.72 | 1.99 |
| Sales | sales (log) | 45827 | 6.2 | 1.8 |
| Exports | exports (log) | 25380 | 4.12 | 2.42 |
| Panel C : firm − product level variables | | | | |
| q | quantity (log) | 99705 | 9.31 | 4.22 |
| $\mu$ | markups (log) | 98114 | 0.04 | 1.97 |
| p | unit value (log) | 99229 | -11.69 | 3.7 |
| cost | marginal cost (log) | 98114 | -11.73 | 4.08 |

The table reports summary statistics for key variables.

Table 6: Within Firm Effects

| | Performance | | Production | | |
|---|---|---|---|---|---|
| Dependent Variable : | $\Delta$Sales | $\Delta$Exports | $\Delta$Wages | $\Delta$Capital | $\Delta$Materials |
| | (1) | (2) | (3) | (4) | (5) |
| $\text{IP}^{China}_{ij,t-3}$ (A) | 0.338 | 0.158 | -0.489*** | -0.258*** | 0.150 |
| | (0.425) | (0.378) | (0.137) | (0.0976) | (0.414) |
| $\text{IS}^{China,US}_{ij,t-3}$ (B) | 0.102 | -0.965* | -0.138 | 0.0402 | 0.810 |
| | (0.614) | (0.543) | (0.255) | (0.260) | (0.597) |
| Instrumented Variables | A | A | A | A | A |
| Firm FE | Yes | Yes | Yes | Yes | Yes |
| Industry(NIC3 – digit) – Year FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 27,446 | 27,457 | 27,457 | 27,457 | 27,432 |

Table reports results from regressing three period growth in firm level outcomes on firm level measure of Chinese import competition, $\text{IP}^{china}_{ij,t-3}$ and import share of China in the US market, $\text{IS}^{China,US}_{ij,t-3}$. Chinese import competition measure is instrumented using import values to other developing countries, namely Malaysia, Brazil, Indonesia and Mexico as an instrument for Chinese import values to India. Robust standard errors are in parentheses and are clustered at the industry (NIC 4 digit) level. The regressions include output and input tariffs as explanatory variables. Significance * 10%, ** 5%, *** 1%

Table 7: Within Firm-Product Effects: Growth in Prices, Marginal Costs and Markups

| Dependent Variable : | $\Delta$Price | | | $\Delta$cost | | | $\Delta$markups | | |
|---|---|---|---|---|---|---|---|---|---|
| (10) | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| $IP^{china}_{j,t-3}$ (A) | -0.429*** | -0.425*** | -0.992*** | -3.245*** | -3.365*** | -2.095*** | 2.825*** | 2.951*** | 1.096** |
| | (0.0698) | (0.0890) | (0.352) | (0.341) | (0.285) | (0.547) | (0.326) | (0.278) | (0.457) |
| $INP^{china}_{j,t-3}$ (B) | | 0.604 | -0.869 | | -18.44 | -19.78* | | 19.19 | 19.13 |
| | | (7.491) | (7.331) | | (11.41) | (10.91) | | (11.91) | (11.99) |
| $IP^{china}_{j,t-3}$ x $PF_{ip,t-3}$ (D) | | | 0.763 | | | -2.109*** | | | 2.903*** |
| | | | (0.535) | | | (0.700) | | | (0.634) |
| $PF_{ip,t-3}$ | | | -0.895*** | | | -0.374*** | | | -0.513*** |
| | | | (0.0893) | | | (0.137) | | | (0.0843) |
| $IS^{China,US}_{j,t-3}$ (F) | -0.806* | -0.805* | -0.997* | 0.481 | 0.473 | 0.568 | -1.307** | -1.299** | -1.568** |
| | (0.487) | (0.484) | (0.549) | (0.397) | (0.372) | (0.444) | (0.634) | (0.571) | (0.623) |
| $IS^{China,US}_{j,t-3}$ x $PF_{ip,t-3}$ (E) | | | 0.444 | | | -0.190 | | | 0.599 |
| | | | (0.355) | | | (0.558) | | | (0.411) |
| Instrumented Variables | A | AB | ABC | A | AB | ABC | A | AB | ABC |
| Firm – product FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry(NIC3 – digit) – Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 49,664 | 44,504 | 44,504 | 49,480 | 44,341 | 44,341 | 49,480 | 44,341 | 44,341 |

Dependent variable is three period growth in prices(columns 1-3), growth in marginal costs (columns 4-6) and growth in markups (columns 7-9). We use $IV^{china}_{jt}$ computed in (2) as instrument for Chinese import penetration ratio for industry $j$ in India, $IP^{china}_{jt}$. The import penetration ratio for inputs to the industry,$INP^{china}_{j,t-3}$, is instrumented by $IV_{INP^{china}_{jt}}$ calculated in (4). Quality is estimated following the methodology of Khandelwal et al. (2013) using the elasticity values from Broda et al. (2006) in columns 3,6 & 9. The quality measure is then used to estimate proximity to frontier variable,$PF_{ip,t-3}$, in columns 3,6 and 9. $IS^{China,US}_{j,t-3}$ denotes the import share of China in the US market in industry$j$. Robust standard errors are in parentheses and are clustered at the industry level. The regressions include output and input tariffs as explanatory variables. Significance * 10%, ** 5%, *** 1%

## Table 8: Within Firm-Product Effects: Quality Growth

| Dependent Variable : | ΔQuality | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Quality : | Khandelwal et al. (2013) | | | | | | Forlani et al. (2016) | | | Unit Values |
| | $\sigma_j$ | | | $\sigma = 5$ | | | | | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| $IP^{china}_{j,t-3}$ (A) | 0.158 | 0.119 | -1.001*** | -0.269*** | -0.264** | -1.063*** | -34.73*** | -33.68*** | -51.72*** | -1.093*** |
| | (0.103) | (0.142) | (0.371) | (0.0819) | (0.106) | (0.298) | (4.681) | (5.604) | (7.133) | (0.360) |
| $INP^{china}_{j,t-3}$ (B) | | -5.944 | -7.712 | | 0.792 | -1.081 | | 160.4 | 56.00 | -2.363 |
| | | (10.51) | (10.57) | | (8.799) | (8.871) | | (224.1) | (218.5) | (8.603) |
| $IP^{china}_{j,t-3}$ x $PF_{ip,t-3}$ (D) | | | 1.604*** | | | 0.998** | | | 13.39* | 0.922* |
| | | | (0.543) | | | (0.423) | | | (7.714) | (0.528) |
| $PF_{ip,t-3}$ | | | -1.177*** | | | -1.181*** | | | -7.412*** | -0.854*** |
| | | | (0.0853) | | | (0.0869) | | | (0.970) | (0.0819) |
| $IS^{China,US}_{j,t-3}$ x $PF_{ip,t-3}$ (E) | | | 0.643* | | | 0.796** | | | 16.47*** | 0.266 |
| | | | (0.330) | | | (0.382) | | | (6.312) | (0.368) |
| $IS^{China,US}_{j,t-3}$ (F) | -0.888 | -0.891 | -1.169 | | | -1.375** | | | -3.761 | -1.059* |
| | (0.648) | (0.664) | (0.720) | | | (0.682) | | | (4.847) | (0.596) |
| Instrumented Variables | A | AB | ABC | A | AB | ABC | A | AB | ABC | ABC |
| Firm – product FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry(NIC3 – digit) – Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 49,664 | 44,504 | 44,504 | 49,664 | 44,504 | 44,504 | 49,480 | 44,341 | 44,137 | 44,514 |

Table reports results from estimating equation (27) with growth in quality as the dependent variable using instrumental variable estimation. We use $IV^{china}_{jt}$ computed in (2) as instrument for Chinese import penetration ratio for industry $j$ in India, $IP^{china}_{jt}$. The import penetration ratio for inputs to the industry,$INP^{china}_{j,t-3}$, is instrumented by $IV_{INP^{china}_{jt}}$ calculated in (4). Quality is estimated following the methodology of Khandelwal et al. (2013) in columns 1-6 and using the methodology of Forlani et al. (2016) in columns 7-9. In column 10, we take unit values as proxy for quality. Columns 1 to 3 use the elasticity values from Broda et al. (2006). $\sigma$ is set equal to 5 in columns 4-6 for all industries. These quality measures are then used to estimate proximity to frontier variable,$PF_{ip,t-3}$, in columns 3,6 and 9. In column 10, proximity to frontier variable is estimated using unit values as measure of quality. $IS^{China,US}_{j,t-3}$ denotes the import share of China in the US market in industry$j$. Robust standard errors are in parentheses and are clustered at the industry level. The regressions include output and input tariffs as explanatory variables. Significance * 10%, ** 5%, *** 1%

Table 9: Within Firm-Product Effects: Product Switching

| Dependent Variable : | ΔQuality | | | | | |
|---|---|---|---|---|---|---|
| Quality : | Khandelwal et al. (2013) | | | Forlani et al. (2016) | | |
| | V:Switch | V:Add | V:Drop | V:Switch | V:Add | V:Drop |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $IP^{china}_{j,t-3}$ (A) | -0.705 | -0.415 | -0.166 | -50.68*** | -52.29*** | -47.13*** |
| | (0.432) | (0.339) | (0.411) | (7.644) | (7.561) | (7.827) |
| $INP^{china}_{j,t-3}$ (B) | -8.041 | -4.662 | -4.834 | 43.71 | 61.46 | 62.98 |
| | (10.77) | (11.03) | (11.09) | (220.8) | (249.6) | (249.0) |
| $IP^{china}_{j,t-3}$ x $PF_{ip,t-3}$ (C) | 1.318** | 1.297** | 0.983* | 16.60* | 22.09** | 18.70* |
| | (0.583) | (0.492) | (0.551) | (8.509) | (10.15) | (10.10) |
| $IP^{china}_{j,t-3}$ x $PF_{ip,t-3}$ x $V_{ij,t-3}$ (D) | 1.572 | -0.831 | 1.783 | -23.38 | -65.07 | -43.96 |
| | (1.109) | (2.043) | (1.219) | (27.28) | (41.87) | (38.25) |
| $IP^{china}_{j,t-3}$ x $V_{ij,t-3}$ (E) | -1.723** | 0.466 | -1.664 | -8.119 | 6.998 | -11.90 |
| | (0.820) | (1.766) | (1.088) | (14.22) | (11.03) | (15.69) |
| $PF_{ip,t-3}$ x $V_{ij,t-3}$ (F) | -0.188*** | -0.0214 | -0.160*** | 0.895 | 1.257 | 1.175 |
| | (0.0407) | (0.0705) | (0.0587) | (1.338) | (1.414) | (1.377) |
| $PF_{ip,t-3}$ (G) | -1.130*** | -1.164*** | -1.134*** | -7.633*** | -7.413*** | -7.413*** |
| | (0.0890) | (0.0898) | (0.0889) | (1.140) | (1.127) | (1.158) |
| $V_{ij,t-3}$ (H) | 0.132*** | 0.0136 | 0.153*** | -0.344 | -0.450 | 0.0181 |
| | (0.0294) | (0.0469) | (0.0489) | (1.149) | (0.601) | (0.904) |
| $IS^{China,US}_{j,t-3}$ x $PF_{ip,t-3}$ (I) | 0.632* | 0.664* | 0.633* | 16.92** | 17.69** | 17.55** |
| | (0.337) | (0.350) | (0.351) | (6.512) | (6.833) | (6.889) |
| $IS^{China,US}_{j,t-3}$ (J) | -1.146 | -1.410* | -1.363* | -3.739 | -4.020 | -3.751 |
| | (0.728) | (0.714) | (0.724) | (4.923) | (5.019) | (5.059) |
| Instrumented Variables | ABCDE | ABCDE | ABCDE | ABCDE | ABCDE | ABCDE |
| Firm − product FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry(NIC3 − digit) − Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 44,503 | 37,041 | 37,041 | 44,136 | 36,745 | 36,745 |

Table reports results for firm level heterogeneity (based on product switching) in the relationship between quality growth and Chinese import competition, proximity to frontier and the their interaction. The firm level variables for product switching are denoted by $V_{ij,t-3}$ where $V$ is an indicator variable equal to 1 if : firm either adds or drops a product (columns (1) & (4)), drops a product (columns (2) & (5)), and adds a product (columns (3) & (6)) . Quality is estimated following the methodology of Khandelwal et al. (2013) in columns 1-3 and using the methodology of Forlani et al. (2016) in columns 4-6. Columns 1 to 3 use the elasticity values from Broda et al. (2006).These quality measures are then used to estimate proximity to frontier variable,$PF_{ip,t-3}$ We use $IV^{china}_{jt}$ computed in (2) as instrument for Chinese import penetration ratio for industry $j$ in India, $IP^{china}_{jt}$. The import penetration ratio for inputs to the industry,$INP^{china}_{j,t-3}$, is instrumented by $IV_{INP}{}^{china}_{jt}$ calculated in (4).$IS^{China,US}_{j,t-3}$ denotes the import share of China in the US market in industry$j$. Robust standard errors are in parentheses and are clustered at the product-industry level (NIC 4 digit). The regressions include output and input tariffs as explanatory variables. Significance * 10%, ** 5%, *** 1%

Table 10: Alternative Measures of Chinese Import Competition

| Dependent Variable : | ΔQuality | | | | | |
|---|---|---|---|---|---|---|
| Quality : | Khandelwal et al. (2013) | | | Forlani et al. (2016) | | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $IP^{china}_{j,t-3}$ (A) | -2.260** | -3.116*** | -1.138** | -89.58** | -122.8** | -50.21*** |
| | (0.988) | (1.198) | (0.443) | (41.09) | (54.50) | (5.837) |
| $IP^{china}_{j,t-3}$ x $PF_{ip,t-3}$ (B) | 3.152** | 4.381*** | 2.116*** | 33.35** | 48.54** | 21.75*** |
| | (1.282) | (1.423) | (0.660) | (16.63) | (20.20) | (7.915) |
| $PF_{ip,t-3}$ (C) | -1.177*** | -1.184*** | -1.144*** | -6.282*** | -6.394*** | -5.891*** |
| | (0.0786) | (0.0785) | (0.0697) | (0.845) | (0.856) | (0.750) |
| $IS^{China,US}_{j,t-3}$ (D) | -0.828 | -0.835 | -0.858 | 0.863 | 0.950 | 1.656 |
| | (0.651) | (0.656) | (0.657) | (5.621) | (5.636) | (5.052) |
| Instrumented Variables | AB | AB | AB | AB | AB | AB |
| Firm – product FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry(NIC3 – digit) – Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 49,664 | 49,233 | 49,664 | 49,233 | 49,664 | 49,233 |

Table reports results from estimating equation (27) with growth in quality as the dependent variable using instrumental variable estimation. The measure for Chinese import competition is given by: $\frac{M^{IC}}{Y}$ in columns 1 & 4; $\frac{M^{IC}}{Y+M}$ in columns 2 & 5; and $IP^{china}$ x $WTO$ in columns 3 & 6 where $WTO$ is an indicator variable equal to 1 for years 2002 and later . Quality is estimated following the methodology of Khandelwal et al. (2013) in columns 1-3 and using the methodology of Forlani et al. (2016) in columns 4-6. Columns 1 to 3 use the elasticity values from Broda et al. (2006). These quality measures are then used to estimate proximity to frontier variable,PF. $IS^{China,US}$ denotes the import share of China in the US market for an industry. Robust standard errors are in parentheses and are clustered at the industry level. The regressions include output and input tariffs as explanatory variables. Significance * 10%, ** 5%, *** 1%

# Figures

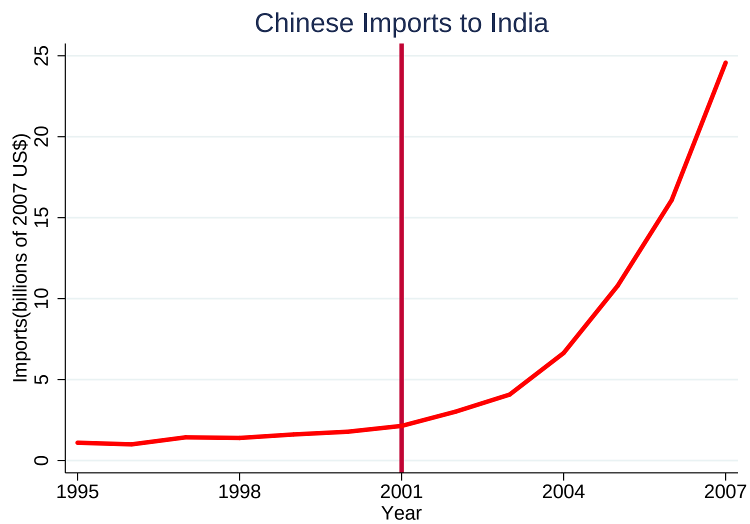


Figure 1: Chinese imports to India from 1995-2007

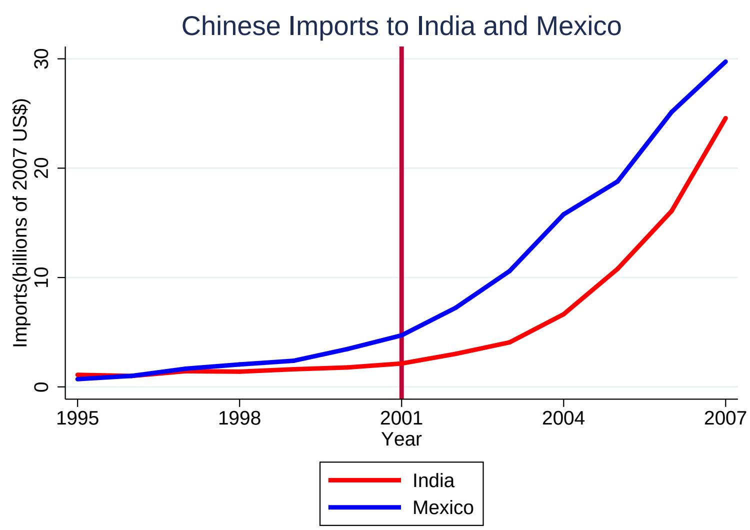


Figure 2: Chinese imports to India from 1995-2007

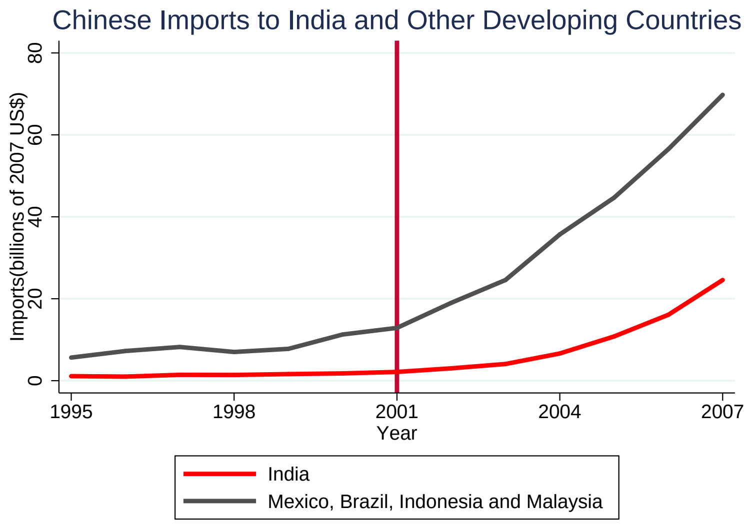


Figure 3: Chinese imports to India and other developing countries, namely Brazil, Malaysia, Indonesia and Mexico, from 1995-2007

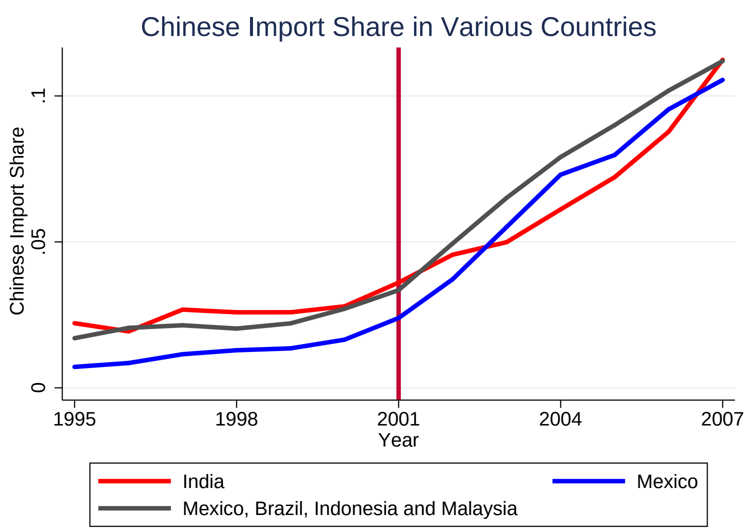


Figure 4: Chinese import share in India and other developing countries, namely Brazil, Malaysia, Indonesia and Mexico, from 1995-2007

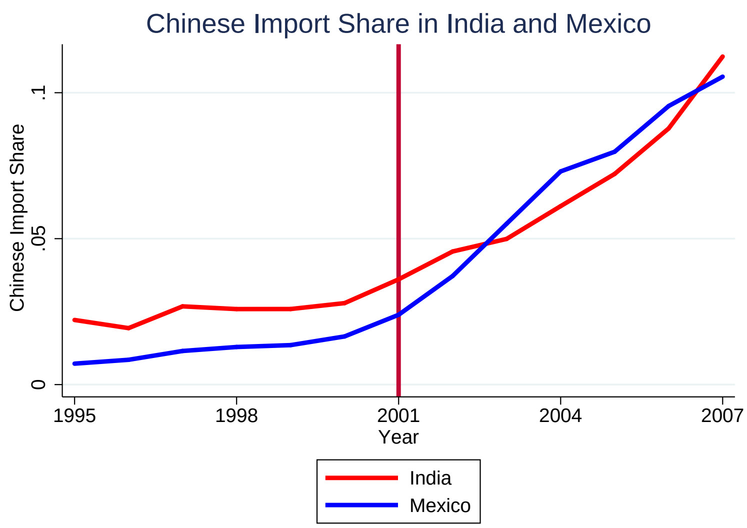


Figure 5: Chinese import share in India and Mexico, from 1995-2007

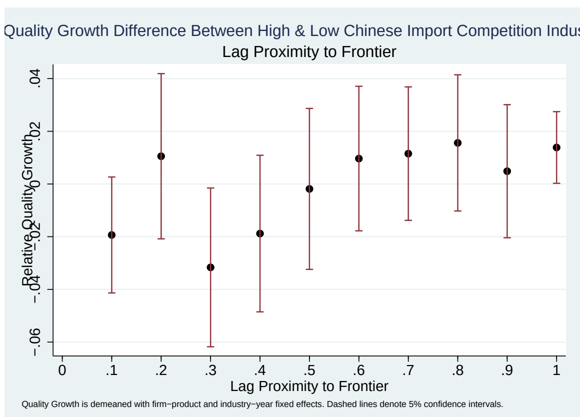


Figure 6: Difference in Quality growth between high and low Chinese Import competition industries

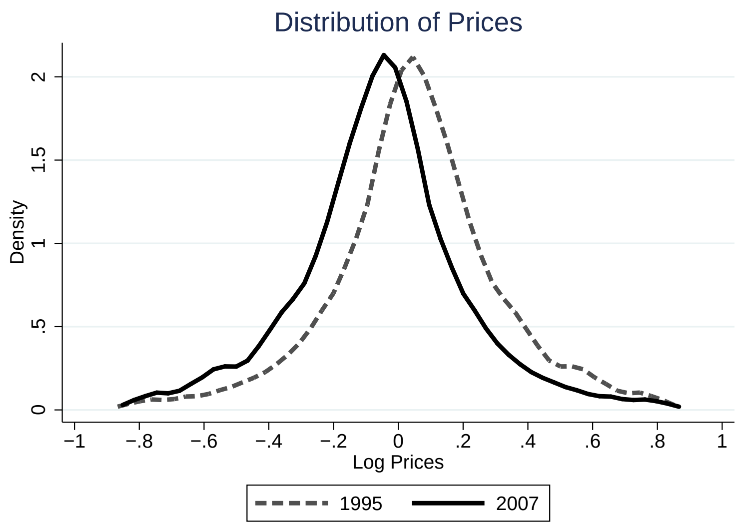


Figure 7: Sample only includes firm-product pairs present in 1995 and 2007. Values are demeaned using firm-product fixed effects.

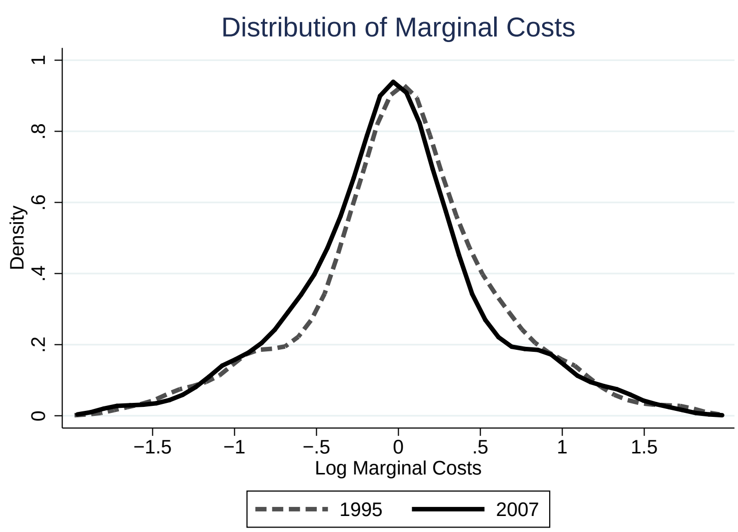


Figure 8: Sample only includes firm-product pairs present in 1995 and 2007.

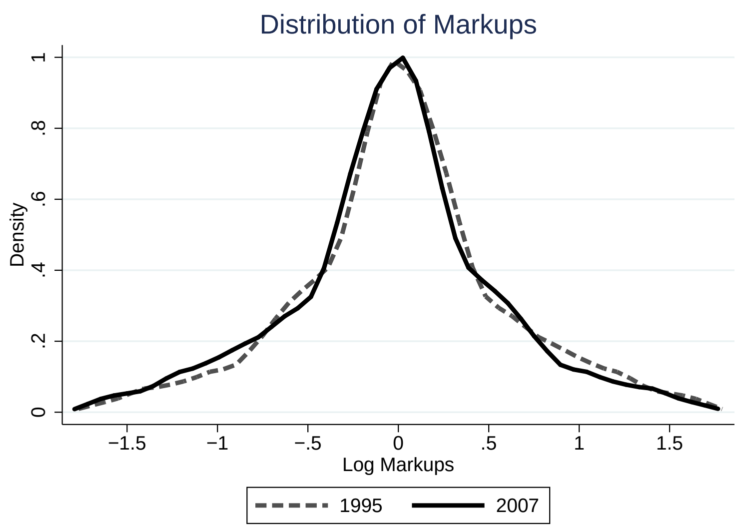


Figure 9: Sample only includes firm-product pairs present in 1995 and 2007.

# 6 Appendix

Table A1: Pro-competitive effects

| | $\text{markups}_{ipt}$ |
|---|---|
| | (1) |
| $\text{IP}_{jt}^{china}$ | -0.158*** |
| | (0.0593) |
| $\text{marginalcost}_{ipt}$ | -0.867*** |
| | (0.0482) |
| $\text{marginalcost}_{ipt}^2$ | -0.00707*** |
| | (0.00115) |
| Observations | 91,942 |
| Within $\text{R} - \text{squared}$ | 0.639 |
| $\text{Firm} - \text{product FE}$ | Yes |
| $\text{Industry(NIC3} - \text{digit)} - \text{Year FE}$ | Yes |

Dependent variable is log of markups. We use $\text{IV}_{jt}^{china}$ computed in (2) as an instrument for Chinese import penetration ratio for industry $j$ in India, $\text{IP}_{jt}^{china}$. Robust standard errors are in parentheses and are clustered at the NIC 3-digit industry level. The regressions include output and input tariffs as explanatory variables. Significance * 10%, ** 5%, *** 1%