Credit Constraints and Export Prices: Theory and Evidence from China*

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Abstract

This paper examines how credit constraints affect unit value export prices and the relation between export prices and firm productivity. The model extends Melitz (2003) by introducing endogenous quality of variety, credit constraints as well as marketing costs to a heterogeneous-firm trade model. There are three key findings. First, there exists a positive relationship between firm productivity and export prices because the quality effect (via higher-quality input) dominates the adjustment of marginal cost. Second, more binding credit constraints (or less credit accesses) decrease optimal prices set by the firm as the quality effect dominates the price distortion due to misallocation of upfront costs between variable and fixed costs. Third, if quality was homogeneous across firms, completely opposite impacts would have occurred: there was a negative correlation between prices and productivity, and prices increased as more stringent credit constraints (or lower level of financial development) were faced by firms. The empirical application to Chinese bank loans data, Chinese firm-level data from National Bureau of Statistics of China (NBSC), and Chinese Customs data strongly supports the theoretical predictions from the heterogeneous-quality model, and we find a significant impact of credit constraints on export prices, indicating the prevalence of heterogeneous quality across firms.

JEL: F1, F3, D2, G2

Keywords: credit constraints, financial development, productivity, export prices, endogenous quality, heterogeneous firms, heterogeneous quality

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1. Introduction

There is a growing body of literature on the effects of credit constraints on international trade, especially after the financial crisis of 2008. Most prior studies focus on either the mechanism of why exporters need more credit than domestic producers (e.g., Amiti and Weinstein, 2009; Feenstra, Li, and Yu, 2011), or the consequences of credit constraints on export revenue or multinational activities (Manova, 2011; Manova, Wei, and Zhang, 2011, among others). While the impacts of credit constraints on firms' optimal pricing rule have not been explored to the best of our knowledge.

Despite the thin literature on credit constraints and prices, analyzing the mechanisms through which credit constraints affect prices has important implications for a better understanding of firm exporting behavior. In particular, it helps explain differences in the intensive margin of trade at product level by examining the effects of credit constraints on unit value export prices, as the intensive margin at product level pins down export value of each product and the changes in intensive margin stem from two different sources: the change in quantity exported and the change in unit value export prices. Therefore a thorough analysis on the effect of credit constraints on export prices facilitates our understanding of intensive margin at product level which is an important aspect in international trade. Moreover, credit constraints affect allocation of bank loans on upfront costs between fixed and variable costs, and with more binding credit constraints, the misallocation of upfront costs between fixed and variable costs would distort firms' optimal prices. Therefore it is important to investigate how credit constraints, or conversely, credit accesses, affect export prices.

We thus build a heterogeneous-firm trade model to examine the impacts of credit constraints on prices based on Melitz (2003) by introducing endogenous quality and credit constraints. Similar to Arkolakis (2010), we also introduce marketing costs of advertisements. The main departure of our model from Arkolakis (2010) is twofold. First, we introduce endogenous quality of inputs. Consistent with the quality-and-trade literature, more productive firms tend to choose higher-quality inputs which yields higher export prices.[1] However, the net relation between prices and productivity depends on two opposing forces: the quality effect (via higher input quality associated with high productivity) and the productivity effect (via lower marginal cost associated with higher productivity). Given certain parameter values (for example, the elasticity of substitution between varieties and the elasticity of fixed costs with respect to quality), the quality effect domi-

[1] See Verhoogen (2008), Kugler and Verhoogen (forthcoming), Hallak (2010), Hallak and Sivadasan (2011), Gervais (2009), Johnson (2012), Manova and Zhang (forthcoming), among others.

nates and firm's optimal prices are positively correlated with productivity.

Second, we introduce credit constraints by assuming that firms need to externally finance a certain proportion of all costs, including variable costs and fixed costs to produce and to enter foreign markets. This proportion reflects the *financial needs* of the firm, which we call "*credit constraint*" parameter. The higher this proportion, the more likely binding credit constraints are faced by the firm. Correspondingly, we assume that due to some restrictions in financial markets firms cannot borrow more than a certain fraction of their expected cash flow. Hence, this fraction of firms' expected cash flow captures the situation of *credit accesses* to firms, which we call "*financial development*" parameter. The higher the financial development, the more credit access to the firm. The impacts of credit constraint on prices also depend on two opposing forces: the quality effect which lowers input quality and hence decreases prices when more binding credit constraints are imposed; the misallocation of upfront costs between variable and fixed costs which increase price distortion when credit constraints are more stringent. The mechanisms through which credit constraints impact optimal prices are not trivial. When quality is heterogeneous across firms, the quality effect dominates the misallocation of upfront costs, and therefore optimal prices decrease when more binding credit constraints or less credit accesses are faced by firms. The economic intuition is that firms can optimally choose input quality to mitigate the price distortion caused by more binding credit constraints or less credit access. While if we assume quality is homogeneous across firms, exactly opposite scenario would occur: more stringent credit constraints or lower financial development would increase optimal prices due to the misallocation effect.[2]

Next we confront our model with the matched Chinese firm-product level data, using Chinese firm-level production data from National Bureau of Statistics of China (NBSC) and Chinese Customs data at transaction-product level. The unique advantage of this merged dataset is that it contains the information on unit value prices of both imports and exports at product-firm level as well as the information to measure credit constraints. We used the augmented Olley-Pakes (1996) approach to estimate firms' total factor productivity, controlling for the problems of simultaneity bias and selection bias. To measure the severity of credit constraints (or, financial needs) faced by firms, we first follow Manova et al. (2011) to employ four different measures at industry level: external finance dependence, R&D intensity, inventory-to-sales ration, and asset tangibility from the US data which are widely used in cross-country studies in the previous literature. For the robustness checks, we also follow Rajan and Zingales (1998) and Manova (2011) to calculate external

[2]In another case that only fixed costs are subject to credit constraints and quality is heterogeneous, more binding credit constraints also decrease optimal export prices.

finance dependence using the information in cash flow statements from Chinese firm-level data.[3] To proxy for financial development, we collect balance of bank credits, long-term bank loans and short-term bank loans by province in China to reflect the situation of credit accesses to firms located in different regions. In addition, we compare different types of firm ownership in China to differentiate their different levels of credit access.

We then test the theoretical predictions of our model using model-based estimation equation, and all empirical results strongly support the theoretical predictions from the heterogeneous-quality model: first, there exists a significant, robust positive relation between export prices and firm productivity. Second, more stringent credit constraints significantly decrease the optimal prices charged by firms, while financial development increases prices. We also test the mechanism of quality in our model by comparing the effects of productivity, credit constraints, and financial development on prices under three different scenarios: without controlling for input quality, with controlling for quality using average wage, and with controlling for more factors of input quality such as unit value prices of imported inputs and the share of workers with college degree in total employee. The test results confirm the validity of the mechanism of quality. Overall, our empirical results suggest that the heterogenous-quality model prevails over the homogeneous-quality model and the mechanism of quality is key to fully understand the impacts of credit constraints on firms' optimal pricing rule.

The main contribution of this paper is to offer both theoretical examination and empirical evidence on the novel findings of the impacts of credit constraints and financial development on export prices set by firms, which contributes to the emerging literature on the role of financial constraints in international trade. As most prior studies on credit constraints focus on the effects of credit constraints on export revenue (or export cutoff condition) and the difference in the needs of credit between exporters and non-exporters, this paper makes a unique contribution to the literature from a novel perspective by linking credit constraints directly with firm attributes such as productivity and optimal pricing rules.

This paper also contributes to the vast quality-and-trade literature and confirms the prevalence of the heterogeneous-quality model over the homogeneous-quality model in reality by highlighting the mechanism of quality through both theoretical modeling and empirical investigation. Our finding on the positive relation between firm productivity and export prices is consistent with the prior literature on heterogeneous quality (e.g., Verhoogen, 2008; Kugler and Verhoogen, forthcom-

[3]External finance dependence is the fraction of capital expenditures not financed with cash flow from operations.

ing; Hallak, 2010; and Hallak and Sivadasan, 2011). While our findings that the impacts of credit constraints on optimal prices depend on the assumption of quality are novel in the literature. To the best of our knowledge, this paper provides the first compelling analysis of the impacts of credit constraints on prices under a heterogeneous-firm trade framework and supports the predictions from the heterogenous-quality model.

Finally, this paper contributes to the empirical studies on the role of input quality in international trade, by employing detailed product-firm level data, taking advantage of a matched dataset of Chinese manufacturing firms and Chinese customs data. Our results provide direct evidence that the quality of inputs (e.g., through imported intermediated inputs or highly skilled labor inputs) is strongly and positively associated with unit value export prices. It complements the existing studies on the role of imported inputs in international trade, for example, Goldberg et al. (2010) find that the use of imported inputs increases product scope for Indian firms.

The remainder of the paper is organized as follows. Section 2 presents a heterogenous-firm trade model with endogenous quality, marketing costs, and credit constraints to illustrate the relationship between export prices and firm productivity, as well as the impact of credit constraints on optimal pricing rule. Section 3 describes the data and introduces the empirical strategy. Section 4 presents the empirical results and Section 5 provides robustness checks. The last section concludes.

2. Model

In this section we present a partial equilibrium model to study unit value export prices across firms that compete for the same product-destination market. The model is based on the monopolistic competition framework proposed by Melitz (2003) and now incorporated endogenous quality, credit constraints, and marketing costs. Goods are differentiated, and each good is produced by a firm. The main departure from the previous literature is that firms are heterogeneous in both their productivity and credit constraints. Firms choose not only the optimal price but also the optimal quality of products as well as the optimal volume of advertisement.

2.1. Preference and Market Structure

We denote the source country by i and the destination country by j, where $i, j \in 1, \ldots, N$. Country j is populated by a continuum of consumers of measure L_j. Consumers in country j has access to a potentially different set of goods Ω_j. In each source country i, there is a continuum of firms of measure J that ex ante differ in their productivity level, ϕ, the credit access, θ. A firm with higher θ has more credit access. We assume that a representative consumer in country j has the constant-elasticity-of-substitution (CES) utility function:

$$U_j = \left[\int_{\omega\in\Omega_j} \left(h_{ij}\left(q_{ij}(\omega), a_{ij}(\omega)\right) x_{ij}\left(\omega\right)\right)^{\frac{\sigma-1}{\sigma}} d\omega\right]^{\frac{\sigma}{\sigma-1}}$$

where ω indexes varieties in the product set Ω_j, $h_{ij}\left(q_{ij}, a_{ij}\right)$ is a demand shifter which is equal to $q_{ij}\left(\omega\right) a_{ij}\left(\omega\right)$, $q_{ij}\left(\omega\right) \geq 1$ represents the factor in demand shifter induced by quality of variety ω from country i, $a_{ij}\left(\omega\right)$ captures the factor in demand shifter induced by advertisement volume, $x_{ij}\left(\omega\right)$ is the quantity demand of variety ω from country i, and $\sigma > 1$ captures the elasticity of substitution between varieties.[4] Then, consumer optimization yields the following demand for variety ω:

$$x_{ij}\left(\omega\right) = \left(q_{ij}(\omega)a_{ij}(\omega)\right)^{\sigma-1} \frac{\left(p_{ij}\left(\omega\right)\right)^{-\sigma}}{P_j^{1-\sigma}} Y_j$$

where $p_{ij}\left(\omega\right)$ is the price of variety ω, $P_j = \left[\int_{\omega\in\Omega_j} \left(p_{ij}\left(\omega\right) / \left(q_{ij}(\omega)a_{ij}(\omega)\right)\right)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}$ is an aggregate price index (adjusted by the demand shifter), and Y_j represents the total expenditure of country j. Given the same price, higher-quality products and intensively-advertised products generate a larger demand.

2.2. Firm Problem

Firms are heterogenous in their productivity ϕ and credit access θ. Firm technology is captured by a cost function that exhibits constant marginal cost (if no quality upgrading) with fixed overhead costs. Labor is the only factor of production. Following convention, we assume the standard iceberg trade cost that a firm from country i exporting to country j must produce and ship $\tau_{ij} \geq 1$ units of the good for one unit to arrive in j.[5] To simplify notation, the indices for products and destinations are subsumed hereafter. In addition, the common wage rate is normalized to one.

Following the recent quality-and-trade literature, we assume a positive relationship between quality and marginal cost of production. It implies that in order to produce higher-quality prod-

[4]Following convention, $h_{ij}\left(\omega\right) x_{ij}\left(\omega\right)$ captures the "implicitly measured quantity" of each variety consumed, which is implicitly measured in units of utility.

[5]Firms face no trade costs in selling in its home market, i.e., $\tau_{ii} = 1$.

ucts, higher marginal costs of production would incur.[6] The marginal cost of production is assumed to be q^{α}/ϕ, where $\alpha \in [0, 1]$. Hence, the marginal cost increases in quality, and α captures the elasticity of marginal cost with respect to quality.

Firms face two types of fixed costs: the fixed cost of marketing and the fixed costs of production. The fixed cost of marketing is $f(a)$, which is assumed to be $f_x \frac{a^{1+\epsilon}}{1+\epsilon}$ and represents the penetration cost to enter foreign markets, where $\epsilon > 0$ and f_x is constant. The modeling of advertising technology draws upon the work of Butters (1977), Stegeman (1991), and Dinlersoz and Yorukoglu (2008). The advertising technology, $f(a)$, is exogenously given and common to all firms. For any given $a \in [0, +\infty)$, $f(a)$ yields the total fixed cost of marketing in terms of advertisements.[7] The formula of the advertising technology captures the empirical evidence that the effectiveness of advertising is subject to diminishing returns, reviewed by Sutton (2007). The fixed cost of production is assumed to be $f_d q^{\beta}$ ($\beta > 0$), which represents fixed investments in improving the quality (e.g., R&D expenditures or costs of employing higher-quality inputs), where f_d denotes the fixed production cost in domestic market without quality improvement and $1/\beta$ measures the effectiveness of fixed expenditures in raising quality.

We posit that all costs are subject to liquidity constraints. Similar with the extended model in Manova (2011), we assume that exporters need to raise outside capital for a fraction $d \in (0, 1)$ of all costs associated with foreign sales, including variable costs and two types of fixed costs.[8] This fraction d represents the *financial needs* of firms. The higher financial needs, the more likely binding credit constraints. Hence, we call this fraction d the "*credit constraint*" parameter. When d is higher, it is more likely for firms to face binding credit constraints. We also assume that firms cannot borrow more than a fraction θ of the expected cash flow from exporting. If θ is higher, firms can borrow more from external finance (mainly through bank loans). Therefore, θ captures the *credit accesses* to firms, which we call "*financial development*". Then, the optimization problem

[6]The positive relationship between quality and marginal cost is common to the recent quality-and-trade literature, including Baldwin and Harrigan (2009), Verhoogen (2008), and Johnson (2012).

[7]Here advertising is merely a representative channel of marketing. Any other form of fixed marketing cost is also included in $f(a)$, which we view as penetration costs to enter foreign markets.

[8]We also consider the case that firms only need to raise outside capital for fixed costs in Proposition 6 and the proof is in Appendix.

of a firm with productivity ϕ, financial development θ, and credit constraint d becomes:[9]

$$\max_{p,q,a} \left(p - \frac{\tau q^{\alpha}}{\phi}\right)(qa)^{\sigma-1} \frac{p^{-\sigma}}{P^{1-\sigma}} Y - f_x \frac{a^{1+\epsilon}}{1+\epsilon} - f_d q^{\beta} \tag{1}$$

$$\text{s.t. } \theta \left(\left(p - (1-d)\frac{\tau q^{\alpha}}{\phi}\right)(qa)^{\sigma-1} \frac{p^{-\sigma}}{P^{1-\sigma}} Y - (1-d)\left(f_x \frac{a^{1+\varepsilon}}{1+\varepsilon} + f_d q^{\beta}\right)\right) \tag{2}$$
$$\geq d\left(\frac{\tau q^{\alpha}}{\phi}(qa)^{\sigma-1} \frac{p^{-\sigma}}{P^{1-\sigma}} Y + f_x \frac{a^{1+\varepsilon}}{1+\varepsilon} + f_d q^{\beta}\right)$$

where the budget constraint (2) can be viewed as "cash flow constraint" condition, in the same spirit with Manova (2011) and Feenstra et al. (2011). Solving this optimization problem with respect to price p, quality q, and advertisement a yields

$$p = \frac{\sigma}{\sigma-1}\left(1 + d\frac{(1-\theta)\lambda}{\theta(1+\lambda)}\right)\frac{\tau q^{\alpha}}{\phi} \tag{3}$$

$$(qa)^{\sigma-1} \frac{p^{1-\sigma}}{P^{1-\sigma}} Y = \frac{\sigma\beta}{(1-\alpha)(\sigma-1)}\left(1 + d\frac{(1-\theta)\lambda}{\theta(1+\lambda)}\right) f_d q^{\beta} \tag{4}$$

$$(qa)^{\sigma-1} \frac{p^{1-\sigma}}{P^{1-\sigma}} Y = \frac{\sigma}{(\sigma-1)}\left(1 + d\frac{(1-\theta)\lambda}{\theta(1+\lambda)}\right) f_x a^{1+\epsilon} \tag{5}$$

where λ is the Lagrangian multiplier associated with the budget constraint condition (2).

The equation (4), together with (5), yields the relation between optimal quality q and optimal advertisement a:

$$\frac{\beta}{(1-\alpha)} f_d q^{\beta} = f_x a^{1+\epsilon} \tag{6}$$

The previous expression, together with the budget constraint (2) and the conditions (3) and (4), implies:

$$\frac{\sigma\beta}{(1-\alpha)(\sigma-1)}\left(1 + d\frac{(1-\theta)\lambda}{\theta(1+\lambda)}\right) \geq \left(1 - d + \frac{d}{\theta}\right)\left(\frac{\beta}{(1-\alpha)} + \frac{\beta}{(1+\varepsilon)(1-\alpha)} + 1\right) \tag{7}$$

Let $\frac{\beta}{(1-\alpha)(\sigma-1)} \equiv \Lambda$ and $\frac{1+\epsilon}{\sigma-1} \equiv 1+\Theta$. Given credit constraint d, there exists a cutoff of credit access θ_h such that the budget constraint (2) is binding if and only if $\theta < \theta_h$; given credit access θ, there exists a cutoff of credit constraint d_h such that the budget constraint (2) is binding if and only if $d > d_h$.[10] Next, we analyze two cases according to different scenarios of budget constraint (2).

Case 1: The budget constraint (2) is binding.

[9]For simplicity of notation, we suppress variety ω and subscripts of country (i, j). It should be also pointed out that we do not consider the intertemporal structure of costs of borrowing from banks as the current model is a static, one-period model.

[10]$\theta_h = \frac{d(\Lambda(\sigma+\sigma\Theta-\Theta)+1+\Theta)}{\sigma\Lambda(1+\Theta)-(1-d)(\Lambda(\sigma+\sigma\Theta-\Theta)+1+\Theta)}$; $d_h = \frac{\theta}{1-\theta}\frac{(\sigma\Lambda-1)(1+\Theta)-\Lambda(\sigma+\sigma\Theta-\Theta)}{\Lambda(\sigma+\sigma\Theta-\Theta)+1+\Theta}$

Then the equation (7) yields:

$$\left(1+d\frac{(1-\theta)\,\lambda}{\theta\,(1+\lambda)}\right)=\left(1-d+\frac{d}{\theta}\right)\left(\frac{\sigma+\sigma\Theta-\Theta}{\sigma+\sigma\Theta}+\frac{1}{\sigma\Lambda}\right)$$

Let $\left(1+d\frac{(1-\theta)\lambda}{\theta(1+\lambda)}\right)\equiv\Delta$. It is obvious that price distortion Δ is related to credit access θ and credit constraint d. A higher credit constraint d (given credit access θ) or a lower credit access θ (given credit constraint d) increases the price distortion caused by the binding budget constraint and the corresponding allocation of upfront costs between fixed and variable costs.

Now, the equation (2), together with (3) and (6), implies the optimal quality chosen by firms satisfies the following condition:

$$q^{\frac{\Theta\beta}{1+\Theta}-(1-\alpha)(\sigma-1)}=\frac{\Delta^{-\sigma}}{\sigma\Lambda f_d}\left(\frac{\Lambda\,(\sigma-1)\,f_d}{f_x}\right)^{\frac{1}{1+\Theta}}\left(\frac{\sigma}{(\sigma-1)}\frac{\tau}{\phi}\right)^{1-\sigma}\frac{Y}{P^{1-\sigma}} \tag{8}$$

Under the condition $\Theta\beta>(1-\alpha)\,(\sigma-1)\,(1+\Theta)$, there is a positive correlation between firm productivity ϕ and quality q, given credit access θ and credit constraint d. This suggests that more productive firms choose higher quality, which is consistent with the previous quality-and-trade literature. Given productivity, an increase in financial development parameter θ and a reduction in credit constraint parameter d (i.e., more credit access or less binding credit constraint) leads to higher optimal quality q chosen by the firm and a higher quality q leads to higher price. We call this mechanism *quality effect*. There exists a reinforcing mechanism for *quality effect*: firms with more credit access or lower needs to borrow choose higher quality, and choosing higher quality increases firms' profit, further increasing firms' ability to borrow by relaxing the cash flow constraint, which is associated with further increase in credit access and reduction in credit constraints. Therefore, firms with higher productivity usually choose higher quality, which in turn mitigates the price distortion caused by less credit access or more binding credit constraints.

Hence, the equation of optimal pricing rule (3), together with the previous expression (8), implies:

$$p=\Delta^{1-\sigma\Psi}\left(\frac{1}{\sigma\Lambda f_d}\right)^{\Psi}\left(\frac{\Lambda\,(\sigma-1)\,f_d}{f_x}\right)^{\frac{\Psi}{1+\Theta}}\left(\frac{\sigma}{(\sigma-1)}\frac{\tau}{\phi}\right)^{1+(1-\sigma)\Psi}\left(\frac{Y}{P^{1-\sigma}}\right)^{\Psi} \tag{9}$$

where $\Psi=\frac{\alpha(1+\Theta)}{\Theta\beta-(1-\alpha)(\sigma-1)(1+\Theta)}>0$. If the condition $1+(1-\sigma)\Psi<0$ holds, then firms' optimal prices are positively correlated with firm productivity. This is equivalent to the following two conditions: (1) $\Theta\beta>(1-\alpha)\,(\sigma-1)\,(1+\Theta)$; and (2) $(\sigma-1)(1+\Theta)-\Theta\beta>0$. If the above conditions hold, firms with higher productivity charge higher optimal prices. The economic implications for the above conditions are as follows. Given $\Theta\beta > (1-\alpha)(\sigma-1)(1+\Theta)$, for products with a high elasticity of substitution between varieties (i.e., a high σ), a high degree of effectiveness of fixed investment in raising quality (i.e., a high $1/\beta$) and a high degree of effectiveness in market penetration (i.e., a low Θ, or equivalently, a low ϵ or a high σ), the condition $(\sigma-1)(1+\Theta)-\Theta\beta > 0$ also holds.[11]

The mechanism behind this positive correlation between firm productivity and export prices is due to two opposing effects of credit constraints on the optimal price. One is caused by the distortion in the allocation between fixed costs and variable costs. The other is caused by the distortion in the optimal quality chosen by firms. The former effect generated by misallocation between fixed costs and variable costs tends to increase the optimal price when firms face a higher credit constraint d and a less credit access θ (i.e., when d increases or θ decreases, the price distortion Δ increases and therefore price increases). But, the later effect caused by quality distortion associated with less credit access or a higher credit constraint decreases the optimal price. The ultimate effect of productivity on price depends on which effect dominates.

Under the conditions (1) and (2), we have $1+(1-\sigma)\Psi < 0$, and hence the condition $1-\sigma\Psi < 0$ is also satisfied. Then according to equation (9), the price distortion Δ is negatively correlated with optimal price. As a higher credit constraint parameter d or a low credit access parameter θ increases price distortion Δ, the ultimate effect of credit constraints on the optimal price shows that a higher credit constraint d or a less credit access θ decreases the optimal price. It implies that the later effect, quality effect, dominates the former effect, according to equation (9). The graph in the left panel of Figure 1 illustrates the relationship between prices, productivity, and credit constraints: the solid line corresponds to the more credit access and less binding credit constraint situation (i.e., a higher θ and a lower d), and the dash line captures the less credit access and more binding credit constraint situation (i.e., a lower θ and a higher d).

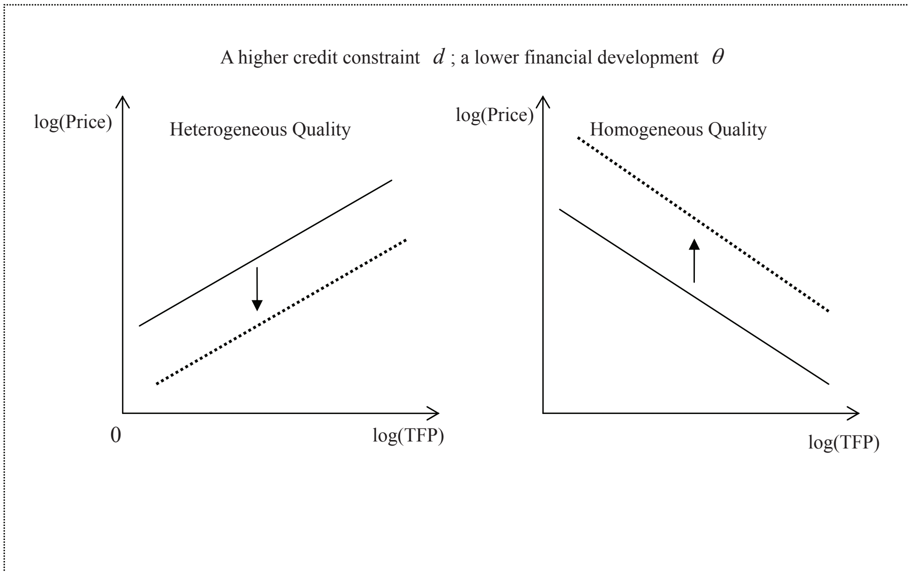
Case 2: The budget constraint (2) is unbinding, i.e., $\lambda = 0$.

The equation (4), together with (3) and (6), implies:

$$q^{\frac{\Theta\beta}{1+\Theta}-(1-\alpha)(\sigma-1)} = \frac{1}{\sigma\Lambda f_d}\left(\frac{(\sigma-1)\Lambda f_d}{f_x}\right)^{\frac{1}{1+\Theta}}\left(\frac{\sigma}{\sigma-1}\frac{\tau}{\phi}\right)^{1-\sigma}\frac{Y}{P^{1-\sigma}} \tag{10}$$

[11]Since $(\sigma-1)$ captures the sensitivity of demand shifter with respect to quality and advertisements, a high σ implies a high degree of effectiveness in marketing penetration. Similarly, $(1+\epsilon)$ represents the sensitivity of fixed marketing costs with respect to the volume of ads. Hence, a low ϵ represents a high degree of effectiveness of advertising.

Figure 1: The relationship between prices, TFP, and credit constraints



Under the condition $\Theta\beta > (1-\alpha)(\sigma-1)(1+\Theta)$, the firm with higher productivity will choose higher quality. Then, the equation (10), together with (3), implies the optimal pricing rule is given by

$$p = (\sigma\Lambda f_d)^{-\Psi}\left(\frac{(\sigma-1)\Lambda f_d}{f_x}\right)^{\Psi/(1+\Theta)}\left(\frac{\sigma}{\sigma-1}\frac{\tau}{\phi}\right)^{1+(1-\sigma)\Psi}\left(\frac{Y}{P^{1-\sigma}}\right)^{\Psi} \tag{11}$$

When $(\sigma-1)(1+\Theta) > \Theta\beta$, again the condition $1+(1-\sigma)\Psi < 0$ holds, and hence the quality effect dominates, implying a positive correlation between prices and productivity. In this case, optimal prices are not affected by financial development parameter θ and credit constraint parameter d, because firms have sufficient credit access ($\theta > \theta_h$) or face unbinding credit constraint ($d < d_h$).

Therefore, we derive the following three testable propositions:

Proposition 1 *When the quality chosen is heterogeneous across firms, the higher productivity of the firm, the higher prices.*

Proposition 2 *Given the credit constraint d, the less financial development (or, less credit access, i.e., a lower θ) decreases the optimal price set by the firm.*

Proposition 3 *Given the credit access θ, the more stringent credit constraint (i.e., a higher d) decreases the optimal price set by the firm.*

The above analysis is based on the assumption that quality is heterogeneous across firms and endogenously chosen by firms. Next, we analyze the traditional Melitz-type model, where quality chosen by firms is homogeneous. In this case, quality effect does not exist and only productivity effect occurs through the adjustment of marginal cost, which yields that the optimal price decreases in productivity. The intuition for this case is straightforward: more productive firms are able to lower their marginal cost of production and hence charge lower prices to outperform the market. Meanwhile, the price distortion caused by credit constraints occurs only via the misallocation between fixed costs and variable costs as quality effect does not exist. Hence, more binding credit constraint (i.e., a higher d) and less credit access (i.e., a lower θ) increase the optimal prices charged by firms in the traditional Melitz-type model. See the graph if the right panel of Figure 1 for illustration. We summarize the properties for the homogeneous-quality model in the following proposition (see Appendix A for the proof of Proposition 4).

Proposition 4 *When the quality chosen is homogeneous across firms, the more productive firms set lower prices. Given the credit constraint d, the less financial development (i.e., a lower θ) increases the optimal price set by the firm; given the credit access θ, the more stringent credit constraint (i.e., a higher d) increases the optimal price set by the firm.*

In the previous discussion, we assume that all costs are subject to credit constraints. Therefore, the variable costs cannot be financed internally and firms need to raise outside capital for a fraction $d \in (0, 1)$ of the variable costs and the fixed costs including the fixed marketing cost and the fixed investment cost. However, if the firms only need to raise outside capital for a fraction $d \in (0, 1)$ of fixed costs, misallocation between fixed costs and variable costs does not exist. As a result, the effects of credit constraint (or credit access) on optimal prices remain unchanged if quality is heterogeneous. While the optimal price is unrelated with financial constraint when quality is homogeneous. We summarize the properties for this case in the following proposition (see Appendix B for the proof of Proposition 5).

Proposition 5 *When only fixed costs are financed by outside capital and variable costs can be financed internally, a higher credit constraint d or a less credit access θ decreases the optimal price if quality is heterogeneous, and prices increase in productivity. However, when quality is homogeneous, the optimal price is unrelated with credit constraint d or credit access θ, and prices decrease in productivity.*

The discussion in this section suggests that there are two competing theories to explain the relation between firm productivity and export prices as well as the effect of credit constraints on optimal pricing rule. As illustrated in Figure 1, the model that assumes quality is heterogeneous across firms presents the positive relation between productivity and export prices, and we should expect that more binding credit constraints and less credit access decrease the optimal prices set by the firm due to the dominant quality effect. While the model that assumes quality is homogeneous across firms presents the negative relation between productivity and export prices, and we should expect that more binding credit constraints and less credit access increase the optimal prices due to the sole effect of misallocation between fixed costs and variable costs. In the next section we use data from China to test the relation between productivity and prices as well as the impact of credit constraints on export prices. Our results support the heterogeneous-quality model.

3. Empirical Specification, Data and Measurement

3.1. Empirical Specification

The propositions in Section 2 imply that export prices are a function of firm productivity and can be affected by financial development or credit constraints. We test the proposed propositions with the following reduced form estimating equation:

$$\log price_{fpct} = b_0 + b_1 \log(TFP_{ft}) + \gamma X_{ft} + \chi_1 FinDev_r + \chi_2 ExtFin_i + \mu \Gamma_{ft} + \varphi_p + \varphi_c + \varphi_t + \epsilon_{fpct} \quad (12)$$

where $price_{fpct}$ represents the unit value export price of product p (disaggregated at HS 8-digit level) exported by firm f located in province r to destination country c in year t; TFP_{ft} denotes a firm f's productivity in year t; X_{ft} is a vector of time-varying firm attributes of firm f in year t; $FinDev_r$ captures the financial development (credit access) in province r; $ExtFin_i$ reflects the credit constraint situation at industry i and external finance dependence is one of those credit constraint measures; Γ_{ft} is a vector of input quality by firm f at year t; φ_p, φ_c, and φ_t are fixed effect terms of product, destination country, and year, respectively; ϵ_{fpct} is the error term that includes all unobserved factors that may affect the export prices. The vector of time-varying firm attributes X_{ft} includes firm size and capital intensity: employment is used to stand for firm size and to control for the economies of scale; capital-labor ratio, K/L, is used to control for production technique, which may not be captured by the technology level of a firm. The input quality Γ_{ft} is measured by average payments for each worker, the ratio of college worker to total employee, and the unit value price of imported inputs.

3.2. Firm-level and Product-level Data

To investigate the relationship between firms' productivity and their export prices as well as the role of credit constraints, we merge the following two highly disaggregated large panel data sets: (1) the firm-level production data, and (2) the product-level trade data. The sample period is between 2000 and 2006.

The data source for the firm-level production data is the annual surveys of Chinese manufacturing firms, which was conducted by the National Bureau of Statistics of China (NBSC). The database covers all state-owned enterprises (SOEs), and non-state-owned enterprises with annual sales of at least 5 million RMB (Chinese currency).[12] Between 2000 and 2006, the approximate number of firms covered by the NBSC database varied from 163,000 to 302,000. This database has been widely used by previous studies of Chinese economy and other economic questions based on evidence from Chinese data (e.g., Cai and Liu, 2009; Lu et al., 2010; Feenstra et al., 2011; Brandt et al. 2012; among others) as it contains detailed firm-level information of manufacturing enterprises in China, such as ownership structure, employment, capital stock, gross output, value added, firm identification (e.g., company name, telephone number, zip code, contact person, etc.), and complete information on the three major accounting statements (i.e., balance sheets, profit & loss accounts, and cash flow statements). Among all the information contained in the NBSC Database, we are mostly interested in the variables related to measuring firm total factor productivity and credit constraints. We also need to use firm identification information to merge the NBSC Database with the product-level trade data to obtain the import and export prices.

The second database we use is the Chinese trade data at HS 8-digit level, provided by China's General Administration of Customs. This Chinese Customs Database covers the universe of all Chinese exporters and importers in 2000-2006. It records detailed information of each trade transactions, including import and export values, quantities, quantity units, products, source or destination countries, contact information of the firm (e.g., company name, telephone, zip code, contact person), type of enterprises (e.g. state owned, domestic private firms, foreign invested, and joint ventures), and customs regime (e.g. "Processing and Assembling" and "Processing with Imported Materials"). Among all the information in the customs database, import and export values and quantities are of special interest to this study as they yield unit value price of imported input and export.

[12]It equals to US$640,000 approximately, according to the official end-of-period exchange rate in 2006, reported by the central bank of China.

In order to merge the above two databases, we match the product-level trade data contained in the Chinese Customs Database to manufacturing firms contained in the NBSC Database, according to the contact information of firms, because there is no consistent coding system of firm identity between these two databases.[13] Our matching procedure is done in three steps. First, the vast majority of firms (89.3%) are matched by company names exactly. Second, an additional 10.1% are matched by telephone number and zip code exactly. Finally, the remaining 0.6% of firms are matched by telephone number and contact person name exactly.[14] Compared with the manufacturing exporting firms in the NBSC Database, the matching rate of our sample (in terms of the number of firms) varies from 52% to 63% between 2000 and 2006, which covers 56% to 63% of total export value reported by the NBSC Database between 2000 and 2006. In total, the matched sample covers more than 60% of total value of firm exports in the manufacturing sector reported by the NBSC Database and more than 40% of total value of firm exports reported by the Customs Database.

3.3. Measurement

3.3.1. Measures of TFP

We use a Cobb-Douglas production function as estimation specification for TFP:[15]

$$Y_{ft} = A_{ft} L_{ft}^{\beta_l} K_{ft}^{\beta_k} \tag{13}$$

where production output of firm f at year t, Y_{ft}, is a function of labor, L_{ft}, and capital, K_{ft}; A_{ft} captures firm f's TFP in year t. We use deflated firm's value-added to measure production output. We do not include intermediate inputs (materials) as one of input factors in our main results because the prices of imported intermediate inputs are different from those of domestic intermediate inputs. As processing trade in China accounts for a substantial proportion of its total trade since 1995, using China's domestic deflator to measure its imported intermediate input would raise another unnecessary estimation bias (Feenstra et al., 2011). However, for robustness checks, we also

[13]In the NBSC Database, firms are identified by their corporate representative codes and contact information. While in the Customs Database, firms are identified by their corporate custom codes and contact information. These two coding systems are neither consistent, nor transferable with each other.

[14]In order to obtain more precise matching, we do not use contact person and zip code to match trade transactions to manufacturing firms since there are many different companies, which have the same contact person name in the same zip-code region.

[15]An alternative specification would be to use a trans-log production function, which also leads to similar estimation results.

estimated TFP based on the formula including material using the value of intermediate inputs. It turns out that including intermediate inputs (materials) in the estimation of TFP does not alter our empirical results of testing the theoretical predictions.

As the traditional OLS estimation method suffers from simultaneity bias and selection bias, we employ the augmented Olley-Pakes (1996) approach to estimate firms' total factor productivity to deal with both the simultaneity bias and selection bias in measured TFP. Our approach is based on the recent development in the application of the O-P method, for example, Amiti and Konings (2007), Feenstra et al. (2011), and Yu (2011), among others.

First, to measure real terms of firm's inputs (labor and capital) and output, we use different input price deflators and output price deflators, using the data directly from Brandt et al. (2012).[16] In Brandt et al. (2012), the output deflators are constructed using "reference price" information from China's Statistical Yearbooks and the input deflators are constructed based on output deflators and China's national input-output table (2002).

Second, we construct the real investment variable by adopting the perpetual inventory method to investigate the law of motion for real capital and real investment. To capture the depreciation rate, we use each firm's real depreciation rate provided by the Chinese firm-level data.

Furthermore, to take into account firm's trade status in the TFP realization, following Amiti and Konings (2007) we include two trade-status dummy variables-an export dummy (equal to one for exports and zero otherwise) and an import dummy (equal to one for imports and zero otherwise). In addition, as we deal with Chinese data and our sample period is between 2000 and 2006, similar with Feenstra et al. (2011) and Yu (2011), we include a WTO dummy (i.e., one for a year after 2001 and zero for before) in the Olley-Pakes estimation. The WTO dummy can capture the effect of China joining WTO on TFP realization because the WTO accession in 2001 was a positive demand shock for China's exports. Our estimation results of TFP coefficients at 2-digit industry level are reported in Table 1 and the magnitude of our estimates is similar to that reported by Feenstra et al. (2011).

3.3.2. Measures of Financial Development

To proxy for financial development, we collect balance of total bank credits, long-term bank loans, and short-term bank loans and calculate the bank loans to GDP ratio at provincial level. As regional heterogeneity is huge in China, we believe bank loans by province serve as a good proxy

[16] The data can be accessed via http://www.econ.kuleuven.be/public/N07057/CHINA/appendix/.

for regional financial development. Our sample includes 31 provincial-level regions (including 22 provinces, 4 municipalities, and 5 autonomous regions). The data source is Almanac of China's Finance and Banking (2000-2007). If financial development level is higher, it implies more credit access and hence we expect to see an increase in optimal prices under the heterogeneous-quality model.

Another measure we use to proxy for credit access is firm ownership. We compare state-owned enterprises (SOE) with domestic private enterprises (DPE) and multinational corporation (MNC) with joint venture (JV). We compare different types of firms in China because the literature clearly suggests that given the underdevelopment of Chinese financial markets, the Chinese DPE face less credit access than SOE do, because SOE can finance a larger share of their investments through external financing from bank loans provided by state-owned banks. For example, Boyreau-Debray and Wei (2005) point out that the Chinese banks–mostly state owned–tend to offer easier credit to SOE. Dollar and Wei (2007) and Riedel, Jin, and Gao (2007) report that private firms rely significantly less on bank loans and significantly more on retained earnings as well as family and friends to finance investments. Song, Storesletten, and Zilibotti (2011) also show that SOE finance more than 30 percent of their investments through bank loans compared to less than 10 percent for domestic private firms, and forms of official market financing (through bank loans) are marginal for private firms in China as private firms rely more on internal or informal financing. Hence, it is safe to conclude that SOE in China face more credit access, compared with DPE. Analogously, the literature also indicates that multinational companies have better credit access than joint ventures as multinational companies are able to reallocate resources in the global scale and finance their subsidiaries from headquarters or other affiliates. Therefore, according to the previous theoretical discussion, if the heterogeneous-quality model prevails over the homogeneous-quality model, we expect the optimal prices set by SOE higher than DPE and the optimal prices set by MNC higher than JV, respectively.

3.3.3. Measures of Credit Constraints

Following Manova et al. (2011), we employ four different measures of industries' financial vulnerability at 2-digit industry level to proxy for the industrial situation of credit constraints. The idea is that if an industry is more financially vulnerable, it is more likely to face binding credit constraint. These measures have been widely used in the literature on the role of credit constraints in international trade and growth. It should be noted that these measures are meant to reflect technologically determined characteristics of each industry that are beyond the control of individual firms. Therefore, these measures of industrial financial vulnerability are inherent to the nature of technological advancement across industries, which should be viewed as exogenously given for each individual firm.

These four measures are external finance dependence, R&D intensity, inventories-to-sales ratio, and asset tangibility. Industries' external finance dependence ($ExtFin_i$) is defined as the share of capital expenditure not financed with cash flows from operations. If external finance dependence is high, the industry is more financially vulnerable and hence, more likely to face binding credit constraint. R&D intensity is defined as R&D spending to total sales ratio (RD_i), which can also reflect the industry's financial vulnerability, because research and development activities are capital intensive. Typically, R&D expenditures, as the impetus for production, occur before products can be manufactured and successfully marketed and thus require large financial support. Third, we use inventories-to-sales ratio ($Invent_i$) as it proxies the duration of the manufacturing process and the working capital firms require in order to maintain inventories and meet demand. Last but not least, a measure of asset tangibility ($Tang_i$) can also capture the liquidity situation of industry and it is defined as the share of net value of fixed assets (such as plants, properties and equipments) in total book value assets. Among these four measures, higher external finance dependence, R&D intensity, and inventory-to-sales ratio imply more likely binding credit constraint (i.e., a higher d). While higher asset tangibility implies less likely binding credit constraint (i.e., a lower d) as more tangible assets can serve as collateral and alleviate credit constraints.

In the main tests, we employ these four measures of industries financial vulnerability constructed originally by Kroszner, Laeven and Klingebiel (2007) and followed by Manova et al. (2011), based on data on all publicly traded U.S.-based companies from Compustat's annual industrial files. Those measures are constructed following the methodology of Rajan and Zingales (1998) and Claessens and Laeven (2003). They are averaged over the 1980-1999 period for the median U.S. firm in each sector, and appear very stable over time. The four indicators of industries financial vulnerability are available for 29 sectors in the ISIC 3-digit classification system. We match Chinese HS 8-digit product codes to these ISIC 3-digit sector categories in our empirical analysis.

The application of those measures from US data in the context of countries other than US is standard in the literature (e.g., Rajan and Zingales, 1998; Kroszner et al., 2007, Manova et al., 2011). The reason is that those measures reflect the ranking of financial needs induced by technological advancement, which is inherent to the nature of industry attributes. As argued by Rajan and Zingales (1998), Kroszner et al. (2007), and Claessens and Laeven (2003), among others, there is a technological reason why some industries depend more on external finance than others and these technological differences persist across countries. Manova et al. (2011) also point out that the ranking of industries in terms of their financial vulnerability remains relatively stable across countries. In fact, Rajan and Zingales (1998) explicitly indicate that "most of the determinants of ratio of cash flow to capital are likely to be similar worldwide: the level of demand for a certain product, its stage in the life cycle, and its cash harvest period". This implies that, in principle, the measures calculated by data from any country with well-functioning capital markets apply to our study. Therefore, we follow the literature of financial dependence to use an industry's financial vulnerability identified by the US data as measures of its credit constraint in China in our main tests. Another reason that we use US data to calculate credit constraint measures is Chinese financial markets are not mature and hence cannot completely reflect the *real* financial needs by firms.

However, for robustness, we also construct the measure of external finance dependence calculated at 2-digit Chinese Industrial Classification (CIC) level using Chinese firm-level data and report our results in Table 2 in comparison with the results from US data.[17] Due to the immaturity of Chinese financial markets, capital expenditures by Chinese firms are more likely supported internally. As a result, the mean external finance dependence in China is lower.[18] Consistent with the statement in prior studies that the external finance dependence of U.S. firms is a good proxy for other countries, we find that the rankings of industries in China and US are similar with each other, with reasonable difference across industries as the two countries use different industry classification system. For example, tobacco industry is always at the top of the ranking list and less credit constrained. While petroleum products industry and professional and scientific equipment industry are at the bottom of the ranking list as they are usually more technological intensive and need more external capital.

[17] Data available in year 2004-2006 in the NBSC Database. We calculate the aggregate rather than the median external finance dependence at 2-digit industry level, because the median firm in Chinese database often has no capital expenditure. In our sample, approximately 68.1% firms have zero capital expenditure. Hence, we cannot use median firm approach to calculate external finance dependence.

[18] According to our calculation, the mean external finance dependence in China is approximately -0.57 while the mean external finance dependence from the US data is about -0.16.

4. Results

In this section, we report our empirical results which support theoretical predictions based on the heterogeneous-quality model.

4.1. Prices and TFP

From the previous theoretical discussion, if the homogeneous-quality model prevails, we should expect to see a negative relation between firm productivity and export prices. Conversely, if the heterogeneous-quality model prevails, we should expect that prices increase in productivity, as stated in Proposition 1. The reason is that now firm productivity affects product prices through two channels. On the one hand, higher-productivity firms have lower marginal costs, leading to lower product prices. On the other hand, more productive firms use more expensive inputs to produce goods of higher quality, leading to higher product prices. As the quality effect dominates, the ultimate effect is that prices increase in productivity. In Tables 3-6, when we run regressions of log(price) on log(TFP) according to the estimating equation (12), we find that the coefficients on TFP in all specifications are always positive and significant at 0.001 level. This suggests that there exists a positive relation between productivity and prices, which is consistent with the heterogeneous-quality model.

4.2. Effects of Financial Development and Credit Constraints

We are interested in examining the impacts of financial development (or credit access) and credit constraints on optimal prices. According to Proposition 2-3, if the heterogeneous-quality model prevails, we should expect that less financial development or more binding credit constraints decrease the optimal prices set by the firm. Otherwise, if the homogeneous-quality model prevails, we should expect the opposite effects of financial development and credit constraints on export prices.

We report our main results in four tables (Table 3-6) and our results suggest that the predictions based on the heterogeneous-quality model are consistent with reality. In each of the four tables, we use three types of bank loans to GDP ratio and the different types of firm ownership to control for credit access, and employ one of the four measures of financial vulnerability (i.e., external finance dependence, R&D intensity, inventory-to-sales ratio, and asset tangibility) to proxy for credit constraints.

In Table 3-6, specifications (1)-(3) show the regression results under three different measures of financial development using bank loans. Specifications (4) and (5) include two firm-type dummy variables, SOE, which is equal to 1 if the firm belongs to state-owned enterprises (SOE) and 0 if it belongs to domestic private enterprises (DPE); and MNC, which is equal to 1 if the firm is a multinational corporation (MNC) and 0 if it belongs to a joint venture (JV). According to Proposition 2 and further discussion in Section 3.3.2., we expect the coefficients on three types of bank loans as well as SOE and MNC to be positive, if the heterogeneous-quality model prevails. We find that the coefficients on all measures of financial development (or credit access) are significantly positive at 0.001 level, implying that firms with more access of bank loans set higher prices, and the prices set by SOE and MNC are significantly higher than the prices set by DPE and JV, respectively. These results verify Proposition 2.

Analogously, if the heterogeneous-quality model prevails, according to Proposition 3 and the further discussion in Section 3.3.3., we should expect that the coefficients on external finance dependence, R&D intensity, and inventory-to-sales ratio are negative while the coefficients on asset tangibility are positive because firms in industry with higher external finance dependence, R&D ratio, and inventory-to-sales ratio face more binding credit constraints while more tangible assets relax credit constraints as more collateral can be used. Again, the results presented in Table 3-6 confirm the heterogeneous-quality model: given financial development, the more stringent credit constraints significantly decrease the optimal prices.

4.3. Mechanism of Quality

The previous results confirm the predictions from the heterogeneous-quality model. This model works through the mechanism of quality if firms choose optimal quality according to their productivity, credit constraint and financial development. First, optimal prices increase in firm productivity because the quality effect dominates the adjustment of marginal cost. Second, optimal prices decrease in credit constraints but increase in financial development because the quality effect dominates the misallocation between fixed and variable costs distorted by credit constraints.

In this section, we further test the mechanism of quality and show why quality is a valid mechanism in our model. The previous theoretical discussions suggest that in the heterogeneous-quality model, the choice of input quality is the key element through which optimal prices increase in productivity and decrease (or increase) in credit constraints (or credit access). Otherwise if quality is homogeneous across firms the exactly opposite effects would occur.

If input quality is indeed a valid mechanism, we should expect that without controlling for input quality the effects of productivity, credit constraints, and financial development on prices would have been amplified. We thus run the similar regressions as in Table 3-6 but do not control for input quality measured by log wage (i.e., we compare the regressions without wage as control variables of input quality with those with wage). In Table 7 we present the regression results using external finance dependence and R&D intensity to represent credit constraints and in Table 8 we report results based on inventory-to-sales ratio and asset tangibility as credit constraint measures. Comparing Table 7 with Table 3 and 4, we find that without controlling for input quality, the coefficients on TFP almost double and the effects of credit constraints and final development on prices are also substantially increased. The similar patterns exist when we compare Table 8 with Table 5 and 6.

We then conduct another test to show that if more factors of input quality are controlled for in regressions, we should expect to observe substantial reduction in the effects of productivity, credit constraints, and financial development on optimal prices. In specifications (1)-(3) in Table 9, we use three different measures of input quality: the unit value price of imported inputs, average payments for each worker, and the ratio of college worker to total employee. The rationale is that it is believed in emerging markets firms employing imported intermediate inputs with higher prices and more skilled workers do sell their products at higher prices. In general, the average unit value price represents the quality of goods. Hence, imported inputs with higher unit value prices imply that the higher-quality inputs are used by firms and should yield higher selling prices. As for the skilled workers, the database from NBSC provides the average wage paid by each firm. In addition, information on workers' education is available for the year of 2004. In specifications (4)-(6) in Table 9 we run regressions using wage as the only indicator of input quality, in comparison with specifications (1)-(3) using three different indicators of input quality. We find that once we control more for input quality (specifications (1)-(3)), the magnitude of the effects of productivity, credit constraints, and financial development on prices reduce substantially. In addition, as capital-labor ratio (K/L) partly reflects the technology advancement which is not captured by TFP, we also expect the coefficients on capital-labor ratio to decrease when more factors of input quality are controlled for (specifications (1)-(3)), which is, again, consistent with our results. Therefore, the results in Table 9 further confirm the mechanism of quality in our model: the effects of productivity, credit constraints, and financial development on prices indeed go through input quality.

It should be noted that our results only confirm quality as a correct mechanism through which those variables of interest (i.e., productivity, credit constraint, and financial development) impact prices, but quality may not serve as the sole mechanism. Hence, it is not surprising to observe persistent effects of productivity, credit constraints and financial development on prices even after controlling for three different measures of input quality. Moreover, it is very unlikely that one can perfectly control for input quality in the empirical investigation.

5. Robustness

In addition to the estimation results in previous tables, we test a number of other specifications that yield substantively the same patterns of the positive relation between productivity and export prices as well as the positive impact of financial development and negative impact of credit constraints on prices.

In the main tables we report the results based on the measures of credit constraints constructed by US firm data as they represent technological characteristics across industries which are inherent by the nature of manufacturing process. In the robustness checks, we construct the key measurement of credit constraint-external finance dependence-using Chinese firm data and report regression results in Table 10. As discussed in Section 3.3.3., the ranking of industries using Chinese data is quite similar with the one from US data. Thus, we expect that the results based on the external finance dependence from Chinese data are also consistent with the predictions from the heterogeneous-quality model: the coefficients on productivity and financial development are significantly positive; while the coefficients on credit constraints are significantly negative. The results in Table 10 indeed confirm those predictions.

Furthermore, the results reported in main tables are estimated using ordinary trade data as we believe firms doing processing trade behave differently in their exporting behavior. In our sample, ordinary trade accounts for more than 73% of total transactions. Thus the results based on ordinary trade in fact reflect the general situation in our sample. In another robustness check, we include processing trade data and find that all predictions from the heterogeneous-quality model remain significantly valid except for the sign of coefficient on the firm-ownership dummy variable MNC now becomes negative (see Table 11). This is because many Hong Kong or Taiwan invested firms are viewed as multinational companies but they are in fact doing processing trade and thus behave differently compared with other multinational companies from OECD countries.

In addition, we also include material as input factor to compute TFP as a robustness check and find that the main results are preserved.

6. Conclusion

In this paper we build a tractable trade model of heterogenous firms to investigate the relation between firm productivity and unit value export prices, and the impacts of credit constraints and financial development on optimal prices. Our model departures from Melitz (2003) by introducing marketing costs, endogenous quality, and credit constraints. The way marketing costs are introduced here is different in form, but same in spirit, compared to that in Arkolakis (2010) to ensure that the effectiveness of advertising is subject to diminishing returns. Compared with Arkolakis (2010), we introduce endogenous quality of variety and credit constraints. The mechanism of quality is key in our model. As firms endogenously choose input quality to produce goods according to their productivity and credit constraints, the more productive firms tend to choose higher-quality inputs, which is called quality effect. This quality effect dominates the adjustment of marginal cost (i.e., higher productivity yields lower marginal cost) and therefore more productive firms charge higher export prices. It is also because the quality effect dominates the misallocation between fixed and variable costs, optimal prices increase in credit access and decrease in credit constraints, i.e., firms charge lower prices when facing more binding credit constraints or less credit access. However, if quality was homogeneous across firms, exactly opposite effects would have occurred, i.e., optimal prices decrease in productivity and credit access while firms charge higher prices when facing more binding credit constraints.

We use different types of bank loans and firm ownership to proxy for different levels of credit access and employ external finance dependence, R&D intensity, inventory-to-sales ratio, and asset tangibility to proxy for credit constraints to test whether the heterogeneous-quality model or the homogeneous-quality model yields more sensible predictions which are consistent with the reality. Our empirical results show that all predictions from the heterogeneous-quality model are confirmed at 0.001 significant level, implying that the heterogeneous-quality model prevails.

The main contribution of this paper is to offer both theoretical explanation and empirical evidence on the novel finding of the impacts of credit constraints and financial development on export prices set by firms. Though the studies of the role of credit constraints in international trade have expanded significantly in recent years, the examination of effects of credit constraints on firms' optimal prices has not been well conducted to the best of our knowledge. Via the new angle of prices, our paper contributes to the emerging literature of credit constraints and trade by linking credit constraints directly with firm attributes such as productivity and optimal pricing rules. Our paper also contributes to the vast quality-and-trade literature and confirms the prevalence of the heterogeneous-quality model in reality by highlighting the mechanism of quality through both theoretical model and empirical investigation.

There are also some limitations. One concern is that, similar to the previous studies of credit constraints, we aggregate credit constraints at 2-digit industry level, without taking into account the distribution effects of credit constraints within an industry. As Chaney (2005) indicates that the intra-industry distribution of liquidity constraints may impact exports. It is reasonable to suspect the sizable impact of distribution of credit constraints on export prices as well as the relation between productivity and prices. A thorough analysis of this issue seems fruitful and is left for future research. Another limitation is that the current empirical findings and the theoretical propositions build upon exogenous credit constraints. If credit constraints are endogenously determined, some dynamic effects may emerge and thus affect the exit and entry of firms. In the current paper our database does not include nonexporting firms because the domestic price data are not available at firm-product level. If domestic price data are available, we shall be able to construct a model to analyze the difference between exporters and nonexporters in firm dynamics with respect to the impacts of credit constraints on prices. For this endeavor, it would be useful to acquire and construct firm- and product-level data on prices in domestic markets.

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A Proof of Proposition 5 (Quality is homogeneous)

When quality is homogeneous across firms, the optimization problem of a firm with productivity ϕ, financial development θ, and credit constraint d becomes:

$$\max_{p,a}\left(p-\frac{\tau}{\phi}\right)\frac{a^{\sigma-1}p^{-\sigma}}{P^{1-\sigma}}Y-f_x\frac{a^{1+\varepsilon}}{1+\varepsilon}-f_d \tag{14}$$

$$\text{s.t. }\theta\left(\left(p-(1-d)\frac{\tau}{\phi}\right)\frac{a^{\sigma-1}p^{-\sigma}}{P^{1-\sigma}}Y-(1-d)\left(f_x\frac{a^{1+\varepsilon}}{1+\varepsilon}+f_d\right)\right) \tag{15}$$

$$\geq d\left(\frac{\tau}{\phi}\frac{a^{\sigma-1}p^{-\sigma}}{P^{1-\sigma}}Y+f_x\frac{a^{1+\varepsilon}}{1+\varepsilon}+f_d\right)$$

Solving this optimization problem with respect to price p, and advertisement a yields:

$$p=\frac{\sigma}{\sigma-1}\left(1+d\frac{(1-\theta)\lambda}{\theta(1+\lambda)}\right)\frac{\tau}{\phi} \tag{16}$$

$$\frac{a^{\sigma-1}p^{1-\sigma}}{P^{1-\sigma}}Y=\frac{\sigma}{(\sigma-1)}\left(1+d\frac{(1-\theta)\lambda}{\theta(1+\lambda)}\right)f_xa^{1+\epsilon} \tag{17}$$

where λ is the Lagrangian multipliers associated with budget constraint condition (15). Next, we analyze this optimization problem in two cases.

Case A.1: The budget constraint (15) is binding.

According to the equations (16) and (17), we have:

$$\left(\frac{\sigma}{\sigma-1}\frac{\tau}{\phi}\right)^{1-\sigma}\frac{Y}{P^{1-\sigma}}=\frac{\sigma}{\sigma-1}\left(1+d\frac{(1-\theta)\lambda}{\theta(1+\lambda)}\right)^{\sigma}a^{(\sigma-1)\Theta} \tag{18}$$

where $1+\Theta\equiv\frac{1+\epsilon}{\sigma-1}$. The budget constraint (15), together with the equations (16) and (17), implies:

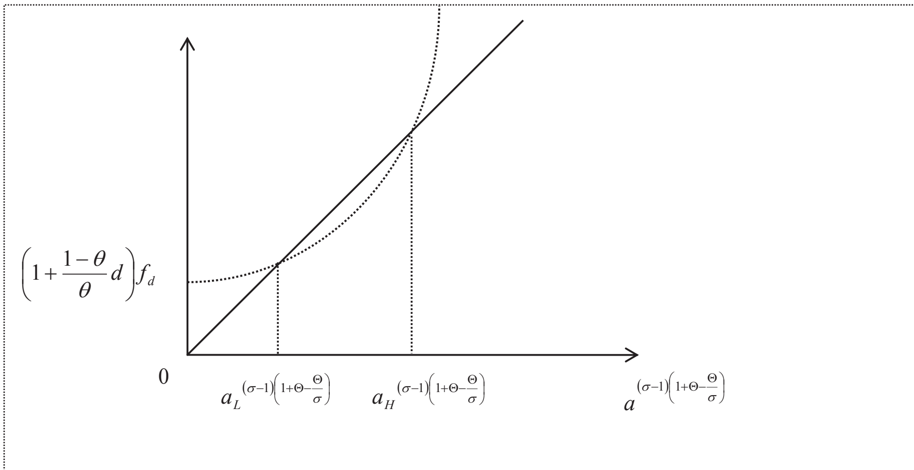
$$\frac{\sigma}{(\sigma-1)}\left(1+d\frac{(1-\theta)\lambda}{\theta(1+\lambda)}\right)f_xa^{(\sigma-1)(1+\Theta)}\geq\left(1-d+\frac{d}{\theta}\right)\left(f_xa^{(\sigma-1)(1+\Theta)}+f_x\frac{a^{(\sigma-1)(1+\Theta)}}{(\sigma-1)(1+\Theta)}+f_d\right) \tag{19}$$

Hence, the previous two equations (18) and (19) yield

$$\left(\frac{\tau}{\phi}\right)^{\frac{1-\sigma}{\sigma}}\left(\frac{Y}{P^{1-\sigma}}\right)^{\frac{1}{\sigma}}a^{(\sigma-1)\left(1+\Theta-\frac{\Theta}{\sigma}\right)}\geq\left(1-d+\frac{d}{\theta}\right)\left(\frac{\sigma+\sigma\Theta-\Theta}{(\sigma-1)(1+\Theta)}f_xa^{(\sigma-1)(1+\Theta)}+f_d\right) \tag{20}$$

This equation implies that the budget constraint (15) holds only in the zone $a\in[a_L,a_H]$ as shown in Figure 2. If **the first-best solution** does not belong in this zone, then budget constraint is bind-

Figure 2: When quality is homogeneous



ing. Now, firm's profit satisfies:

$$\left(p-\frac{\tau}{\phi}\right)\frac{a^{\sigma-1}p^{-\sigma}}{P^{1-\sigma}}Y-f_x\frac{a^{1+\varepsilon}}{1+\varepsilon}-f_d=\frac{1-\theta}{\theta}d\left(\frac{\tau}{\phi}\frac{a^{\sigma-1}p^{-\sigma}}{P^{1-\sigma}}Y+f_x\frac{a^{(\sigma-1)(1+\Theta)}}{(\sigma-1)(1+\Theta)}+f_d\right)$$
$$=\frac{1-\theta}{\theta}d\left(f_x a^{(\sigma-1)(1+\Theta)}+f_x\frac{a^{(\sigma-1)(1+\Theta)}}{(\sigma-1)(1+\Theta)}+f_d\right)$$

Then firms will choose their second-best solution a_H in order to maximize their profit. We use Figure 2 to illustrate: In Figure 2, the horizontal axis denotes $a^{(\sigma-1)\left(1+\Theta-\frac{\Theta}{\sigma}\right)}$ and the vertical axis denotes any multiplicative scale of $a^{(\sigma-1)\left(1+\Theta-\frac{\Theta}{\sigma}\right)}$. The dotted curve represents the right-hand-side of the inequality (20) with intercept $\left(1+\frac{1-\theta}{\theta}\right)f_d$. The solid line represents the left-hand-side of the inequality (20). As shown in Figure 2, given firm's productivity ϕ, the dotted curve in Figure 2 will shift upward as credit constraint d increases or financial development θ decreases. As a result, the optimal demand shifter induced by advertisement will decline. Meanwhile, the optimal price distorted by $1+d\frac{(1-\theta)\lambda}{\theta(1+\lambda)}$ rises according to the equation (18). Therefore, more binding credit constraint (i.e., a higher d) or less credit access (i.e., a lower θ) leads to higher prices when quality is homogeneous. Given credit access θ and credit constraint d, the solid line in Figure 2 will shift upward when the productivity ϕ increases. This yields a higher a_H, which implies the distortion $1+d\frac{(1-\theta)\lambda}{\theta(1+\lambda)}$ decreases according to the equation (19). Hence, the optimal price will decrease in productivity according to the pricing rule (16).

Case A.2: The budget constraint (15) is unbinding. There is no distortion caused by credit constraint in the price setting and the optimal pricing rule is given by $p=\frac{\sigma}{\sigma-1}\frac{\tau}{\phi}$. Hence, the optimal price is unrelated with credit constraint and decreases in productivity. QED.

B Proof of Proposition 6 (Only fixed costs are financed by outside capital)

B1. Under heterogeneous quality

Now, the optimization problem of a firm with productivity ϕ, financial development θ, and credit constraint d becomes:

$$\max_{p,q,a}\left(p-\frac{\tau q^{\alpha}}{\phi}\right)(qa)^{\sigma-1}\frac{p^{-\sigma}}{P^{1-\sigma}}Y-f_x\frac{a^{1+\epsilon}}{1+\epsilon}-f_dq^{\beta} \tag{21}$$

$$\text{s.t. } \theta\left(\left(p-\frac{\tau q^{\alpha}}{\phi}\right)(qa)^{\sigma-1}\frac{p^{-\sigma}}{P^{1-\sigma}}Y-(1-d)\left(f_x\frac{a^{1+\epsilon}}{1+\epsilon}+f_dq^{\beta}\right)\right)\geq d\left(f_x\frac{a^{1+\epsilon}}{1+\epsilon}+f_dq^{\beta}\right) \tag{22}$$

Solving this optimization problem with respect to price p, quality q, and advertisement a yields

$$p=\frac{\sigma}{\sigma-1}\frac{\tau q^{\alpha}}{\phi} \tag{23}$$

$$(qa)^{\sigma-1}\frac{p^{1-\sigma}}{P^{1-\sigma}}Y=\frac{\sigma\beta}{(1-\alpha)(\sigma-1)}\left(1+d\frac{(1-\theta)\lambda}{\theta(1+\lambda)}\right)f_dq^{\beta} \tag{24}$$

$$(qa)^{\sigma-1}\frac{p^{1-\sigma}}{P^{1-\sigma}}Y=\frac{\sigma}{\sigma-1}\left(1+d\frac{(1-\theta)\lambda}{\theta(1+\lambda)}\right)f_xa^{1+\epsilon} \tag{25}$$

where λ is the Lagrangian multipliers associated with budget constraint (22). Then the equations (24) and (25) imply that the optimal volume of advertisement, a, is positively correlated with product quality, q.

$$q^{\beta}=\frac{(1-\alpha)}{\beta f_d}f_xa^{1+\epsilon} \tag{26}$$

The previous expression, together with the budget constraint (22) and the conditions (23) and (24), implies

$$\Lambda\left(1+d\frac{(1-\theta)\lambda}{1+\theta\lambda}\right)\geq\left(1-d+\frac{d}{\theta}\right)\left(\frac{\Lambda}{1+\Theta}+1\right)$$

Then we also analyze in two cases.

Case B.1: The budget constraint (22) is binding. Now, the equation (22), together with (23) and (26), implies:

$$\left(1-d+\frac{d}{\theta}\right)\left(\frac{\Lambda}{1+\Theta}+1\right)\sigma f_dq^{\frac{\Theta\beta}{1+\Theta}-(1-\alpha)(\sigma-1)}=\left(\frac{(\sigma-1)\Lambda f_d}{f_x}\right)^{\frac{1}{1+\Theta}}\left(\frac{\sigma}{\sigma-1}\frac{\tau}{\phi}\right)^{1-\sigma}\frac{Y}{P^{1-\sigma}} \tag{27}$$

Under the condition $\Theta\beta > (1-\alpha)(\sigma-1)(1+\Theta)$, there is positive correlation between firm productivity ϕ and quality q. Combining the equations (27) and (23), the optimal price in this case is given by:

$$p = \left(\frac{1}{\left(1-d+\frac{d}{\theta}\right)\left(\frac{\Lambda}{1+\Theta}+1\right)\sigma f_d} \right)^{\Psi} \left(\frac{(\sigma-1)\Lambda f_d}{f_x} \right)^{\frac{\Psi}{1+\Theta}} \left(\frac{\sigma}{\sigma-1}\frac{\tau}{\phi} \right)^{1+(1-\sigma)\Psi} \left(\frac{Y}{P^{1-\sigma}} \right)^{\Psi}$$

where $\Psi = \frac{\alpha(1+\Theta)}{\Theta\beta-(1-\alpha)(\sigma-1)(1+\Theta)}$. Under the two conditions: (1) $\Theta\beta > (1-\alpha)(\sigma-1)(1+\Theta)$; and (2) $(\sigma-1)(1+\Theta)-\Theta\beta > 0$, the optimal price increases in productivity. In addition, less credit access (i.e., a lower θ) or more binding credit constraint (i.e., a higher d) leads to lower prices.

Case B.2: The budget constraint (22) is unbinding. Based on the same derivation, the optimal pricing rule also satisfies:

$$p = (\sigma\Lambda f_d)^{-\Psi} \left(\frac{(\sigma-1)\Lambda f_d}{f_x} \right)^{\Psi/(1+\Theta)} \left(\frac{\sigma}{\sigma-1}\frac{\tau}{\phi} \right)^{1+(1-\sigma)\Psi} \left(\frac{Y}{P^{1-\sigma}} \right)^{\Psi}$$

Hence under the conditions (1) $\Theta\beta > (1-\alpha)(\sigma-1)(1+\Theta)$ and (2) $(\sigma-1)(1+\Theta)-\Theta\beta > 0$, the optimal price increases in productivity. However, the optimal price is unrelated to credit constraints and credit access.

B2. Under homogeneous quality

Then, the optimal price satisfies:

$$p = \frac{\sigma}{\sigma-1}\frac{\tau}{\phi}$$

Hence, the optimal price decreases in productivity. In addition, the optimal price is independent of credit constraints and credit access. QED.

C Appendix: Tables

Table 1: Total Factor Productivity of Chinese Plants (2000-2006)

Chinese Industrial Classification (2-digit code):	Labor coeff	Capital coeff
Processing of Food from Agricultural Products (13)	0..5136	0.2834
Manufacture of Foods (14)	0.5717	0.3562
Manufacture of Beverages (15)	0.5427	0.4335
Manufacture of Tobacco (16)	0.4559	0.6209
Manufacture of Textile (17)	0.4710	0.2279
Manufacture of Textile Wearing Apparel, Footware, and Caps (18)	0.5505	0.2313
Manufacture of Leather, Fur, Feather and Related Products(19)	0.4801	0.2476
Processing of Timber, Manufacture of Wood, Bamboo, Rattan, Palm, and Straw Products (20)	0.5021	0.2893
Manufacture of Furniture (21)	0.5871	0.1442
Manufacture of Paper and Paper Products (22)	0.4960	0.3371
Printing, Reproduction of Recording Media (23)	0.4939	0.2791
Manufacture of Articles For Culture, Education and Sport Activity (24)	0.5036	0.1299
Processing of Petroleum, Coking, Processing of Nuclear Fuel (25)	0.3238	0.4445
Manufacture of Raw Chemical Materials and Chemical Products (26)	0.3799	0.3485
Manufacture of Medicines (27)	0.5082	0.2284
Manufacture of Chemical Fibers(28)	0.5118	0.4046
Manufacture of Rubber (29)	0.4403	0.1651
Manufacture of Plastics (30)	0.4601	0.2859
Manufacture of Non-metallic Mineral Products (31)	0.4173	0.2873
Smelting and Pressing of Ferrous Metals (32)	0.5029	0.3298
Smelting and Pressing of Non-ferrous Metals (33)	0.4349	0.3244
Manufacture of Metal Products (34)	0.4443	0.3000
Manufacture of General Purpose Machinery (35)	0.4686	0.3035
Manufacture of Special Purpose Machinery (36)	0.4949	0.3610
Manufacture of Transport Equipment (37)	0.5488	0.3269
Manufacture of Electrical Machinery and Equipment (39)	0.4873	0.3097
Manufacture of Communication Equipment, Computers and Other Electronic Equipment (40)	0.5327	0.2537
Manufacture of Measuring Instruments and Machinery for Cultural Activity and Office Work (41)	0.4310	0.2347
Manufacture of Artwork and Other Manufacturing (42)	0.4649	0.2000

Table 2: External Finance Dependence: US v.s China

Industry Name (US)	ISIC	value	value	CIC	Industry Name (CHN)
Tobacco	314	-1.14	-2.59	35	General Purpose Machinery
Leather products	323	-0.95	-1.54	16	Tobacco
Footwear	324	-0.74	-1.34	41	Measuring Instruments and Machinery for Cultural Activity and Office Work
Printing and Publishing	342	-0.42	-1.32	18	Textile Wearing Apparel, Footware, and Caps
Pottery, china, earthenware	361	-0.41	-1.11	19	Leather, Fur, Feather and Related Products
Furniture	332	-0.38	-0.93	34	Metal Products
Paper products	341	-0.35	-0.8	23	Printing, Reproduction of Recording Media
Other chemical products	352	-0.3	-0.72	20	Processing of Timber, Manufacture of Wood, Bamboo, Rattan, Palm, and Straw Products
Non-metallic products	369	-0.29	-0.72	15	Beverages
Fabricated metal products	381	-0.25	-0.72	37	Transport Equipment
Apparel	322	-0.21	-0.65	21	Furniture
Industrial chemicals	3511	-0.19	-0.62	42	Artwork and Other Manufacturing
Food products	311	-0.15	-0.48	17	Textile
Non-ferrous metals	372	-0.12	-0.47	30	Plastics
Transport equipment	384	-0.08	-0.47	13	Processing of Food from Agricultural Products
Machinery, except electrical	382	-0.04	-0.44	27	Medicines
Petroleum refineries	353	-0.02	-0.44	39	Electrical Machinery and Equipment
Plastic products	356	-0.02	-0.41	28	Chemical Fibers
Rubber products	355	-0.02	-0.4	24	Articles For Culture, Education and Sport Activity
Textiles	321	0.01	-0.32	14	Foods
Beverages	313	0.03	-0.29	31	Non-metallic Mineral Products
Synthetic resins	3513	0.03	-0.27	36	Special Purpose Machinery
Glass products	362	0.03	-0.26	29	Rubber
Iron and steel	371	0.05	-0.23	26	Raw Chemical Materials and Chemical Products
Wood products	331	0.05	-0.1	33	Smelting and Pressing of Non-ferrous Metals
Petroleum and coal products	354	0.13	0.02	40	Communication Equipment, Computers and Other Electronic Equipment
Electrical machinery	383	0.24	0.07	22	Paper and Paper Products
Other manufactured products	390	0.28	0.33	32	Smelting and Pressing of Ferrous Metals
Professional and scientific equipment	385	0.72	0.62	25	Processing of Petroleum, Coking, Processing of Nuclear Fuel
	mean	-0.16	-0.57	mean	

Table 3: External Finance Dependence: Export Price v.s Productivity

Regressor:	(1)	(2)	(3)	(4)	(5)
log(TFP)	0.057 ***	0.054 ***	0.056 ***	0.022 ***	0.064 ***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Labor)	0.025 ***	0.022 ***	0.024 ***	-0.019 ***	0.020 ***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Capital/Labor)	0.044 ***	0.045 ***	0.046 ***	0.019 ***	0.058 ***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Wage)	0.251 ***	0.277 ***	0.244 ***	0.169 ***	0.286 ***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.002)
ExtFin	-2.985 ***	-3.007 ***	-2.963 ***	-3.008 ***	-3.023 ***
	(0.028)	(0.028)	(0.028)	(0.054)	(0.038)
All Credits to GDP Ratio	0.299 ***				
	(0.003)				
Short-term Loans to GDP Ratio		0.374 ***			
		(0.007)			
Long-term Loans to GDP Ratio			0.558 ***		
			(0.005)		
SOE				0.286 ***	
				(0.007)	
MNC					0.017 ***
					(0.002)
Year fixed effects	yes	yes	yes	yes	yes
Destination fixed effects	yes	yes	yes	yes	yes
Product fixed effects	yes	yes	yes	yes	yes
constant	yes	yes	yes	yes	yes
Observations	2670022	2670022	2670022	656343	1532337
Adjusted R^2	0.538	0.537	0.538	0.586	0.501

Notes: Standard errors in parentheses. $^{*}p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: RD Intensity: Export Price v.s Productivity

Regressor:	(1)	(2)	(3)	(4)	(5)
log(TFP)	0.056 ***	0.054 ***	0.056 ***	0.021 ***	0.064 ***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Labor)	0.025 ***	0.022 ***	0.024 ***	-0.019 ***	0.020 ***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Capital/Labor)	0.044 ***	0.045 ***	0.045 ***	0.018 ***	0.058 ***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Wage)	0.251 ***	0.278 ***	0.244 ***	0.169 ***	0.286 ***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.002)
RD	-25.55 ***	-25.73 ***	-25.40 ***	-25.33 ***	-25.12 ***
	(0.451)	(0.451)	(0.451)	(0.844)	(0.637)
All Credits to GDP Ratio	0.299***				
	(0.003)				
Short-term Loans to GDP Ratio		0.366***			
		(0.007)			
Long-term Loans to GDP Ratio			0.561***		
			(0.005)		
SOE				0.285***	
				(0.007)	
MNC					0.017***
					(0.002)
Year fixed effects	yes	yes	yes	yes	yes
Destination fixed effects	yes	yes	yes	yes	yes
Product fixed effects	yes	yes	yes	yes	yes
constant	yes	yes	yes	yes	yes
Observations	2670022	2670022	2670022	656343	1532337
Adjusted R^2	0.537	0.535	0.537	0.585	0.500

Notes: Standard errors in parentheses. $^{*}p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$

Table 5: Inventory Ratio: Export Price v.s Productivity

Regressor:	(1)	(2)	(3)	(4)	(5)
log(TFP)	0.058 ***	0.055 ***	0.057 ***	0.023 ***	0.064 ***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Labor)	0.025 ***	0.022 ***	0.024 ***	-0.020 ***	0.020 ***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Capital/Labor)	0.044 ***	0.045 ***	0.045 ***	0.018 ***	0.058 ***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Wage)	0.251 ***	0.277 ***	0.244 ***	0.167 ***	0.285 ***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.002)
Invent	-15.76 ***	-15.91 ***	-15.69 ***	-20.48 ***	-14.55 ***
	(0.223)	(0.223)	(0.223)	(0.492)	(0.266)
all credits to GDP Ratio	0.298 ***				
	(0.003)				
Short-term Loans to GDP Ratio		0.368 ***			
		(0.007)			
Long-term Loans to GDP Ratio			0.560 ***		
			(0.005)		
SOE				0.288 ***	
				(0.007)	
MNC					0.016 ***
					(0.002)
Year fixed effects	yes	yes	yes	yes	yes
Destination fixed effects	yes	yes	yes	yes	yes
Product fixed effects	yes	yes	yes	yes	yes
constant	yes	yes	yes	yes	yes
Observations	2670022	2670022	2670022	656343	1532337
Adjusted R^2	0.537	0.536	0.537	0.585	0.499

Notes: Standard errors in parentheses. $^{*}p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Asset Tangibility: Export Price v.s Productivity

Regressor:	(1)	(2)	(3)	(4)	(5)
log(TFP)	0.057 ***	0.055 ***	0.056 ***	0.022 ***	0.064 ***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Labor)	0.025 ***	0.022 ***	0.024 ***	-0.019 ***	0.020 ***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Capital/Labor)	0.044 ***	0.045 ***	0.046 ***	0.019 ***	0.058 ***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Wage)	0.252 ***	0.279 ***	0.245 ***	0.168 ***	0.287 ***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.002)
Tang	0.600 ***	0.643 ***	0.567 ***	0.253	0.715 ***
	(0.064)	(0.064)	(0.063)	(0.139)	(0.077)
All Credits to GDP Ratio	0.299***				
	(0.003)				
Short-term Loans to GDP Ratio		0.366***			
		(0.007)			
Long-term Loans to GDP Ratio			0.562***		
			(0.005)		
SOE				0.288***	
				(0.007)	
MNC					0.017***
					(0.002)
Year fixed effects	yes	yes	yes	yes	yes
Destination fixed effects	yes	yes	yes	yes	yes
Product fixed effects	yes	yes	yes	yes	yes
constant	yes	yes	yes	yes	yes
Observations	2670022	2670022	2670022	656343	1532337
Adjusted R^2	0.536	0.535	0.537	0.584	0.498

Notes: Standard errors in parentheses. $^{*}p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: Mechanism of Quality: Export Price v.s Productivity (w.r.t. ExtFin and RD)

Regressor:	(1)	(2)	(3)	(4)	(5)	(6)
log(TFP)	0.103^{***}	0.106^{***}	0.100^{***}	0.102^{***}	0.106^{***}	0.099^{***}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
log(Labor)	0.017^{***}	0.013^{***}	0.016^{***}	0.017^{***}	0.013^{***}	0.016^{***}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
log(Capital/Labor)	0.074^{***}	0.079^{***}	0.075^{***}	0.073^{***}	0.078^{***}	0.074^{***}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ExtFin	-3.011^{***}	-3.056^{***}	-2.982^{***}			
	(0.028)	(0.029)	(0.028)			
RD				-26.12^{***}	-26.45^{***}	-25.91^{***}
				(0.452)	(0.453)	(0.452)
All Credits to GDP Ratio	0.393^{***}			0.393^{***}		
	(0.003)			(0.003)		
Short-term Loans to GDP Ratio		0.552^{***}			0.544^{***}	
		(0.007)			(0.007)	
Long-term Loans to GDP Ratio			0.716^{***}			0.719^{***}
			(0.005)			(0.005)
Year fixed effects	yes	yes	yes	yes	yes	yes
Destination fixed effects	yes	yes	yes	yes	yes	yes
Product fixed effects	yes	yes	yes	yes	yes	yes
constant	yes	yes	yes	yes	yes	yes
Observations	2670022	2670022	2670022	2670022	2670022	2670022
Adjusted R^2	0.534	0.532	0.535	0.533	0.531	0.534

Notes: Standard errors in parentheses. $^{*}p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: Mechanism of Quality: Export Price v.s Productivity (w.r.t. Invent and Tang)

Regressor:	(1)	(2)	(3)	(4)	(5)	(6)
log(TFP)	0.103***	0.107***	0.100***	0.103***	0.107***	0.100***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
log(Labor)	0.017***	0.012***	0.016***	0.017***	0.013***	0.016***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
log(Capital/Labor)	0.073***	0.078***	0.074***	0.073***	0.078***	0.075***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Invent	-16.08***	-16.32***	-15.97***			
	(0.224)	(0.224)	(0.224)			
Tang				0.724***	0.803***	0.678***
				(0.064)	(0.064)	(0.064)
All Credits to GDP Ratio	0.393***			0.394***		
	(0.003)			(0.003)		
Short-term Loans to GDP Ratio		0.546***			0.545***	
		(0.007)			(0.007)	
Long-term Loans to GDP Ratio			0.718***			0.721***
			(0.005)			(0.005)
Year fixed effects	yes	yes	yes	yes	yes	yes
Destination fixed effects	yes	yes	yes	yes	yes	yes
Product fixed effects	yes	yes	yes	yes	yes	yes
constant	yes	yes	yes	yes	yes	yes
Observations	2670022	2670022	2670022	2670022	2670022	2670022
Adjusted R^2	0.533	0.531	0.534	0.532	0.530	0.533

Notes: Standard errors in parentheses. $^{*}p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 9: Mechanism of Quality: Export Price v.s Productivity (with Imported Inputs)

Regressor:	(1)	(2)	(3)	(4)	(5)	(6)
log(TFP)	0.043^{***}	0.040^{***}	0.043^{***}	0.081^{***}	0.079^{***}	0.080^{***}
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
log(Labor)	0.022^{***}	0.020^{***}	0.021^{***}	0.007^{**}	0.010^{***}	0.007^{**}
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
log(Capital/Labor)	0.020^{***}	0.019^{***}	0.022^{***}	0.034^{***}	0.034^{***}	0.036^{***}
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
log(Wage)	0.211^{***}	0.230^{***}	0.208^{***}	0.295^{***}	0.320^{***}	0.288^{***}
	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)
log(Import Price)	0.055^{***}	0.055^{***}	0.055^{***}			
	(0.001)	(0.001)	(0.001)			
Share of College Workers	1.214^{***}	1.252^{***}	1.194^{***}			
	(0.020)	(0.020)	(0.020)			
ExtFin	-3.234^{***}	-3.249^{***}	-3.223^{***}	-3.376^{***}	-3.394^{***}	-3.360^{***}
	(0.093)	(0.093)	(0.093)	(0.094)	(0.094)	(0.094)
All Credits to GDP Ratio	0.234^{***}			0.265^{***}		
	(0.008)			(0.008)		
Short-term Loans to GDP Ratio		0.368^{***}			0.371^{***}	
		(0.021)			(0.021)	
Long-term Loans to GDP Ratio			0.415^{***}			0.486^{***}
			(0.014)			(0.014)
Year fixed effects	yes	yes	yes	yes	yes	yes
Destination fixed effects	yes	yes	yes	yes	yes	yes
Product fixed effects	yes	yes	yes	yes	yes	yes
constant	yes	yes	yes	yes	yes	yes
Observations	341939	341939	341939	341939	341939	341939
Adjusted R^2	0.542	0.542	0.542	0.533	0.532	0.534

Notes: Standard errors in parentheses. $^{*}p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10: Robustness: Export Price v.s Productivity (ExtFin Constructed by Chinese Data)

Regressor:	(1)	(2)	(3)	(4)	(5)
log(TFP)	0.058 ***	0.055 ***	0.056 ***	0.022 ***	0.064***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Labor)	0.025***	0.023 ***	0.025 ***	-0.019 ***	0.020 ***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Capital/Labor)	0.044 ***	0.045 ***	0.046 ***	0.019 ***	0.058 ***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Wage)	0.252 ***	0.279 ***	0.245 ***	0.168 ***	0.287 ***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.002)
ExtFin	-0.028 ***	-0.028 ***	-0.030 ***	-0.030 ***	-0.027***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
All Credits to GDP Ratio	0.299***				
	(0.003)				
Short-term Loans to GDP Ratio		0.362***			
		(0.007)			
Long-term Loans to GDP Ratio			0.562***		
			(0.005)		
SOE				0.290***	
				(0.007)	
MNC					0.017***
					(0.002)
Year fixed effects	yes	yes	yes	yes	yes
Destination fixed effects	yes	yes	yes	yes	yes
Product fixed effects	yes	yes	yes	yes	yes
constant	yes	yes	yes	yes	yes
Observations	2670022	2670022	2670022	656343	1532337
Adjusted R^2	0.536	0.535	0.537	0.584	0.498

Notes: Standard errors in parentheses. $^{*}p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11: Robustness: Export Price v.s Productivity (with Processing Trade)

Regressor:	(1)	(2)	(3)	(4)	(5)
log(TFP)	0.082 ***	0.080 ***	0.082 ***	0.026 ***	0.091 ***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Labor)	0.045 ***	0.046 ***	0.043 ***	-0.012 ***	0.051 ***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Capital/Labor)	0.066 ***	0.066 ***	0.068 ***	0.024 ***	0.090 ***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
log(Wage)	0.298 ***	0.320 ***	0.294 ***	0.186 ***	0.350 ***
	(0.001)	(0.001)	(0.001)	(0.004)	(0.002)
ExtFin	-2.700 ***	-2.728 ***	-2.683 ***	-2.994 ***	-2.611 ***
	(0.024)	(0.024)	(0.024)	(0.053)	(0.030)
All Credits to GDP Ratio	0.345***				
	(0.003)				
Short-term Loans to GDP Ratio		0.631***			
		(0.006)			
Long-term Loans to GDP Ratio			0.593***		
			(0.004)		
SOE				0.271***	
				(0.006)	
MNC					-0.050***
					(0.002)
Year fixed effects	yes	yes	yes	yes	yes
Destination fixed effects	yes	yes	yes	yes	yes
Product fixed effects	yes	yes	yes	yes	yes
constant	yes	yes	yes	yes	yes
Observations	3857020	3857020	3857020	712838	2603900
Adjusted R^2	0.530	0.529	0.530	0.594	0.500

Notes: Standard errors in parentheses. $^{*}p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$