Import Penetration of Low Quality Products : Markups Implications

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Abstract

How are local firms affected by the entry of products that are of low quality and relatively cheaper? China's exports rose vigorously in the last three decades making it one of the most important trading partners in the world. Most studies argue that China exports low quality varieties of goods produced locally in advanced economies, so that these exports are for most accessible at lower prices. This paper provides theoretical and empirical investigation on the differential impact of the import penetration of low quality products on the market power of local firms with different level of quality. In our theoretical framework, the market hit by international competition is segmented in two groups of firms, those of Low quality and those of High quality. The model also features differential demand elasticity for firms of different size through CREMR preferences. Our theoretical implications suggest that the impact on markup resulting from the import penetration of low quality goods is stronger and negative on local firms producing low quality. This prediction is substantiated by the empirical test we conduct on US Compustat data through a diff-in diff estimation with China accession to WTO as break point. Additional empirical investigation suggests that as they face the competition led by products of low quality, local firms of low quality invest more in innovation to upgrade their level of quality, with convergence to a target. As of local firms of high quality, our results indicate that they invest more in advertising to further signal their relative superiority, with no specific pattern in the way they update their quality input. Overall, our findings suggest that the entry of China in WTO has intensified the competition vertically with firms investing either on advertising or in R&D for signalling or differentiation purposes.

Keywords: Import penetration,firm quality status, markup, vertical competition.

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1 Introduction

Since the 2000s, chinese exports have been increasing worldwide. Although the country remained in autarky for several decades, China's exports rose sharply in the last three decades making it one of the most important trading partners in the world. As all witnessed the emergence of China as one of the most competitive trading partner, a growing literature has addressed the potential impact of Chinese competition on third world countries, mostly in labor-intensive industries where evidence shows that China's exports are dominant. As such, there is still a lot to learn on the effects of chinese exports on worlds' markets and especially on advanced economies. To understand these potential effects, first step is reasonably to have a complete and broad view on the characteristics of China's exports. Existing evidence suggests they are mostly of a relatively lower quality Schott (2008) Fontagné et al. (2008) Xu et al. (2010).

Research Objective. This paper assesses the impact of the import penetration of low quality products on the market power of local firms, and specifically their markup. It provides theoretical predictions focusing on quality as the source of heterogeneity across firms, with empirical evidence drawn from the variation in China's exports into USA, following China accession to WTO.

Motivation. Does import competition from China affect markups of low-quality producing firms like it does for high-quality producing firms? Product quality is a key feature determining how countries specialize in production Schott (2004) , the direction of trade between countries Hallak (2006) , and even how countries grow Hummels and Klenow (2005). Thus, a detailed analysis of international competition especially of import penetration should ideally take into account the essential factors that create heterogeneity across firms: quality is one of these. Further, since international competition itself is significantly driven by quality, Hallak (2006) there is value in exploring whether the impact of import competition on a firm's markup will differ depending on how this firm is positioned in the local market relatively to the average quality. Answering this question will help understand the differential impact of import competition on the market power of local firms producing different varieties of products, and inform the design of policies that promote free trade

and consumers' wellbeing.

Because markup creates distorsion, this additional work investigating drivers of change in markup has a policy value. Likewise, trade reforms could rely on the results of the paper to implement adequate public policies similarly to temporary safeguard measures imposed by the Peruvian government that reduced imports from China for a few months. Furthermore, the environmental cost of products of low quality products may be big. This reinforces the relevance of the welfare analysis we are conducting.

Literature. This study is at the intersection of two strands of literature: the one on import competition and quality, and the other on import competition and markup. Studies have investigated how import competition affects firms' markup. For instance, Li and Miao (2020) show that import competition in input affects markup. Amiti and Heise (2021) finds that higher import competition caused a decline in the market shares of the top-20 U.S firms. Still, based on De Loecker et al. (2020) findings, the markup of US firms have overall kept rising even after the accession of China to the WTO. Hence, we aim to desegregate this overall impact by segmenting the market. We thus assess how different types of firms have had their markup affected. Our hypothesis is that firms from the low quality segment of the local market have lost in markup which we assume may result from the fact that, products from China are of low quality mostly, as related papers suggest. Also, going from the overly acknowledged fact that tougher competition implies lower market power, our study provides an additional check on a necessary condition: if local firms of low quality do not have their markup reduces, then the hypothesis that products from China are mostly of low quality may be ruled out. In addition, some studies showed that Trade forces out low-quality firms so that only high quality firm remain in the market. However, in presence of asymmetric information Macedoni (2021) , the inverse happens: low-quality firms remain in the market because they sell cheaper products. High-quality firms on the contrary exit because their products are more expensive and consumers fail to realize that they are of higher quality. Finally, Shapiro (1983) shows that in presence of asymmetric information, it is not clear whether high quality firms will lose in markup, due to reputation. Also, high quality items may be priced above marginal cost because

sellers look for profit flows to compensate for the investment in reputation. Thus, information asymmetries create the conditions for strategic interactions that make the final impact of import penetration not obvious.

This study also contributes to the empirical literature on the impact of China's accession to WTO. Studies on this topic have considered different aspects. Bernard (2006) investigates how import competition from China has affected relative wages in the Chilean manufactured industry. Others have studied the same impact on exports of other Asian countries Eichengreen et al. (2004) . Most studies argue that China exports the low quality varieties of the same products as advanced economies Schott (2008) Fontagné et al. (2008) Xu et al. (2010) . These evidence may suggest that Chinese exports pose only limited competition on advanced economies, or that products of low quality in advanced economy are those that are negatively affected by the import penetration of chinese exports. This is the hypothesis we make and what our paper aims to verify.

This paper provides theoretical and empirical evidence on the impact of the import penetration of low quality products on the market power of local firms. In our theoretical framework, we consider two types of firms; those of Low quality and those of High quality firms. As the objective is to measure how import penetration affects the markup of each group of firms, we use CREMR preference which allows to have, on one hand, a direct link between markups and sales, and on the other hand, demand elasticity varying with firm size. Our theoretical implications suggest that the impact on markup resulting from the import penetration of low quality goods is stronger and negative on local firms producing low quality. This prediction is substantiated by the empirical test we conduct on US Compustat data through a diff-in diff estimation with China accession to WTO as break point. Additional empirical investigation suggests that as they face the competition led by products of low quality, local firms of low quality invest more in innovation to upgrade their level of quality, with convergence to a target. As of local firms of high quality, our results indicate that they invest more in advertising to further signal their relative superiority, with no specific pattern in the way they update their quality input. Overall, our findings suggest that the entry of China in WTO has intensified the competition vertically with firms investing either on advertising or in

R&D for signalling or differentiation purposes.

Structure of Paper. The remaining of the paper is organized as follows. The section 2 unfolds the theoretical model and its implications. The section 3 after describes the data, measurement and empirical strategy. The section 5 lays out the main results and discusses mechanisms. We conduct robustness checks in section 6 and conclude in section 7.

2 Model

The local economy is populated with households and firms. Households consume a variety of products with variety captured by different quality; firms produce these varieties.

2.1 Demand

The domestic market, d, is an economy with two vertically differentiated goods, high-(h) and low quality (l). Following Mrázová et al. (2021) , consumers have CREMR preferences.[2] Given a demand for variety q, $x(q)$, a consumer derives the following inverse demand $p(x(q))$:

$$p(x(q)) = \frac{1}{x(q)}(x(q) - \gamma)^{\frac{\sigma-1}{\sigma}} \tag{1}$$

where γ is the benchmark consumption.

[2]In fact, in the model of Melitz (2003), markup is fixed, while in Melitz and Ottanavio(2008),although the linearity of the demand delivered a variable markup, it is not clear what is the relationship between the markup and the market share, as both are related to the market power of firm. Also, with CES preference, competition effect do not arise in the cross section, in response to a change in the market size, which is important in our study. Furthermore, the CREMR demand is a more general demand function which in particular coincides with the CES demand function when the benchmark γ is equal to 0. Hence, the CREMR demand delivers more comparative statics.

2.2 Supply

Firms differ in their marginal cost to produce, c_q. Firms choose their output $x(q)$ to maximize profit $\pi(q)$, which is equal to revenue minus variable cost - the inverse of productivity :[3]

$$\pi = max((p(x) - c)x \tag{2}$$

Maximizing profits as in (2) leads to the first-order condition, which states that marginal revenue equates marginal cost:

$$p(x) + xp^{'}(x) = c \tag{3}$$

The elasticity of demand with respect to price is not constant and varies with consumption x,

$$\epsilon(x) \equiv \frac{-p(x)}{xp^{'}(x)}.$$

Hence, $xp^{'}(x) = \frac{-p(x)}{\epsilon(x)}$, then the first order condition (equation 3) becomes

$$p(x)(1 - \frac{1}{\epsilon(x)}) = c$$

We get:

$$\frac{p(x)}{c} = \frac{\epsilon((x)}{\epsilon(x)-1} \quad \text{with} \quad \epsilon(x) = \frac{x-\gamma}{x-\gamma\sigma}\sigma$$

The markup $\mu(x)$ is the price above the marginal cost, thus

$$\mu(x) = \frac{p(x)}{c} = \frac{x^* - \gamma}{x^*}\frac{\sigma}{\sigma - 1} \tag{4}$$

with the solution of equation (2) giving x^*

$$x^* = \gamma + [c\frac{\sigma}{\sigma - 1}] \tag{5}$$

[3]We abstracted to adding q subscript for simplicity.

Proposition: The markup varies with sales and the direction depends on the sign of the benchmark consumption γ.

$$\frac{\partial \mu(x)}{\partial x} = \frac{\gamma}{x^2}\frac{\sigma}{\sigma - 1} \tag{6}$$

As showed in Marazova (2021), the relative convexity of CREMR demand function compared to CES demand function is conditioned by the sign of γ. When γ is positive, the CREMR demand function is "subconvex", which means less convex at each point than a CES demand function with the same elasticity. In the case of sub-convexity, the elasticity of demand falls with output, so that larger firms have higher markups. On the contrary, a negative γ implies super-convexity: the CREMR demand function is more convex than a CES demand with the same elasticity, and larger firms have smaller markups.

2.3 Aggregate Demand in autarky economy

With common prices, the firms that produce different varieties of a good in a given quality q achieve similar volume of sales. Let d_q be the total quantity demanded of a typical variety with quality q when all goods are priced according to (4). Then the sales for one firm that produces quality q is :

$$x_q = \frac{d(q)}{n_q} = \frac{1}{n_q}[\gamma + c\frac{\sigma}{\sigma - 1}]. \tag{7}$$

with n_q the number of firms serving quality q on the market. In our case, we assume that the number of firms serving the domestic market in each quality is of mass one ($n_q^d = 1$).

2.4 Model Implications

Now, we turn to the open economy version of the model to investigate the joint effects of the import penetration of products of low quality on the markup of local firms. Following Fajgelbaum et al. (2011) We assume that the economy is in equilibrium. Differentiated products are costly to trade. We denote τ_q the shipping cost of one unit of a variety with quality q. For a good with quality q, the marginal cost of a delivered export unit is $c_q + \tau_q$.

A foreign firm producing a variety with quality $q \in \{l, h\}$ maximizes profits by charging local

consumers a price equal to $[c_q + \tau_q]\frac{x-\gamma}{x}\frac{\sigma}{\sigma-1}$ whereas local firm charges a lower price $\frac{x-\gamma}{x}\frac{\sigma}{\sigma-1}$. Indeed, domestic brands share the market with both domestic and foreign rivals, but in as much as imports of a given quality bear a higher price because of shipping costs, the foreign varieties are less effective competitors. For local firms, domestic demand is the same as it would be in autarky with $\tilde{n}_k$ local competitors producing quality q. The number of foreign firms n_l^f - only low quality firms enter the market - who would enter in the absence of trade cost is discounted to "effective competitors" by an amount $\lambda \in (0, 1)$ that reflects the trading cost.

$$x(l) = \frac{1}{\tilde{n}_l} d(l) \qquad \tilde{n}_l = n_l^d + \lambda n_l^f \qquad \text{d domestic, f, foreign} \tag{8}$$

$$x(h) = \frac{1}{n_h} d(h) \tag{9}$$

λ represents the proportion of effective firms that can compete due to the trade cost. The more the trade cost increases, the lower λ is, and the smaller the number of effective firms is. When λ tends to 0, this induces the situation without trade. We use $\lambda(\tau) = e^{-\frac{\tau}{1-\tau}}$, which delivers the prediction, with τ the trading cost. In fact, when τ tends to 0, there is no trade restriction, and λ tends to 1. Thus, trade liberalization causes an increase in competitors and a decrease in the sales for local firms and therefore a change in the markup of local firms more exposed to the competition, as per the proposition enunciated above. This study focuses on the import competition led by products of low quality. So the market for products of high quality is not affected by the competition implied by the opening of the market.

$$\frac{\partial \mu(x(l))}{\partial \tau_l} = \underbrace{\frac{\partial \mu(x(l))}{\partial x(l)}}_{sign \quad of} \gamma \underbrace{\frac{\partial x(l)}{\partial \tau_l}}_{<0} \tag{10}$$

3 Data and Empirical Strategy

3.1 Data

We use the Fundamental Annual Compustat data from Wharton Research Data Services, similarly to recent research for firm-level markups estimation - De Loecker et al. (2020) De Loecker et al. (2020) and Traina (2018) . The unit of observation is a firm operating in the private sector, with information spanning from 1985 to 2015. China joined the WTO in December 2001, so we consider the period before 2001 as the pre-liberalization period and the period after as the post-liberalization phase.

Firms' industry is reported and categorized as manufacturing, wholesale trade, and retail trade. We rely on firm-level balance sheet information to measure markups from the production function approach. In particular, the data includes information on sales, variable input expenditures, capital, and industry classification.

We adjust for nominal variables and convert them into real ones with the NIPA GDP deflator and nonresidential fixed investment good deflator. Also, to identify domestic firms, we rely on standard industry format observations in USD with Foreign Incorporation Codes (FIC) in the USA. Utilities (SIC codes between 6000 - 6999) are exclude because their balance sheets are very different from other firms as well as (SIC codes between 4900 - 4999) since they are regulated on prices. Observations with negative or missing sales, assets,cost of goods sold, operating expenses are excluded.

3.2 Measuring Markup

Q_{fit} denotes the production of a good i, produced by a firm f at time t:

$$Q_{ft} = (L_{ft})^{\alpha_l}(M_{ft})^{\alpha_m}(K_{ft})^{\alpha_k}exp(\omega_{ft}) \tag{11}$$

Where L, M, K are inputs referring respectfully to Labor, materials, capital. Variable inputs are L and M.

3.2.1 Recovering product markups μ_{ft}

The Lagrangian for the cost minimizing program of a specific firm f for product i is:

$$L(L_{ft}, M_{ft}, K_{ft}, \lambda_{ft}) = P_{ft}^{L} L_{ft} + P_{ft}^{M} M_{ft} + r_{ft} K_{ft} + \lambda_{ft}(Q_{ft} - Q_{ft}(.)) \tag{12}$$

$$\frac{\partial L_{ft}}{\partial X_{ft}^{v}} = P_{ft}^{X} - \lambda_{ft} \partial Q_{ft} \partial X_{ft}^{v} = 0 (13)$$

$$\underbrace{\frac{\partial Q_{ft}}{\partial X_{ft}^{v}} \frac{X_{ft}^{v}}{Q_{ft}}}_{Elasticity} = \frac{1}{\lambda_{it}} \frac{P_{ft}^{X} X_{ft}^{v}}{Q_{ft}} \tag{14}$$

$$\theta_{ft}^{X} = \frac{P_{ft}}{\lambda_{ft}} \frac{P_{ft}^{X} X_{ft}^{v}}{P_{ft} Q_{ft}} = \mu_{ft} \frac{P_{ft}^{X} X_{ft}^{v}}{P_{ft} Q_{ft}} \tag{15}$$

1. Thus, recovering μ_{ft} from (5) requires :
   - ◇ Estimating the output elasticity of at least one variable input
   - ◇ Data on expenditures in input X as a proportion of total sales

3.2.2 Estimation of the production function

To recover the output elasticities, we need to estimate the log of the production function and get its derivative with respect the input L. Indeed the input that you will refer to compute our markup is the labor because of data that we have.

$$y_{fit} = lnQ_{ft} + \epsilon_{ft}$$

$$y_{ft} = f(l_{ft}, m_{ft}; \beta) + \omega_{ft} + \epsilon_{ft}$$

$$y_{ft} = \beta_l l_{ft} + \beta_k k_{ft} + \beta_m m_{ft} + \omega_{ft} + \epsilon_{ft} \tag{16}$$

However, the estimation of output elasticities suffers from Omitted Variable Bias. Indeed, Input demand responds to firm productivity w_{ft} and Production should increase with productivity w_{ft}

Therefore, not controlling for w_{ft} leads to upward bias in output elasticity, but productivity or technology shock w_{ft} is unobserved.

3.2.3 Unobserved productivity

We rely on LP(2003) where authors use material to proxy for productivity. Since the demand for material responds to firm productivity, inverting the demand for m_{ft}, delivers an estimate of firms' productivity w_{ft}.[4] All other variables that potentially affect optimal input demand are contained in the vector z_{ft} .

$$m_{ft} = m_t(k_{ft}, w_{ft}, \mathbf{z}_{ft}) \tag{17}$$

$$w_{ft} = h_t(m_{ft}, k_{ft}, \mathbf{z}_{ft})$$

These additional control variables are included because they can potentially affect differences in input demand choices of firms.

3.3 Capturing quality of firms

Following Macedoni and Weinberger (2019) , we use average wage as a measure of quality for our main results. We assume that high salaries attract quality employees, and boost effort, so that the quality of the input is strongly linked to the quality of the output. Firms quality status is measured during the period before the accession of China to WTO. A firm is classified as low quality if its average level of quality over the pre-liberalization period is below the average among local firms over the same period.

We use capital intensity as alternative measure of quality for robustness checks.

3.4 Summary statistics

3.4.1 Whole sample

The table below provides summary statistics on main firm level data that are used in the empirical section. These include markup, annual wage paid, annual spending in innovation and advertising.

[4]Melitz and Levinshon showed that monotonicity's condition of the demand function is sufficient for that result. This condition is verified as long as more productive firms do not set superfluous higher markups than the other firms.

Next, we present the evolution of the markup of US local firms. We have applied the same frame-

Table 1: Summary Statistics

	Obs	Mean	Std. dev.	Min	Max
Markup	216,197	1.4078	.089975	1.210722	1.645742
Quality	14,775	92158.84	1775778	0.6326782	1.15E+8
Innovation	5541	497671.9	1295624	1.02739	1.31E+07
Advertising	14783	1230598	3522713	6.776813	4.83E+07

work as De Loacker et al. (2020) and similarly to their finding, it appears that markup of firms have been overall rising after the accession of China to WTO, but a change in the pace does appear between the pre-liberalization and the post-liberalization period.

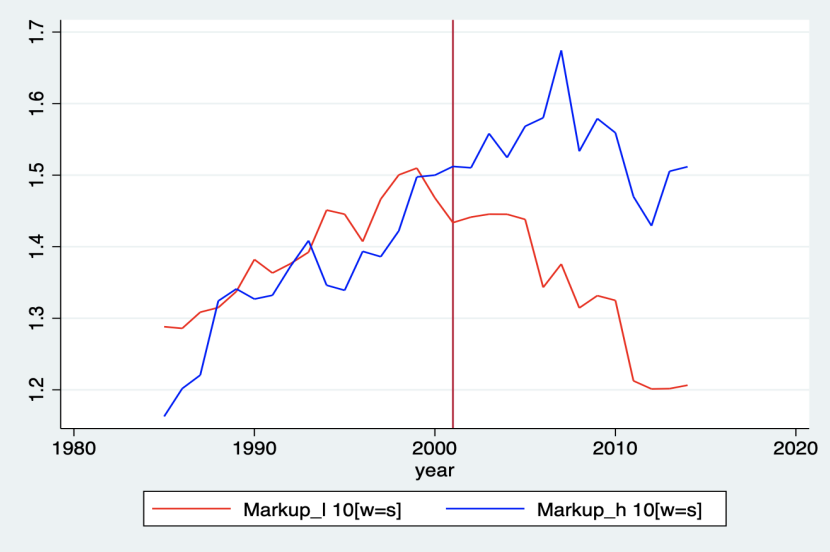
3.4.2 Comparison of Low and High Quality Firms: Parallel Trend Assumption

As discussed previously, we use average wage as a measure of quality. The graph below is a pre-test of the hypothesis that China accession to WTO had a differential impact on markups of firms depending on their quality status. It appears from the graph and the table that before the shock associated with China entry into WTO, the average markup of low quality firms (in red) and high quality firms (in blue) was overall similar. After the shock, there is a marked divergence between the markup of low quality firms and high quality firms.

Table 2: Markup of High and Low quality firms

	Aggregate Markup Low Quality	Aggregate Markup	Aggregate Markup High Quality
1998	1.500382	1.471873	1.422142
1999	1.509847	1.479631	1.497508
2000	1.468114	1.489586	1.499976
2001	1.433657	1.475544	1.512174
2002	1.44139	1.4687	1.510275
2003	1.445471	1.487729	1.55818
2004	1.445313	1.47485	1.524628

Figure 1: Markup of High and Low quality firms



4 Regression specification

We perform a diff-in diff estimation on our US firms over the period 1985 - 2015 to evaluate whether the accession of China to WTO, and the resulting rise in imports from China affected the markup of firms differently depending on their relative quality in the US economy. Below is the model specification:

$$ln(\mu_{ft}) = \beta_0 + \beta_1 T_f + \beta_2 Post_t + \gamma(Post_t T_f) + \mathbf{X}_{ft} + \epsilon_{ft} \tag{18}$$

Where:

1. μ_{ft} is the markup of the firm f at time t, as obtained through the methodology proposed by Deloacker et al. (2020).

2. T_f is the treatment indicator which relates to the quality status of the firm f: a dummy variable which is 1 if the firm f is of Low quality and 0 otherwise. The firm is classified as a Low

quality firm if the average quality over the period before the entry of China (- 2000) is below the average through the same period but computed over all firms operating in the US.

3. $Post_t$ trade shock separator, which is 1 for the period following the accession of China to WTO and 0 before.

4. $\mathbf{X}_{ft}$ refers to the control variables, which include industry fixed effects, to take into account variation across industries, Innovation and advertising, which are important correlates of product and firm quality, as quality could be upgraded through innovation and firms may invest in advertising to promote, or signal their type.

5 Results

5.1 Main Specification: Change in Markup for Low vs High quality Firms

The first 4 columns of Table 3 outline results without Industry Fixed effects and differ based on the set of other controls included, while the last 4 do the same at the difference that industry fixed effects are included. The estimated β_1 is negative, although not precisely estimated, which means that during the period before China's entry - before 2001 - low quality firms (treated group) had a relatively lower markup than high quality firms. This is in line with the well-known stylised fact that higher quality firms set higher markups.

We then note that following China's accession to WTO there was a rise in the markup of high quality US firms - β_2 positive. One potential reason for this rise is that the entry of China into the WTO implied tougher competition for local firms of low quality. High quality firms may have set higher markups to further differentiate and signal their type to consumers that value quality.

Finally, the diff-in-diff estimate γ is negative, indicating that the shock had a negative impact on the markup of low quality firms compared to high quality ones. Presumably, this is due to the fact that Chinese products are mostly of relatively low quality and therefore the competition is more intense on the low quality segment of US production force. The entry of products from China seems

to have forced local firms producing low quality to price down or upgrade their quality - which implies a rise in marginal cost - to remain on the market, revealing they were charging markups that were too high.

To assess our hypothesized explanation that High quality firms may have set higher markups after the entry of China to further differentiate and signal their type to consumers that value quality, we update the aforementioned estimates adding controls for innovation - captured by RD expenditures (column 2), advertising (column 3) and both (column 4). Results from columns 2, 3 and 4 provide insights that help understand how the markup of low vs high quality firms reacted to the rise in imports from China.

Controlling for Innovation only (column 2) shows not only that firms investing on RD charge a higher markup, but also that the relative impact of China entry into WTO on low vs high quality firms is affected by the extent to which firms invest in R&D. Indeed, both the estimate capturing the change in the markup of high quality firms after the entry and the diff in diff estimate remain significant and are even stronger, while the estimate measuring the relative markup of low quality firms has become negative although still imprecisely estimated. These features altogether suggest that lower markups for firms classified as of low quality before China entered WTO had to do with their relative level of expenditures in R&D partially, which would explain why the estimate associated to the treatment indicator was negative and then turned positive when Innovation was controlled for. In addition, the results also support that either low quality firms invested more in innovation after the entry of China or that the impact on the markup of the same amount spent on RD is larger when availed by a low quality firm compared to a high quality one. The second mechanism is a version of the law of diminishing marginal returns. In such cases, not controlling for Innovation led to underestimating how the difference in markup between low and high quality firms changed after the accession of China to WTO: γ and β_2 have larger magnitude.

Based on column 3 results - with advertising as the only control-, a few features show similarities in the way expenditures in advertising and RD affect markups of low vs high quality firms, with a lesser impact from "advertising". Not only the fact that low quality firms have lower markups

before the entry of China seems to have less to do with advertising - the estimated coefficient associated to treatment indicator returns to being negative - , but the change in the markup gap between firms of different quality is lower in column (3) vs (2) although higher in column (3) vs (1). Controlling for both innovation and advertising, reveals that Innovation and advertising are positively correlated but affect markups in opposite direction. And this makes sense since Innovation is an actual investment for quality enhancement, while advertising is an investment for quality signaling. So firms that invest in Innovation also advertises more. However, firms set higher markup when they actually upgrade their quality, and not just because they advertise more. These results overall suggest that advertising remains more a sunk cost than an investment.

The last 4 columns replicate the first four, with industries fixed effects. The results are very similar except that the estimated impact of Innovation on the markup is higher, and consistently, other estimates are lower when "Innovation" is controlled for. This indicates that industries that spend more in R&D also set higher markups on average.

Table 3: Markup response to Import Penetration: Low vs High Quality Firms

VARIABLES	Markup							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treated	-0.135	0.0595	-0.0945	0.0856	0.0192	0.0302	0.113	0.0310
	(0.0913)	(0.119)	(0.0932)	(0.119)	(0.115)	(0.146)	(0.116)	(0.146)
Post	0.283***	0.532***	0.306***	0.521***	0.399***	0.436***	0.414***	0.436***
	(0.0843)	(0.106)	(0.0850)	(0.106)	(0.0990)	(0.120)	(0.0989)	(0.120)
Treated#Post	-0.310**	-0.595***	-0.365***	-0.525***	-0.385***	-0.410**	-0.488***	-0.409**
	(0.129)	(0.176)	(0.131)	(0.177)	(0.145)	(0.194)	(0.146)	(0.194)
log(Innovation)		0.0256*		0.125***		0.0496***		0.0564
		(0.0137)		(0.0318)		(0.0188)		(0.0477)
log(Advertising)			0.0246**	-0.123***			0.0972***	-0.00892
			(0.0117)	(0.0353)			(0.0171)	(0.0572)
Constant	1.595***	1.301***	1.296***	1.797***	1.320	0.119	-0.0302	0.181
	(0.0690)	(0.173)	(0.158)	(0.224)	(0.837)	(2.050)	(0.869)	(2.089)
Industry FE	NO	NO	NO	NO	YES	YES	YES	YES
Observations	14,781	5,541	14,781	5,541	14,781	5,541	14,781	5,541
R-squared	0.003	0.007	0.003	0.009	0.117	0.174	0.119	0.174

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.2 Investigating mechanisms behind the differential change in markups: do firms adjust their quality in response to import penetration ?

Our estimations suggest that after China's accession to WTO, the markup gap between low and high quality firms deepened, with low quality firms incurring lower markups. However, markups may drop as a result of price cut or quality upgrading - which goes along with a rise in marginal cost. Below, we assess how the time-dependent quality of firms responded to the entry of China for the two sets of firms: low and high quality firms.

5.2.1 Quality response to import penetration : Low vs High Quality Firm

We estimate the specification below, where q_{ft} is the time t quality measure of firm f:

$$ln(q_{ft}) = \beta_0 + \beta_1 T_f + \beta_2 Post_t + \gamma(Post_t T_f) + \epsilon_{ft} \tag{19}$$

The results in the table 4 suggest there is adjustment in quality following China's entry into WTO:

Table 4: Quality response to import penetration

	(1)	(2)
VARIABLES	log(quality)	log(quality)
Post	-0.269***	-0.202***
	(0.0199)	(0.0194)
Treated	-1.105***	-0.878***
	(0.0215)	(0.0215)
Post#Treated	0.289***	0.256***
	(0.0304)	(0.0292)
Constant	11.16***	11.04***
	(0.0163)	(0.0160)
Industry FE	NO	YES
Observations	14,775	14,775
R-squared	0.220	0.304

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

the diff-in-diff estimate is positive which means after the entry of China, quality of "low quality

firms" rose relatively more than quality of "high quality firms".

So these results along with the impact on markup indicate that lower quality firms conceded to have a lower markup by upgrading the quality of their production - raising their marginal cost - to maybe differentiate from imported products of lower quality. By doing so, these firms may reach other segment of consumers - who value quality more - and survive. Interesting to note also is that the rise in markup of high quality firms is likely to have resulted from a quality downgrade post China entry. This strategic behaviour is not surprising. Indeed, as a larger amount of low quality products become available on US local market, high quality firms have bigger room to downgrade and remain of a relatively superior quality.

5.2.2 Is there convergence in quality after entry of China?

Having seen that there was adjustment in quality following the entry of China, this section investigates whether quality kept evolving or eventually converged during the period following the entry of China, with q_fjt represent the time t quality measure of firm for a firm classified as of quality j status, j=L,H.

$$\Delta q_{fjt} = \rho q_{fjt-1} + \epsilon_{ft} \tag{20}$$

The result shows that there is convergence in the quality of firms with low quality firms status before the entry of China and divergence for high quality firms.

This result is intuitive and was somehow expected based on the results previously discussed. Indeed, following the entry of China, low quality concede to set lower markup, by upgrading their quality and not reflecting this fully in price adjustment. These adjustments in the quality of firms that were more exposed by the competition led by chinese imported goods are likely to have played as cushion during a transition period for these firms to adjust to shock created by the entry of China. So at some point these adjustments would probably stabilize. For higher quality firms on the contrary, the rationale behind the change in quality is different and likely to be a way for high quality firms to take advantage of the increased availability of products of lower quality. So they may keep updating their quality for a longer period of time as long they can keep attracting consumers with

There is convergence when ρ is negative.

VARIABLES	(1) Δq_{flt}	(2) Δq_{flt}	(3) Δq_{fht}	(4) Δq_{fht}
q_{flt-1}	-0.250***	-0.253***		
	(0.0201)	(0.0202)		
q_{fht-1}			0.300***	0.299***
			(0.0127)	(0.0127)
Constant	1,333***	1,333***	16,329	16,368
	(447.1)	(448.3)	(14,675)	(14,693)
Industry FE	NO	YES	NO	YES
Observations	2,002	2,002	5,642	5,642
R-squared	0.072	0.077	0.090	0.092

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

a higher preference for quality.

5.3 Firm's reaction to decreasing markup : Innovation and Advertising

How do firms' react to import penetration and the resulting impact on their markups, in the way they make their investment choices? We now investigate the relationship between firm-level markup in one period and firms' spending in the following period. We aim to capture the differential impact for firms of different quality status after vs before the entry of China. We thus estimate the specification below:

$$ln(Y_{ft}) = \beta_0 + \beta_1 ln(\mu_{ft-1}) + \beta_2 T_f + \beta_3 Post_t + \gamma ln(\mu_{ft-1}) T_f Post_t + \beta_4 ln(\mu_{ft-1}) T_f + \beta_5 ln(\mu_{ft-1}) Post_t + \beta_6 Post_t T_f + \epsilon_{ft} \quad (21)$$

where Y_{ft} is the measure of spending in innovation or marketing. The equation controls for industry fixed effects. The inclusion of these fixed effects allows to isolate the differences across industry.

The results show that following a decrease in markup, (coefficient on variable "markup" is positive), firms tend to lower their investment both in innovation and in marketing. Over the whole

VARIABLES	(1) $\log(\text{Inovation}_t)$	(2) $\log(\text{Advertising}_t)$
Post	-0.938***	-0.433***
	(0.117)	(0.0634)
Treated	-1.610***	-1.113***
	(0.138)	(0.0709)
Post#Treated	2.091***	1.624***
	(0.211)	(0.0991)
$\log(\text{Markup}_{t-1})$	1.038***	0.790***
	(0.147)	(0.0852)
Post#$\log(\text{markup}_{t-1})$	-0.0285	-0.301***
	(0.176)	(0.0955)
Treated#$\log(\text{Markup}_{t-1})$	-0.540**	-0.395***
	(0.240)	(0.116)
Post#Treated#$\log(\text{Markup}_{t-1})$	-0.219	0.734***
	(0.378)	(0.179)
Constant	10.72***	11.56***
	(0.0874)	(0.0530)
Industry FE	YES	YES
Observations	5,541	14,782
R-squared	0.164	0.205

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

period, this aligns with a more horizontal competition. Indeed, when the competition tightens and forces to reduce prices, firms may not completely reduce their markup but also reduce their costs. After China's entry, the competition becomes more vertical with firms acting to differentiate or signal. Indeed, cuts in markups that follow an import penetration shock (coefficient on markuppost variable) are associated with higher investment in Innovation and advertising in the subsequent year, with stronger evidence on the relationship with advertising. So firms confronted to low quality-led import competition and losses in markup tend to differentiate or signal, they tend to advertise more to signal the relative "superiority" of their products and keep or attract consumers that value quality. They also seem to invest more in RD to differentiate, but our estimates are not precise enough to conclude suggesting there is high dispersion in the decision to invest in innovation. More precisely, by taking into account quality status of firm, a markup drop following import penetration is associated with a relatively higher investment in Innovation, and a relatively

lower investment in advertisement, for low quality compared to high quality firms. This difference in the reaction of low vs high quality firms could be explained by the fact that firms that are already of higher quality have lower incentives to invest in innovation and upgrade further their current quality but higher incentives to invest in marketing and signal the quality content of their products. Local firms of lower quality on the contrary because they are more exposed to the import competition, would prioritize investment in Innovation to further differentiate and attract consumers that value quality so that they escape the competition driven by the entry of products of lower quality. These results are consistent with the results we previously discussed and further underscore that advertising may serve as a tool for firms to signal their type, and is more a "sunk cost" while Innovation is more an investment made by firms to enhance the quality of their production.

6 Robustness Checks

6.1 Alternative measure of quality

As discussed above, our primary measure of quality is average wage, as reasonably, higher wage attracts workers of higher quality, and quality of input is positively correlated with quality of output. We aim to verify that the findings are not an artefact of the measure of quality we used. We thus estimate our main specification using an alternative measure of quality, namely capital intensity, which corresponds to the capital stock divided by number of employees. A bunch of papers have also used this index as an indicator of a firm quality - Macedoni and Weinberger (2019) . Our results - Appendix A1 - do not change significantly; the results do show that there is a stronger link between capital intensity and spending in R&D. Similarly, as shown on Appendix A2, it appears that lower quality local firms conceded to have a lower markup by upgrading the quality of their production - raising their marginal cost, and especially their capital intensity - to maybe differentiate from imported products of lower quality.

6.2 Is China accession to WTO driving the results?

In this section, we provide evidence that the differential change in the markup of local firms with low vs high level of quality is not a coincide, but the plausible consequence of the competition led by imports from China. We run the main regression over the period of 1985 - 2000, using 1990 as a counterfactual break point and our primary measure of quality, wage . The results displayed in Appendix B show that the interaction is never significant even after controlling for spending in R&D and advertising. This provides stronger evidence that the captured change in the markup of low vs high quality firms can be attributed to the implied rise in imports from China following its accession to WTO.

7 Conclusion

This paper investigated the impact of the competition led by imports of Low quality on the markup of Local firms segmented in Low vs High quality. In fact, the availability of multiple varieties of products may affect the market power of firms, and the extent to which consumers are aware of the differences in quality between varieties, may be a strategic information for firms setting their markups. We use the methodology proposed by Deloacker, to recover markups at the firm level. This paper provided theoretical and empirical evidence supporting that the import penetration of low quality products do not affect local firms similarly. Our theoretical implications suggest that the import penetration only affects local firms supplying products of a closest quality level. The empirical test conducted on the full set of US firms, excluding a few industries with peculiarities, are supportive of our theoretical findings. Our main diff-in-diff specification indicates that the rise in imports from China following the accession of China to WTO led to reduction in the markup of local firms producing low quality. Additional tests reveals that low quality firms conceded to lose in markup by upgrading their quality with convergence to a target. Our findings also show these firms raised their spending in Innovation. We interpret this body of evidence as the expression of the firms facing accrued competition willingness to differentiate from the imports of low quality. Our findings also showed that High quality product did not react the same way. Following the ac-

cession of China to WTO and the implied rise in its exports to WTO, high quality firms downgraded with no specific target in their level of quality. Furthermore, unlike local firms of low quality, they invested more in advertising. These findings overall reveal a strategic behaviour since the greater availability of products of low quality grant them larger room to downgrade while remaining of a relatively superior quality, which they signal through increased spending in advertising. Overall, this paper showed that the competition led by imports of low quality intensifies the vertical competition that exists in the local market with different reactions behind from firms of different status quality.

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A Sensitivity to index of quality : Capital intensity

A.1 Main specification

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES					Markup			
Treated	-0.0519	0.406***	-0.0296	0.324**	0.0729	0.671***	0.0880	0.583***
	(0.111)	(0.149)	(0.111)	(0.150)	(0.116)	(0.148)	(0.116)	(0.149)
Post	0.261**	0.755***	0.285**	0.692***	0.377***	0.905***	0.389***	0.839***
	(0.111)	(0.157)	(0.111)	(0.157)	(0.113)	(0.155)	(0.113)	(0.155)
Treated#Post	-0.142	-0.582***	-0.193	-0.497**	-0.239*	-0.714***	-0.282**	-0.623***
	(0.140)	(0.194)	(0.142)	(0.195)	(0.142)	(0.189)	(0.143)	(0.189)
Log(Inovation)		0.0315**		0.140***		0.0390***		0.187***
		(0.0138)		(0.0311)		(0.0138)		(0.0332)
log(Advertising)			0.0268**	-0.135***			0.0271**	-0.184***
			(0.0116)	(0.0348)			(0.0126)	(0.0376)
Constant	1.559***	0.938***	1.241***	1.580***	1.445***	0.650***	1.133***	1.498***
	(0.0981)	(0.205)	(0.169)	(0.264)	(0.102)	(0.201)	(0.177)	(0.265)
Industry FE					YES	YES	YES	YES
Observations	14,783	5,541	14,783	5,541	14,783	5,541	14,783	5,541
R-squared	0.001	0.005	0.002	0.008	0.015	0.104	0.016	0.108

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

A.2 Quality updates

VARIABLES	(1) Log(quality)	(2) Log(quality)
Post	-1.258***	-0.969***
	(0.0434)	(0.0377)
Treated	-2.482***	-1.742***
	(0.0433)	(0.0385)
Post#Treated	1.543***	1.272***
	(0.0549)	(0.0471)
Constant	13.42***	12.91***
	(0.0385)	(0.0338)
Industry FE	NO	YES
Observations	14,725	14,725
R-squared	0.226	0.451

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

A.3 Quality convergence

VARIABLES	(1) Δq_{flt}	(2) Δq_{flt}	(3) Δq_{fht}	(4) Δq_{fht}
q_{flt-1}	-0.0104***	-0.0113***		
	(0.00384)	(0.00388)		
q_{fht-1}			0.0230*	0.0228
			(0.0139)	(0.0140)
Constant	5,997***	5,988***	260,863	260,933
	(1,482)	(1,479)	(617,101)	(618,335)
Observations	2,490	2,490	5,154	5,154
R-squared	0.003	0.016	0.001	0.001

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

A.4 Reaction to Import Penetration: Spending in Advertising and R&D

	(1)	(2)	(3)	(4)
VARIABLES	Log(Inovation$_t$)	Log(Advertising$_t$)	Log(Inovation$_t$)	Log(Advertising$_t$)
Post	-1.988***	-0.992***	-1.526***	-0.539***
	(0.182)	(0.0902)	(0.180)	(0.0856)
Treated2	-1.439***	-1.101***	-1.036***	-0.761***
	(0.178)	(0.0911)	(0.177)	(0.0879)
Post#Treated2	2.901***	1.737***	2.501***	1.494***
	(0.229)	(0.115)	(0.223)	(0.108)
Log(Markup$_{t-1}$)	0.587	-0.0469	0.862**	0.135
	(0.448)	(0.142)	(0.432)	(0.132)
Post#Log(Markup$_{t-1}$)	-0.119	0.366**	-0.239	0.188
	(0.464)	(0.151)	(0.446)	(0.140)
Treated2#Log(Markup$_{t-1}$)	0.243	0.943***	-0.0180	0.575***
	(0.466)	(0.158)	(0.447)	(0.148)
Post#Treated#Log(Markup$_{t-1}$)	0.472	0.329*	0.468	0.202
	(0.509)	(0.192)	(0.490)	(0.179)
Constant	11.20***	11.87***	10.79***	11.53***
	(0.160)	(0.0815)	(0.159)	(0.0778)
Industry FE			YES	YES
Observations	5,541	14,782	5,541	14,782
R-squared	0.075	0.059	0.165	0.200

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

B Faking China Accession in 1990

	(1)	(2)	(3)	(4)
VARIABLES			markup	
Treated	-0.00407	0.0150	0.0744	0.0715
	(0.0442)	(0.0447)	(0.0685)	(0.0679)
Post	0.117***	0.112***	0.170***	0.165***
	(0.0366)	(0.0366)	(0.0503)	(0.0499)
Treated#Post	-0.0797	-0.0797	0.0361	0.0791
	(0.0520)	(0.0519)	(0.0812)	(0.0807)
Log(Inovation)			0.0324***	0.156***
			(0.00746)	(0.0194)
Log(Advertising)		0.0145***		-0.147***
		(0.00514)		(0.0214)
Constant	1.459***	1.290***	1.096***	1.664***
	(0.0303)	(0.0672)	(0.0901)	(0.122)
Industry FE	YES	YES	YES	YES
Observations	6,235	6,235	2,632	2,632
R-squared	0.082	0.083	0.104	0.120

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1