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JEL: F10, F36, F61, L11
Keywords: Credit constraints, General equilibrium, Globalization, Imperfect capital markets, Welfare

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Capital Market Imperfections and Trade Liberalization in General Equilibrium*

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December 1, 2015

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This paper develops a new international trade model with capital market imperfections and endogenous borrowing costs in general equilibrium. A key element of our model is that firm heterogeneity arises from the interaction of credit constraints at the firm-level with financial frictions at the country-level. Producers differ in pledgeability of sales which results in firm heterogeneity, if financial institutions are imperfect. We show that endogenous adjustments of capital costs represent a new channel that reduces common gains from globalization. Trade liberalization increases the borrowing rate, leads to a reallocation of market shares towards unconstrained producers and a larger fraction of credit-rationed firms. This increases the within-industry variance of sales and reduces welfare gains as consumers dislike price heterogeneity. Our theory is consistent with new empirical patterns from World Bank firm-level data. We highlight that credit frictions are positively related to the degree of product market competition, and to the variance of sales across firms.

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1 Introduction

International activity of firms usually depends on access to external capital. Credit from outside investors is used to finance production costs, machinery, the purchase of material inputs, and up-front investments. Empirical studies show that access to external capital and financial development are important determinants of trade activity. Countries with better-developed financial systems export relatively more in industries with higher dependence on external finance and lower asset tangibility (Beck, 2003; Svaleryd & Vlachos, 2005; Manova, 2008, 2013). Existing theoretical work builds on the interaction of credit constraints at the industry- or country-level with ex-ante firm heterogeneity à la Melitz (2003), and shows negative effects of credit frictions on trade flows (Manova, 2013; Chaney, 2013).[1] These models typically focus on partial equilibrium and do not consider welfare implications.

The purpose of this paper is to analyze the effects of globalization on firm performance and welfare, when producers differ in their exposure to financial frictions and borrowing costs are endogenous. A novel feature of this model is that firm heterogeneity results from the interaction between capital market imperfections at the country-level and credit constraints at the firm-level. Producers require external capital to cover production costs and differ in their incentive to divert external funds, while being homogenous in other respects. This firm-specific moral hazard problem reduces the pledgeability of sales and causes credit-rationing for some producers. Firm heterogeneity arises if financial institutions are imperfect, as only a fraction of firms can overcome credit frictions and behaves optimally. Producers with high incentives to misbehave face credit-rationing and have to restrict production. Hence, the share of financially constrained firms is endogenous in our model.

As a second departure from previous theoretical work, we explicitly model a capital market equilibrium which determines the interest rate.[2] We analyze the effects of globalization and show that adjustments of capital costs represent an additional channel which reduces common gains from trade. Trade liberalization increases the market size as well as competition through entry of foreign firms. A positive market size effect induces output expansion of all firms, raises capital demand, and thus leads to upward pressure on the interest rate. Higher borrowing costs, as well as stronger foreign competition, lead to a larger fraction of financially constrained producers. Hence, some initially unconstrained firms face credit-rationing and have to set higher prices. Furthermore, existing constrained producers are hurt more by higher capital costs, leading to a reallocation of profits towards unconstrained firms. These two adjustments increase the within-industry variance of prices in the economy. We

[1] See Foley & Manova (2014) for a review of the trade and finance literature.

[2] One exception is Foellmi & Oechslin (2010), which we discuss below.

consider the indirect utility associated with quadratic preferences as a welfare measure. As consumers dislike price heterogeneity, a higher within-industry variance represents a negative welfare channel of globalization.

To motivate our theoretical model, we exploit enterprise survey data from the World Bank and highlight three novel empirical patterns. First, we use the ratio of tangible assets over total assets as a proxy for access to external finance, and show that the majority of variation in this measure is across firms within industries rather than between industries. This pattern is consistent with empirical studies showing that financial health and access to external finance are important determinants of export and innovation activity, even after controlling for firm characteristics, such as size and productivity.[3] The high within-industry heterogeneity with respect to credit constraints motivates the analysis of firm-specific financial frictions in our theoretical model. Second, we show that in industries with a higher degree of competition, a larger fraction of firms is financially constrained. Third, more financially constrained industries and countries with lower financial development show a larger variance of firm sales and a higher share of credit-rationed producers.[4] All relationships hold after controlling for firm characteristics such as productivity or size.

Our theoretical model provides a rationale for these patterns. A higher degree of competition captures that consumers react more sensitive to price increases. This competition effect reduces firm sales and thus the pledgeable income, such that more producers become financially constrained. Lower financial development corresponds to weaker contract enforcement which results in stronger credit frictions. Hence, a larger fraction of producers faces financial constraints and firm-level differences in pledgeability translate into larger within-industry heterogeneity in sales.

This paper contributes to the growing literature on capital market imperfections in international trade. Theoretical work introduces credit frictions in trade models with heterogeneous firms.[5] This strand of literature differs regarding (i) the usage of external funds (e.g. trade related fixed or variable costs), (ii) the theoretical motivation of financial constraints (e.g. moral hazard, imperfect contractibility, information asymmetry), and (iii) the underlying preference structure (e.g. CES vs. linear demand). To the best of our knowledge, this model is the first to introduce firm-specific credit frictions based on moral hazard, which leads to heterogeneity with respect to firm performance in the absence of ex-ante

[3]See Berman & Héricourt (2010), Minetti & Zhu (2011), Gorodnichenko & Schnitzer (2013), and Muûls (2015), among others.

[4]The link between credit frictions and international trade is particularly relevant in developing countries where the quality of financial institutions is low (Banerjee & Duflo, 2005, 2014).

[5]See e.g. Muûls (2008), Manova (2013), and Chaney (2013) for extensions of the Melitz (2003) model by financial frictions. Peters & Schnitzer (2015) introduce borrowing constraints in the framework of Melitz & Ottaviano (2008).

productivity or wealth differences. Related to that, in Yeaple (2005), technology choice and different skill levels across workers generate firm heterogeneity among initially homogenous producers. In a dynamic model of trade and finance, Felbermayr & Spiegel (2014) introduce heterogeneity in default probabilities which results in firm-specific borrowing rates.

Existing work analyzes the effects of credit frictions on product markets in general equilibrium without explicitly modelling capital markets. One exception is Foellmi & Oechslin (2010), who also consider an endogenous interest rate determined by capital market clearing. However, the focus of their approach is a different one. In a model with CES preferences and heterogeneity in wealth, they analyze the distributive impact of trade liberalization in less-developed countries. The authors show that globalization impedes access to external finance, especially for poor entrepreneurs, resulting in an increase of income inequality in the economy. In our setting with linear demand, we can disentangle the market size from the competition effect and separately analyze their impacts on equilibrium outcomes. In contrast to a model with CES preferences, markups are endogenous and thus affected by pro-competitive effects of globalization. The advantage of our framework is its high tractability, which allows us to explicitly solve for all endogenous variables, and to conduct comparative static analysis with respect to financial development and globalization. Furthermore, we derive welfare and show how capital market adjustments alter the gains from trade. Another paper that analyzes the welfare implications of credit frictions is Formai (2013). In a general equilibrium framework based on Melitz (2003), she shows how credit frictions distort the entry decision of producers, whereas trade liberalization can lead to negative welfare effects.

In our framework, the crucial mechanism in general equilibrium is the endogenous adjustment of the interest rate after globalization. Therefore, our analysis is related to models that study how credit frictions affect international capital and trade flows. In a Heckscher-Ohlin model with heterogeneous financial frictions across countries and sectors, Antràs & Caballero (2009) show that trade integration increases the interest rate in financially underdeveloped countries. Whereas this result is driven by specialization and across-sector reallocation of inputs, in our model interest rate adjustments after globalization lead to within-sector reallocation of market shares between constrained and unconstrained firms.

The paper is structured as follows. The next section provides empirical motivation for our theoretical setup. Section 3 presents the theoretical model and discusses comparative statics in partial equilibrium. The following section introduces the capital market and discusses general equilibrium effects of globalization. Section 5 shows simulation results of the gains from globalization in both partial and general equilibrium. In section 6, we extend the model by free entry and show that the effects of globalization remain robust, and finally, section 7 concludes.

2 Empirical motivation

In this section, we present new empirical patterns by exploiting firm-level data from the World Bank. The empirical analysis is entirely descriptive and aims to motivate our theoretical framework. First, we show that a substantial fraction of the total variation in the exposure to financial constraints is across firms within industries rather than between industries. This pattern implies that credit frictions at the firm-level are important and that producers within the same industry face very different degrees of credit rationing. Second, a higher degree of competition is associated with a larger fraction of financially constrained firms. Third, more financially constrained industries and countries with lower financial development show a larger variance of firm sales and a higher share of credit-rationed producers. The first subsection describes the data set and variables used. The second subsection presents empirical patterns that motivate our theoretical model.

2.1 Data description

We use cross-sectional firm-level data from the World Bank Enterprise Surveys (WBES).[6] Following existing firm-level studies, the first part of the analysis uses the ratio of tangible assets over total assets (TOA) as a proxy for access to external finance. We measure tangible assets as land and buildings which reflects the availability of collateral and thus better access to credit.[7] We use this continuous proxy for credit access to investigate the variation in the exposure to financial constraints across firms within industries and between industries. Additionally, we are interested in the degree of product competition at the firm- as well as the industry-level. Therefore, we exploit a survey question which asks firms to assess the impact of a hypothetical price increase by 10% for their main product on own demand. The answers are captured by a categorical variable, whereas a value of 1 reflects that consumers are insensitive to the price increase (low competition), and a value of 4 means that customers would stop buying (high competition). We use variation of this variable at the firm-level and compute the industry mean. Furthermore, we compute the mean of tangible over total assets by industry and country and relate it to the variance in log sales across firms. Variables are reported in local currency units, which we convert it to 2005 U.S. dollars. For the first part of the empirical motivation, we exploit a cross-section for the period 2002-2005. As information on competition and tangible assets is not available for all countries, we restrict

[6] The database is available at http://www.enterprisesurveys.org.

[7] Other studies that use similar proxies for financial constraints are Greenaway *et al.* (2007), Berman & Héricourt (2010), and Goerg & Spaliara (2013), among others. For a survey of empirical studies using firm-level data see Wagner (2014). Results remain significant and robust if we include machinery and equipment in our proxy for tangible assets.

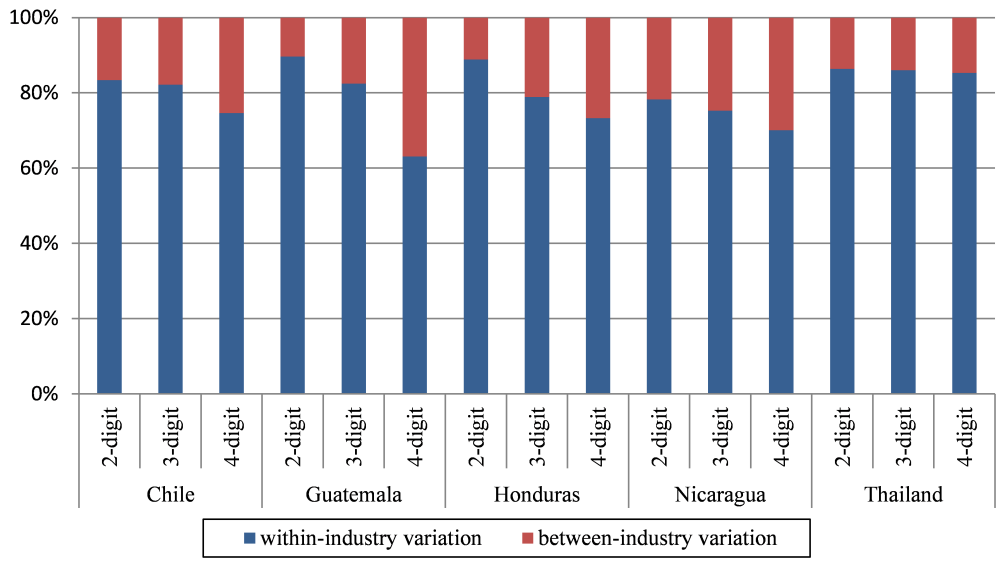

Figure 1: Within- and between-industry variation of tangible assets

our analysis to a subsample. Table 5 in Appendix 9.1 provides summary statistics of the variables of interest and shows the number of observations.

The second part of the empirical analysis further investigates the relationship between financial constraints and the variance of firm sales at the country-level. Therefore, we exploit cross-section data for the years 2009 and 2013 which is available for a larger set of countries.[8] We use domestic credit to the private sector in percentage of GDP as a proxy for financial development and relate it to the within-country variance of firm sales as well as the share of financially constrained producers by country.[9] To obtain the latter measure, we consider a survey question which asks firms to state whether access to financing (including availability and costs) is an obstacle to the current operations of the establishment. The categorical variable ranges from 0 (no obstacle) to 4 (very severe obstacle).[10] We introduce a dummy variable for financially constrained producers which takes the value of 1 if firms perceive access to financing as a major or very severe obstacle (values 3 and 4 of the categorical variable). We take means by country as a measure for credit constraints.

[8]See Table 5 in the Empirical Appendix for summary statistics, as well as Tables 7 and 8 for summary statistics by country.

[9]The data on financial development is taken from the World Development Indicators of the World Bank.

[10]Gorodnichenko & Schnitzer (2013) use self-reported information from the 2002 and 2005 Business Environment and Enterprise Performance Survey (BEEPS) for 27 transition countries to analyze the effect of credit constraints on innovation activity.

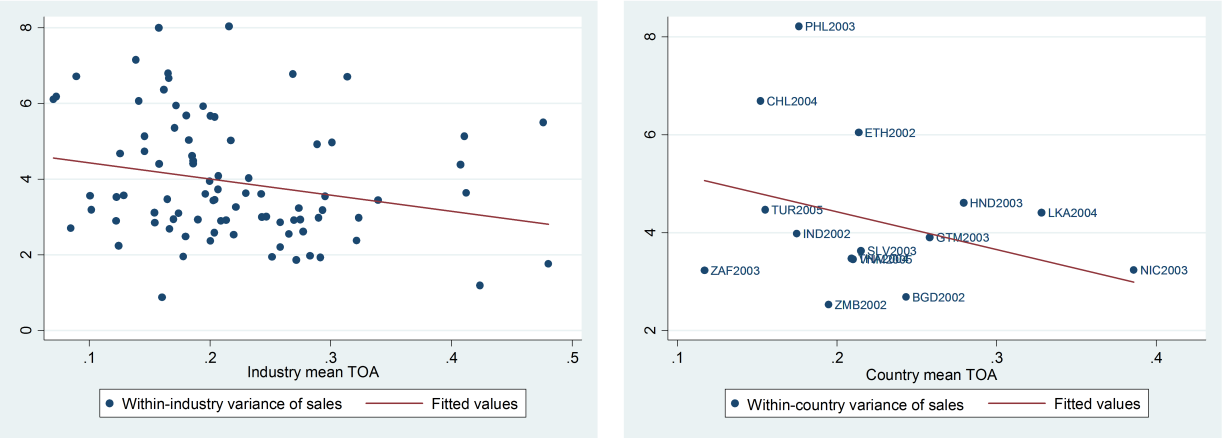

Figure 2: TOA and variance of sales within-industry (left) and within-country (right)

2.2 Empirical results

The first pattern decomposes the total variation in the measure for credit access (tangible over total assets) into within- and between-industry variation. The literature on international trade stresses the importance of firm heterogeneity. Hence, one concern could be that the within-industry variation is mainly driven by differences in firm characteristics such as size or productivity. To address this, we include a set of firm-level controls related to productivity, size, legal status and ownership structure. Figure 1 shows results for five countries at three levels of industry aggregation and reveals that a substantial part of the variation is within industries. The observed pattern suggests that producers within the same industry are affected very differently by credit constraints, even after controlling for other firm characteristics.[11]

Empirical pattern 1 *The majority of variation in financial constraints is across firms within industries rather than between industries.*

In the following, we relate measures of credit constraints at the industry- as well as the country-level to the degree of competition and to the variance of sales. To motivate the main features of our theoretical model, we focus on simple pairwise correlations in the main text. Empirical studies show that larger and more productive firms are less credit-constrained. Hence, a major concern is that the correlations are driven by firm characteristics. Therefore, we conduct a regression analysis in Appendix 9.2 and show that our results are robust when we include firm- and industry controls.

[11]The pattern holds for all countries with available data in our sample. Table 6 in Data Appendix 9.1 shows results for the full set of countries.

Furthermore, we relate the degree of competition to credit constraints. Table 1 shows the correlations both at the firm- as well as the industry-level. Firms that report more price-sensitive consumers face stronger credit-rationing. The positive relationship holds at the industry-level as well, whereas in industries with a higher degree of competition a larger fraction of producers is financially constrained.[12]

Table 1: Correlation credit constraints and competition

Degree of competition	Access to finance	Share constrained firms
Firm-level	0.0832***	
Industry-level		0.0586**
Obs.	27,474	1,590

Notes: *** indicates 1%, and ** 5% significance.

Empirical pattern 2 *Industries with a higher degree of product competition show a larger fraction of financially constrained firms.*

As a next step, we use the mean of the firm-level tangible assets over total assets ratio to compute a measure for credit access at the industry-level. We relate this proxy to the within-industry variation of firm sales. The left panel of Figure 2 depicts within-industry variances of firm-level sales, whereas the right panel shows results at the country-level. To compute the within-industry variances, we restrict our analysis to sectors with more than 25 firm observations. Figure 2 shows that industries with a higher ratio of tangible over total assets are characterized by a lower within-industry variance of firm sales. This relationship is significantly negative after controlling for industry effects and firm characteristics (see Table 10 in Appendix 9.2).

We use more recent cross-section data of the WBES for the years 2009 and 2013, which is available for a larger set of countries, to investigate the relationship between financial development and firm heterogeneity at the country-level. For the year 2009, the left panel of Figure 3 shows a significantly negative relationship between domestic credit provided to the private sector (in % of GDP) and the within-country variance of firm sales. Furthermore, the right panel depicts that higher financial development is associated with a lower share of financially constrained firms within a country. Table 2 summarizes the correlation coefficients for both years and further shows that the share of financially constrained producers is positively related to the variance of firm sales in a country.[13]

[12]Table 9 in Appendix 9.2 shows that the positive relationship between competition and credit constraints remains robust after controlling for firm characteristics, as well as year and country fixed effects.

[13]Tables 10 and 11 in Appendix 9.2 show that empirical pattern 3 still holds after controlling for firm

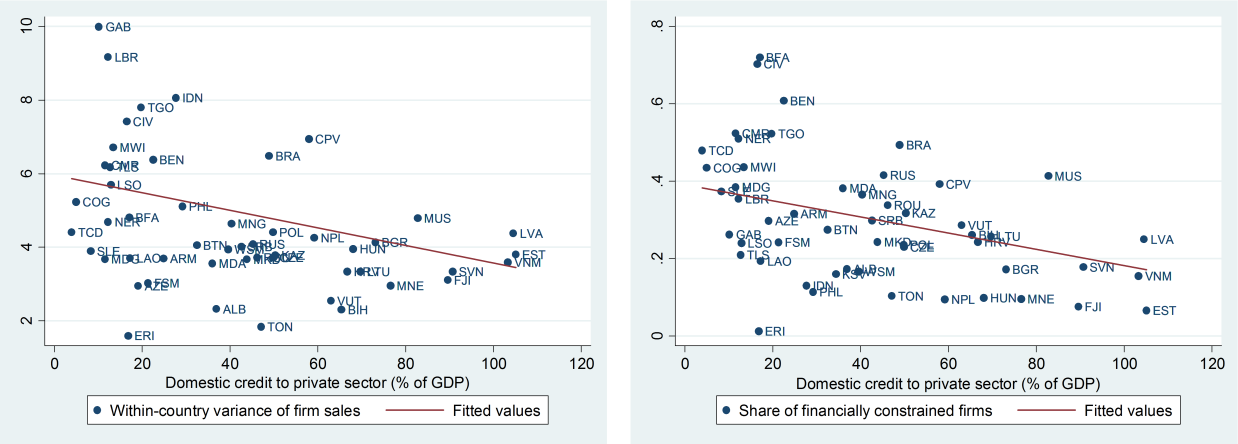

Figure 3: Financial development and within-country heterogeneity

Table 2: Correlation credit constraints and variance of firm performance

	Within-country variance sales		Share constrained firms	
	2009	2013	2009	2013
Private credit / GDP	-0.3884***	-0.4312***	-0.4683***	-0.2692*
Obs.	51	39	54	40
Share constrained firms	0.4539***	0.4051***		
Obs.	54	44		

Notes: *** indicates 1% significance, * 10% significance.

Empirical pattern 3 *More financially constrained industries and countries with lower financial development are characterized by a larger variance of firm sales, as well as a higher share of credit-rationed producers.*

Motivated by the first empirical pattern, the next section introduces a new international trade model with heterogeneity in credit frictions at the firm-level. Our theoretical framework provides a rationale for empirical patterns 2 and 3. Furthermore, we analyze how globalization induces differential effects across firms within industries in the presence of credit frictions. The next section presents the setup of the theoretical model.

characteristics and industry effects. For the year 2013, Figure 10 in Data Appendix 9.1 shows the relationship between financial development and within-country heterogeneity, whereas Figure 11 relates the share of financially constrained firms to the within-country variance of firm sales.

3 The model

This section develops a model of international trade with heterogeneity in credit frictions at the firm-level. The world economy consists of k identical countries, each of which is populated by a number of L consumers and an exogenous mass of m producers. We motivate financial frictions by a simple moral hazard problem between borrowing firms and external investors. The following subsection presents the demand side of the model, whereas we assume a quadratic specification of preferences and derive market demand by aggregating over the number of consumers in the economy. Section 3.2 shows how firms optimally behave in the presence of capital market imperfections depending on their exposure to financial frictions. The industry equilibrium, outlined in section 3.3, is determined by total industry output and an endogenous share of credit-rationed producers. Finally, in section 3.4, we analyze the effects of globalization and of an interest rate shock in partial equilibrium.

3.1 Consumer side

The representative consumer's utility is defined over per variety consumption $q(i)$ and total consumption $Q \equiv \int_{i\in\Omega} q(i)di$, where the index i represents one variety and Ω is the set of horizontally differentiated products:

$$U = aQ - \frac{1}{2}b\left[(1-e)\int_{i\in\Omega} q(i)^2 di + eQ^2\right]. \tag{1}$$

The quadratic utility function depends on the non-negative preference parameters a, b and on an inverse measure of product differentiation e which lies between 0 and 1. Lower values of e imply that products are more differentiated and hence less substitutable. If $e = 1$, consumers have no taste for diversity in products and demand depends on aggregate output Q only. Thus, the parameter e determines the degree of product market competition and is closely related to the competition variable in our empirical motivation. Consumers maximize utility in equation (1) subject to the budget constraint $\int_{i\in\Omega} p(i)q(i)di \leq I$, where $p(i)$ denotes the price for variety i and I is individual income.[14] The maximization problem yields the linear inverse demand function:

$$\lambda p(i) = a - b\left[(1-e)q(i) + eQ\right], \tag{2}$$

where λ is the marginal utility of income, the Lagrange multiplier attached to the budget constraint. As firms are infinitesimally small in the economy, they take λ as given. In the

[14] In general equilibrium, aggregate income consists of firm profits and factor income. We assume that capital is the only factor of production. Section 4 discusses the general equilibrium of the model.

following, we set the marginal utility of income as the numéraire equal to one.[15] To ensure market-clearing, total output of each firm equals the aggregate demand of all consumers in the world economy: $x(i) = kLq(i)$. Hence, the inverse world market demand is given by:

$$p(i) = a - b' \left[(1-e)x(i) + eX\right], \tag{3}$$

where a is the consumers' maximum willingness to pay and $b' \equiv \frac{b}{kL}$ is an inverse measure for the market size. Finally, $X \equiv \int_{i\in\Omega} x\left(i\right) di$ represents the total volume of varieties produced and consumed in the world economy.

3.2 Firm's maximization problem

The industry consists of an exogenous mass of m firms, each producing a horizontally differentiated variety i.[16] Firms receive revenues $p(i)x(i)$ and have to finance total variable production costs $cx(i)$ by external capital. There are no fixed costs of production. Motivated by empirical pattern 1 we assume that firms differ in their exposure to credit constraints. While producers are homogenous in marginal production costs c, the interaction of firm-level credit frictions and capital market imperfections creates firm heterogeneity. If financial institutions are imperfect, only a fraction of producers can overcome credit frictions, receives the required capital amount and is able to produce the optimal output. In contrast, firms with high exposure to credit constraints suffer from underprovision of external capital and cannot behave optimally. In equilibrium, the share of financially unconstrained firms is endogenously determined and affected by trade shocks. As we are interested in the effects of globalization on producers with different exposure to credit constraints, we do not consider endogenous entry and exit decisions. In the following, we describe the firm's maximization problem and introduce credit frictions at the firm- as well as the country-level.

The decision problem of a producer consists of two stages. At date $t = 0$, the firm borrows the credit amount $d(i)$ from an outside investor at the interest rate r. In partial equilibrium, the interest rate is treated as exogenous, whereas we endogenize it in general equilibrium as discussed in section 4. To motivate credit frictions at the firm-level, we introduce a managerial action which is non-verifiable for outside investors and hence prone to moral hazard.[17] After credit provision, the manager of the firm can choose whether to use

[15] Using the marginal utility of income as a numéraire ($\lambda = 1$) is standard in the literature of oligopoly in general equilibrium (GOLE). See Neary (2003) for further discussion.

[16] In section 6, we endogenize the number of firms by allowing for free entry and show that the qualitative implications of our model remain robust.

[17] See Holmstrom & Tirole (1997) as well as Tirole (2006) for moral hazard in corporate finance. Recent papers that introduce credit constraints motivated by moral hazard in a trade context are Ehrlich & Seidel (2013) and Egger & Keuschnigg (2015).

the external funds for production or divert the credit amount and invest it for own purposes. At date $t = 1$, production yields profits which consist of revenues net of loan repayment:

$$\pi(i) = p(i)x(i) - rd(i), \tag{4}$$

whereas the firm faces the following budget constraint:

$$d(i) \geq cx(i). \tag{5}$$

Alternatively, the manager can choose to divert the loan without using the provided capital in the production process. In this case, no revenues are realized and the loan cannot be repaid. Instead the manager reaps a share $\beta(i)\,(1-\phi)$ of the credit amount $d(i)$ and invests it on the capital market at interest rate r. Hence, the non-verifiable private benefit from managerial misbehavior at date $t = 1$ is equal to $rd(i)\beta(i)\,(1-\phi)$. This private benefit consists of a country-specific and a firm-level component. We follow Antràs *et al.* (2009) and assume that private benefits are negatively related to the quality of financial institutions captured by the parameter $\phi \in [0,1]$. Countries with better financial institutions (larger ϕ) tend to enforce laws that limit the ability of managers to divert funds or enjoy private benefits.[18]

In contrast to standard moral hazard approaches, we assume that producers are uniformly distributed at the unit interval and are heterogeneous in $\beta(i) \in [0,1]$, which we denote the agency costs of a firm i. A higher $\beta(i)$ increases the private benefit and thus the incentive for managerial misbehavior. This assumption introduces heterogeneity in credit constraints at the firm-level. The agency costs $\beta(i)$ can be interpreted in two ways. First, the parameter may capture differences in managerial incentives to divert external funds. This could be the case if managers attach different values to the misuse of loans. Second, a high $\beta(i)$ might reflect a larger scope for managerial misbehavior as investment projects are opaque or corporate control is weak. To prevent misbehavior of agents and thus losses from lending, investors have to ensure that the following incentive constraint holds:

$$\pi(i) \geq \beta(i)\,(1-\phi)\,rd(i). \tag{6}$$

At period $t = 1$, profits in case of production and loan repayment have to be (weakly) higher than private benefits in case of misbehavior. Rearranging equation (6) shows that moral hazard restricts the borrowing capacity:

[18] See Tirole (2006) as well as Antràs *et al.* (2009) for a similar notion of financial contract enforcement in models with moral hazard.

$$d(i) \leq \frac{p(i)x(i)}{r\left[1+\beta(i)\left(1-\phi\right)\right]}. \tag{7}$$

Firms with high agency costs $\beta(i)$ derive large private benefits from diverting the loan. Hence, investors restrict credit provision to prevent managerial misbehavior. If financial institutions are perfect ($\phi = 1$), managers have no incentives to misbehave and equation (6) collapses to a zero-profit condition. In this case, differences in agency costs $\beta(i)$ play no role and firms are homogenous. In contrast, if financial institutions are imperfect ($\phi < 1$), firm-specific moral hazard divides agents into two groups. First, producers with relatively low $\beta(i)$ choose the optimal output level as the financial constraint is not binding. Second, firms with higher agency costs face credit rationing and have to restrict production. To solve for outputs and prices, firms maximize profits (4) subject to the budget constraint (5) and the financial constraint (7).

Constrained firms For firms with high agency costs $\beta(i)$, the financial constraint is binding such that the constrained price equals the effective marginal production costs:

$$p_C\left(\beta\right) = cr\left[1+\beta(i)\left(1-\phi\right)\right]. \tag{8}$$

Producing one unit of the good yields the price $p_C\left(\beta\right)$ which has to compensate for the marginal production costs cr and the opportunity costs of diligent behavior $cr\beta(i)\left(1-\phi\right)$. The quantity of credit-rationed producers is given by:

$$x_C\left(\beta\right) = \frac{a - b'eX - cr\left[1+\beta(i)\left(1-\phi\right)\right]}{b'\left(1-e\right)}. \tag{9}$$

More financially constrained firms with a higher value of $\beta(i)$ face larger opportunity costs of production and have to set higher prices which results in lower outputs.

Unconstrained firms For unconstrained firms, the financial constraint is not binding such that optimal output is independent of $\beta(i)$:

$$x_U = \frac{a - b'eX - cr}{b'\left(2-e\right)}. \tag{10}$$

By inserting equation (10) into the inverse demand function (3), we derive the optimal price of unconstrained firms:

$$p_U = \frac{a - b'eX + \left(1-e\right)cr}{2-e}. \tag{11}$$

In our model, the only source of firm heterogeneity occurs in β. As optimal output (10) and prices (11) do not depend on β, all unconstrained producers behave in the same way. It can be shown that unconstrained firms charge lower prices and offer larger quantities compared to credit-rationed producers.

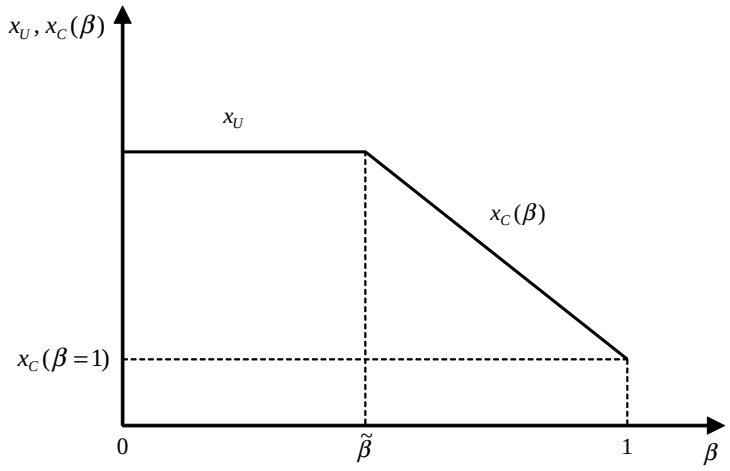

Figure 4: Output profile of constrained and unconstrained firms

3.3 Industry equilibrium

In equilibrium, we derive a critical value of agency costs $\widetilde{\beta}$ above which firms are financially constrained. We exploit that for the marginal unconstrained producer the financial constraint (6) is just binding and insert the optimal output from equation (10), which leads to:

$$\widetilde{\beta} = \frac{a - b'eX - cr}{(2-e)(1-\phi)cr}. \tag{12}$$

The share of financially constrained firms is given by $1-\widetilde{\beta}$, which corresponds to the fraction in empirical patterns 2 and 3. In a particular industry, a fraction $\widetilde{\beta}$ of firms is unconstrained and chooses the identical optimal output as shown in Figure 4. Following equation (9), output of constrained firms decreases in agency costs β. Consistent with our empirical motivation, the share of financially constrained firms depends on financial development and the degree of competition. We show that a higher degree of product market competition (larger e) reduces $\widetilde{\beta}$, conditional on industry characteristics:

$$\frac{\partial \widetilde{\beta}}{\partial e} = \frac{a - cr - 2b'X}{(1-\phi)(2-e)^2 cr} < 0. \tag{13}$$

Proposition 1 *The share of unconstrained firms $\widetilde{\beta}$ decreases in the degree of competition e.*
Proof. *Equation (13) is negative if $X > \frac{a-cr}{2b'}$. Exploiting expression (10) and rearranging yields $X > x_U$, which is always satisfied.* ■

The negative relationship between $\widetilde{\beta}$ and e corresponds to our empirical motivation. The survey question exploited in empirical pattern 2 captures the price sensitivity that a producer faces within an industry. A larger substitutability increases the degree of competition as consumers react more sensitive to an increase in prices. This is captured by the parameter e in our model. Consistent with empirical pattern 3, a higher quality of financial institutions ϕ reduces the fraction of credit-rationed producers. Furthermore, conditional on industry output X, the fraction of unconstrained producers decreases in credit costs cr.

To arrive at an output profile as depicted in Figure 4, we impose two conditions. First, to ensure that both groups of firms occur, the threshold value $\widetilde{\beta}$ has to be smaller than one.

Condition 1 $\widetilde{\beta} < 1$ *if* $\frac{a-b'eX}{cr} < 1 + (1-\phi)(2-e)$

Second, the output of the firm with the highest agency costs, $\beta(i) = 1$, has to be positive. Otherwise it would not be active in the market.

Condition 2 $x_C(\beta = 1) > 0$ *if* $\frac{a-b'eX}{cr} > 2 - \phi$

Inserting Condition 2 in equation (12) leads to a lower limit value for the share of unconstrained firms $\widetilde{\beta}_l = \frac{1}{2-e}$. To determine the industry equilibrium, average output $\widetilde{x}$ in the economy can be expressed as:

$$\widetilde{x} = \int_0^{\widetilde{\beta}} x_U di \; + \int_{\widetilde{\beta}}^1 x_C(\beta)\, di. \tag{14}$$

Inserting the optimal outputs (9) and (10) in equation (14) and aggregating leads to:

$$\widetilde{x} = \frac{\left(2 - e - \widetilde{\beta}\right) a - \left[2 - e - \widetilde{\beta} + (2-e)\left(1 - \widetilde{\beta}\right)\mu_c'(1-\phi)\right] cr}{b'\left((2-e)(1-e) + \left(2 - e - \widetilde{\beta}\right) ekm\right)}, \tag{15}$$

with $\mu_c' \equiv \frac{1}{1-\widetilde{\beta}} \int_{\widetilde{\beta}}^1 \beta(i)\, di$ being the average agency costs within the group of constrained producers. Figure 5 depicts the industry equilibrium. As the world economy consists of m producers in k countries, the aggregate output is given by: $X = km\widetilde{x}$. Equations (12) and (15) represent two relationships between the endogenous variables $\widetilde{\beta}$ and $\widetilde{x}$. The curve $Cutoff$: $\widetilde{\beta}(\widetilde{x})$ illustrates equation (12) and determines the fraction of financially constrained

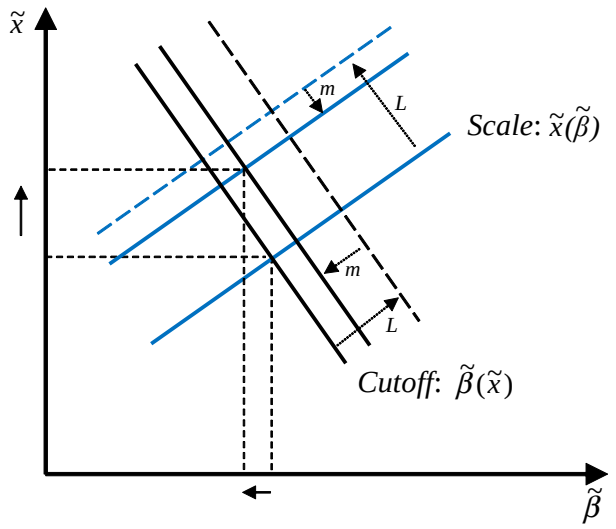

Figure 5: Industry equilibrium and trade liberalization

firms dependent on average industry output. Intuitively, the negative slope captures the fact that higher industry scale increases competition and forces more firms into the constrained status. The curve *Scale*: $\widetilde{x}\left(\widetilde{\beta}\right)$ is derived from equation (15) and reflects that with a higher critical value $\widetilde{\beta}$ more firms are unconstrained and thus choose optimal output levels. Hence, average industry scale increases. The intersection of the two curves in Figure 5 characterizes the industry equilibrium.

3.4 Comparative statics in partial equilibrium

The previous section has characterized the partial equilibrium in the economy. In a next step, we investigate how globalization and an exogenous change in the interest rate affect the industry. All results are derived by total differentiation of the two equilibrium conditions (12) and (15). See Appendix 8.1 for a detailed derivation. Furthermore, section 6 extends the model by free entry and endogenizes the number of producers.

Globalization Following Eckel & Neary (2010), we interpret globalization as an increase in the number of countries k in the integrated world economy. This shock affects optimal firm behavior through two channels. On the one hand, producers face a market size effect which corresponds to an increase in the number of consumers L. On the other hand, globalization is associated with increased competition from foreign firms. Therefore, this competition effect works like a rise in the number of producers m. To gain intuition for the effects of globalization, we analyze the two channels separately.

From equation (3), we observe that a larger market rotates the inverse world demand outwards without affecting the intercept. Thus, firms face a larger demand and raise output levels resulting in a one-to-one increase in industry scale. This market size effect is counteracted but not outweighed by tougher competition. Consequently, globalization increases average industry scale:

$$\frac{d\ln\widetilde{x}}{d\ln k}=\underbrace{1}_{\text{Market size effect}}-\underbrace{\frac{\left(2-e-\widetilde{\beta}\right)ekm}{(2-e)(1-e)+\left(2-e-\widetilde{\beta}\right)ekm}}_{\text{Competition effect}}>0. \tag{16}$$

The positive market size effects shifts the curve $Scale$: $\widetilde{x}\left(\widetilde{\beta}\right)$ upwards and the curve $Cutoff$: $\widetilde{\beta}\left(\widetilde{x}\right)$ outwards in Figure 5. A larger market increases the pledgeable income and thus relaxes the financial constraint (6). As Figure 5 shows, the change in market size does not affect the share of credit-rationed producers in equilibrium. However, the competition effect leads to a partial backward shift of the two curves. A greater number of competitors producing at a larger average scale $\widetilde{x}$ aggravates financial constraints and increases the share of credit-rationed firms:

$$\frac{d\ln\widetilde{\beta}}{d\ln k}=-\underbrace{\frac{(1-e)\,b'eX}{(1-\phi)\,cr\widetilde{\beta}\left[(2-e)(1-e)+\left(2-e-\widetilde{\beta}\right)ekm\right]}}_{\text{Competition effect}}<0. \tag{17}$$

Tougher competition reduces firm revenues and therefore pledgeable income as shown by equation (7). If goods are perfectly differentiated ($e=0$), the competition effect disappears and globalization leads to a one-to-one increase in output without affecting the share of financially constrained producers.

Proposition 2 *In partial equilibrium, globalization increases industry scale as the positive market size effect dominates the counteracting competition effect. The latter increases the share of financially constrained producers (lower $\widetilde{\beta}$).*

Borrowing costs In this section, we analyze the effects of an exogenous change in the interest rate r. An increase in the borrowing costs reduces average industry scale $\widetilde{x}$ and forces more producers into the constrained status:

$$\frac{d\ln\widetilde{x}}{d\ln r}<0\ ;\ \frac{d\ln\widetilde{\beta}}{d\ln r}<0. \tag{18}$$

Proposition 3 *In partial equilibrium, an exogenous increase in the borrowing rate leads to a higher share of financially constrained firms and reduces industry scale.*
Proof. *See Appendix 8.1.* ■

For both groups, an increase in the borrowing rate has a direct negative impact on firm outputs, whereby the effect is stronger for credit-rationed firms. By comparing equations (9) and (10), this can be explained by the agency problem which leads to higher effective marginal production costs for financially constrained producers. Whereas credit-rationed agents experience strong contraction, total differentiation of equation (10) shows a counteracting competition effect for unconstrained firms:[19]

$$\frac{d\ln x_U}{d\ln r} = -\frac{cr}{b'(2-e)\,x_U}\left(1+\frac{eb'X}{cr}\underbrace{\frac{d\ln\widetilde{x}}{d\ln r}}_{(-)}\right)\lessgtr 0. \tag{19}$$

Besides the direct negative impact of an increase in the interest rate, unconstrained producers optimally react to the reduction in industry scale by an increase of individual output. If varieties are perfectly differentiated ($e = 0$), the latter effect vanishes and unconstrained firms clearly reduce sales. However, the larger is the substitutability of goods, the more unconstrained firms benefit from reductions of rival firms' outputs.

4 General equilibrium

The partial equilibrium analysis is based on the assumption that the interest rate is exogenously given. This implies that capital supply is completely elastic. In the next subsection, we endogenize the interest rate by introducing a simple capital market with fixed supply. Our results can be interpreted as a short-run equilibrium as we abstract from endogenous entry and exit decisions of firms (see section 6 for an extension with free entry). Furthermore, we do not allow for adjustments of capital supply. After trade liberalization, the borrowing rate increases caused by higher capital demand. In the long-run, this effect might be counteracted by an increase in capital supply or capital market liberalization. In the following, we analyze how endogenous adjustments of borrowing costs affect the implications of globalization. Furthermore, we show the impact of financial development in general equilibrium.

[19] See Appendix 8.1 for an explicit derivation of the expression $\frac{d\ln\widetilde{x}}{d\ln r} < 0$.

4.1 Capital market clearing

Each firm has to cover variable production costs by external finance and hence demands $cx_j(i)$ units of capital, with $j \in C, U$. We assume that the economy is endowed with a fixed amount of capital K_S. In equilibrium, the inelastic supply of capital has to be equal to total capital demand K_D of m firms in a country:

$$K_S = K_D = cm\left(\int_0^{\widetilde{\beta}} x_U di + \int_{\widetilde{\beta}}^1 x_C(\beta)\, di\right) = cm\widetilde{x}. \tag{20}$$

By evaluating the equilibrium condition (20), we can explicitly solve for the interest rate:

$$r = \frac{\left(2-e-\widetilde{\beta}\right)a - b'\left((2-e)(1-e) + \left(2-e-\widetilde{\beta}\right)ekm\right)\frac{K_S}{cm}}{\left[2-e-\widetilde{\beta} + (2-e)\left(1-\widetilde{\beta}\right)\mu_c'(1-\phi)\right]c}. \tag{21}$$

We add equation (20) to the system of equations from the partial equilibrium analysis (12) and (15). In general equilibrium, profits and capital income determine the aggregate income of consumers I. A rise in the interest rate r has no effect on aggregate income as the resulting increase in capital income is exactly offset by a decrease in firm profits.

4.2 Comparative statics in general equilibrium

This section analyzes the effects of globalization and changes in financial development in general equilibrium. As capital market clearing pins down average industry scale $\widetilde{x}$, we express our equilibrium by two equations in the endogenous variables r and $\widetilde{\beta}$. The curve CUT: $\widetilde{\beta}(r)$ in Figure 6 combines capital market clearing (20) with the financial condition (12). Intuitively, the curve is downward sloping as a higher interest rate increases the share of financially constrained firms and thus reduces the cutoff value $\widetilde{\beta}$. The curve CME: $r\left(\widetilde{\beta}\right)$ is derived by inserting equation (20) into (15), and illustrates the relationship between r and $\widetilde{\beta}$ such that the capital market is in equilibrium. A higher share of unconstrained producers leads to an increase of average output and thus to higher capital demand. To ensure capital market clearing, the interest rate has to rise.[20]

Globalization In general equilibrium, the fixed capital amount determines average industry output. Therefore, in contrast to section 3.4, globalization (an increase in k) has no

[20] In section 6, we show that capital demand still increases after globalization with free entry.

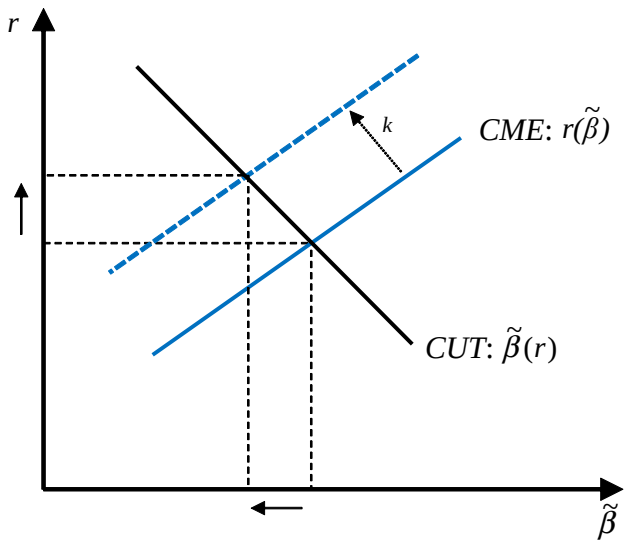

Figure 6: Globalization in general equilibrium

effect on industry scale:

$$\frac{d\ln\widetilde{x}}{d\ln k}=0. \tag{22}$$

Globalization leads to an upward shift of the curve CME: $r\left(\widetilde{\beta}\right)$ in Figure 6. For a given share of financially constrained firms, the dominating market size effect increases capital demand resulting in a higher interest rate:

$$\frac{d\ln r}{d\ln k}>0. \tag{23}$$

This result is based on the assumption of fixed capital supply. An increase in the interest rate occurs as long as capital supply K_S is not completely elastic and trade liberalization is not accompanied by large capital inflows. The curve CUT: $\widetilde{\beta}\,(r)$ is unaffected such that the new equilibrium is characterized by the intersection point with the new capital market clearing condition. Consequently, the share of financially constrained producers increases as higher borrowing costs impose stronger restrictions on the financial constraint:

$$\frac{d\ln\widetilde{\beta}}{d\ln k}<0. \tag{24}$$

Proposition 4 *In general equilibrium, globalization increases the interest rate and the share of financially constrained firms, but has no effect on industry scale.*

Proof. *See Appendix 8.2.* ■

Comparing equations (17) and (24) shows that globalization leads to a stronger increase in the share of financially constrained producers in general equilibrium (see Appendix 8.2 for a formal proof). This result is driven by the endogenous increase in borrowing costs which forces more firms into the constrained status. In contrast to partial equilibrium, the increase in the interest rate leads to different firm responses after globalization:

$$\frac{d\ln x_U}{d\ln k} = 1 - \frac{cr}{a - b'eX - cr}\frac{d\ln r}{d\ln k} > 0, \tag{25}$$

$$\frac{d\ln x_C(\beta)}{d\ln k} = 1 - \frac{[1+\beta(i)(1-\phi)]\,cr}{a - b'eX - cr\,[1+\beta(i)(1-\phi)]}\frac{d\ln r}{d\ln k} < 0. \tag{26}$$

The increase in the number of countries k affects optimal firm behavior in two opposing ways. As shown in partial equilibrium, the market size effect dominates the competition effect which induces firms to increase outputs. The endogenous adjustment of the interest rate in general equilibrium counteracts the positive impact of globalization. The latter effect especially hurts financially constrained producers with high agency costs $\beta(i)$ shown by the larger weight of the interest rate in equation (26) compared to unconstrained firms (25).

Proposition 5 *In general equilibrium, globalization leads to an output expansion among unconstrained firms, whereas financially constrained producers have to reduce output due to increased capital costs.*

Proof. *See Appendix 8.2.* ■

The expansion among unconstrained firms is illustrated in Figure 7 by an upward shift of the output profile. In contrast, credit-rationed producers suffer from increased capital costs and thus decrease output depending on their agency costs. As the most constrained firm with $\beta = 1$ faces the strongest output reduction, the constrained output profile rotates clockwise. The slope is given by $-\frac{cr(1-\phi)}{b'(1-e)}$ (compare equation (9)) and thus increases in the interest rate and the market size. The differential responses across the two groups of producers increase the variance of output and prices within the industry. This result will be crucial for the welfare consequences which we discuss in more detail in section 5. As average industry scale is unaffected due to fixed capital supply, the output gain of unconstrained firms (region A in Figure 7) offsets the contraction of financially constrained producers (region B).

Financial development An increase in ϕ reduces the incentives to reap private benefits and thus enhances the pledgeability of revenues. This shock can be interpreted as an improvement of financial contract enforcement. Comparable to trade liberalization, there is no effect on aggregate output due to fixed capital supply. However, an increase in ϕ relaxes the

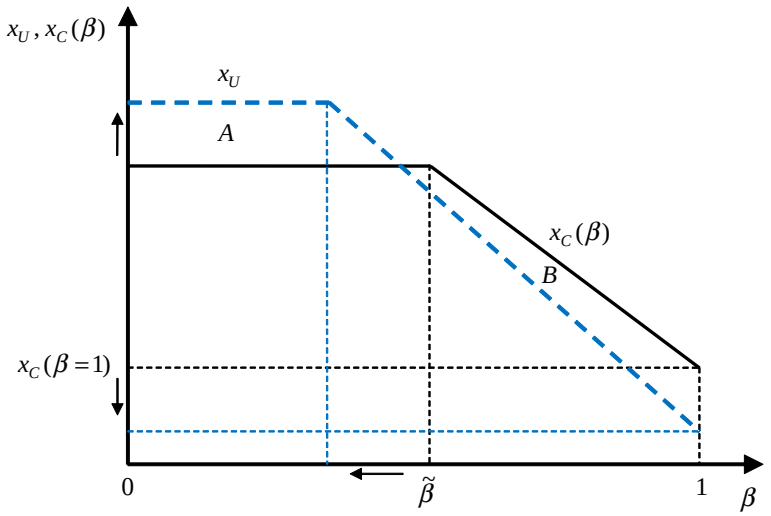

Figure 7: Output profiles and globalization

financial constraint (6) and increases the share of unconstrained producers in the economy:

$$\frac{d\ln\widetilde{\beta}}{d\ln\phi} > 0. \tag{27}$$

Furthermore, the increase in pledgeable income translates into higher capital demand and thus a higher borrowing rate:

$$\frac{d\ln r}{d\ln\phi} > 0. \tag{28}$$

Note that this result holds under the assumption of fixed capital supply. Hence, a higher quality of financial institutions only affects capital demand.[21]

Proposition 6 *In general equilibrium, higher financial development decreases the share of financially constrained firms.*

Proof. *See Appendix 8.2.* ■

An improvement in the quality of financial institutions increases the borrowing capacity of credit-rationed firms. This direct positive effect is counteracted by an increase in capital costs. Whereas financially constrained firms expand output, unconstrained producers do not benefit from higher financial development, but face a higher interest rate:

$$\frac{d\ln x_U}{d\ln\phi} = -\frac{cr}{(2-e)\,b'x_U}\frac{d\ln r}{d\ln\phi} < 0, \tag{29}$$

[21] Appendix 8.1 provides the effects of financial development in partial equilibrium which are not discussed in the main text.

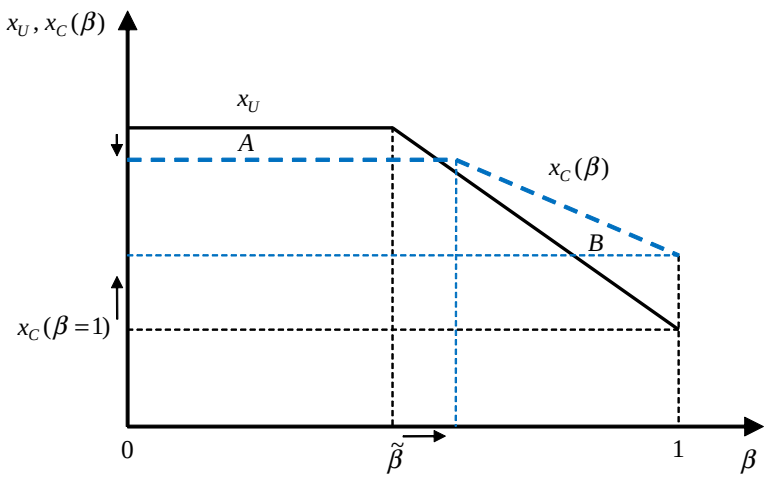

Figure 8: Output profiles and financial development

$$\frac{d\ln x_C}{d\ln \phi} = \frac{cr}{(1-e)\,b' x_C}\left[\phi\beta\,(i) - [1+(1-\phi)\,\beta(i)]\,\frac{d\ln r}{d\ln \phi}\right] > 0. \tag{30}$$

Consequently, an increase in financial development induces a reallocation of market shares towards credit-rationed producers. This effect can be seen graphically by a downward shift of the unconstrained output profile as well as an outward rotation of the output line for constrained firms in Figure 8. Hence, higher financial development reduces the within-industry variance of sales, which provides a rationale for empirical pattern 3.

Proposition 7 *In general equilibrium, higher financial development reduces the variance of sales within an industry as financially constrained firms expand outputs at the expense of unconstrained producers.*

Proof. *See Appendix 8.2.* ■

5 Welfare

This section analyzes how globalization affects consumer welfare. In a first step, we derive a welfare measure for a representative consumer. We use the latter for a numerical simulation of the effects of trade liberalization on consumer welfare.

5.1 Indirect utility

As an appropriate measure for consumer welfare, we derive the indirect utility function for a representative consumer associated with the preference structure in equation (1). As we

choose the marginal utility of income as numéraire ($\lambda = 1$), indirect utility can be expressed as follows:

$$U = km\frac{a^2(1-e) + ekm\left(\overline{p}^U + \overline{p}^C\right)^2 - \left[1 + e\left(km-1\right)\right]\left(\gamma_c^2 + \gamma_u^2\right)}{2b(1-e)\left[1 + e\left(km-1\right)\right]}. \tag{31}$$

The welfare measure increases in the first moments of prices for unconstrained and constrained firms respectively, $\overline{p}_U = \int_0^{\widetilde{\beta}} p_U di$, $\overline{p}_C = \int_{\widetilde{\beta}}^1 p_C(\beta) di$, and decreases in the second moments of prices for both groups, $\gamma_U^2 = \int_0^{\widetilde{\beta}} \left(p_U\right)^2 di$ and $\gamma_C^2 = \int_{\widetilde{\beta}}^1 \left(p_C(\beta)\right)^2 di$. The structure of the utility function is comparable to welfare measures in general oligopolistic equilibrium models.[22] In these papers, consumer welfare decreases in the variance of prices which in our case would be defined as $\sigma_j^2 = \gamma_j^2 - \left(\overline{p}_j\right)^2$ for $j \in C, U$. Two important properties of the welfare function will be crucial for the subsequent analysis. Following from the preference structure in equation (1), consumers love variety and dislike heterogeneity in consumption levels and prices.

5.2 Welfare effects of trade liberalization

The aim of this section is to analyze the welfare implications of globalization. We simulate the changes of consumer welfare (31) to globalization and compare results in partial and general equilibrium.[23] Similar to our previous analysis, we first consider only the market size effect of globalization (change in the number of consumers L). Subsequently, we take into account that trade liberalization increases competition and the number of varieties available to consumers (change in k).

Market size effect The market size effect reflects increased export opportunities after globalization. The left panel of Figure 9 shows that a larger market has no effect on consumer welfare in partial equilibrium (PE), but leads to welfare losses in general equilibrium (GE). This difference is driven by the endogenous adjustment of the borrowing rate when the capital market equilibrium is taken into account.

As equation (31) shows, consumer welfare depends on the first and second moments of prices for both groups. In partial equilibrium, an increase in the market size L leads to a proportional expansion of output among all firms without affecting optimal price setting and the share of unconstrained firms $\widetilde{\beta}$ (compare section 3.4). Therefore, consumer welfare does not respond to changes in the market size as the first and second moments of prices

[22] Compare e.g. Neary (2009), among others.

[23] We simulate the model in general equilibrium with MATLAB. The simulation code is available from the authors upon request.

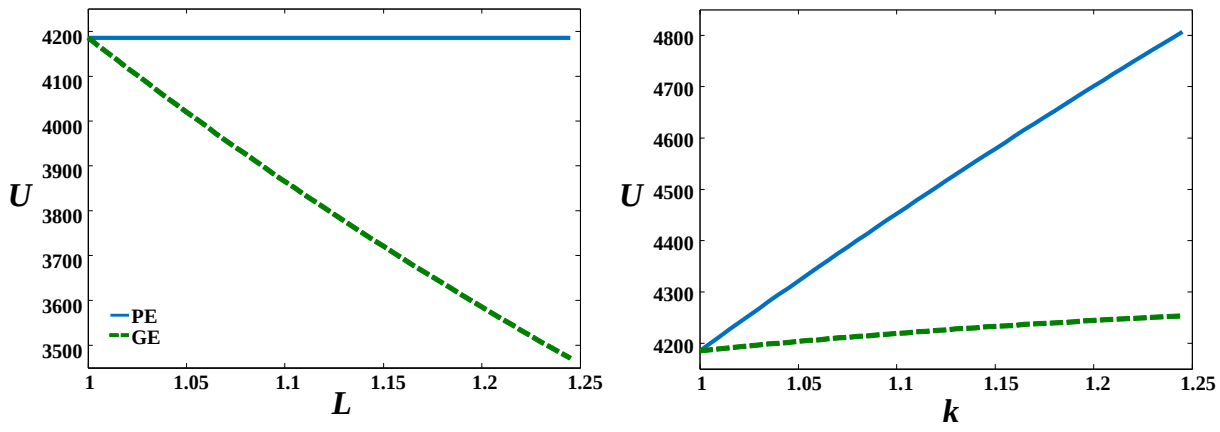

Figure 9: Welfare effects of market size (L) and globalization (k)

remain constant. In contrast, increased capital demand raises the interest rate in general equilibrium which leads to a higher variance of prices and thus to welfare losses. As discussed in section 4.2, higher borrowing costs increase the within-industry variance of prices in two ways. First, a larger fraction of firms becomes financially constrained (lower $\widetilde{\beta}$). Second, unconstrained producers expand output at the expense of credit-rationed firms.

Globalization By considering the effect of an increase in the number of countries k, we introduce two additional channels how globalization affects consumer welfare (31). In contrast to the left graph, the right panel of Figure 9 shows that globalization leads to welfare gains both in partial and general equilibrium resulting from (i) lower prices due to increased competition and (ii) larger consumption variety. Importantly, the positive welfare effects are considerably lower in general equilibrium. Whereas the partial equilibrium analysis reflects well-known gains from trade through competition and larger variety, our model stresses an additional negative welfare channel of globalization driven by an increase in capital costs. Whereas unconstrained firms benefit from trade liberalization due to the market size effect, the higher interest rate especially hurts the most constrained producers (with high values of β). Compared to existing work, the negative welfare channel of a larger market is driven by two components of our model. First, the introduction of heterogeneity in financial frictions at the firm-level induces endogenous selection of producers into unconstrained and constrained groups. Second, by considering capital market clearing in general equilibrium, the interest rate is endogenized and increases with globalization. In the presence of firm-specific credit frictions and endogenous capital costs, trade liberalization leads to a larger variance of prices and reduces positive welfare effects. Table 3 shows outcomes of endogenous

variables for different values of market size L and the number of countries k.

Table 3: Numerical simulation of trade liberalization

L	U_{PE}	U_{GE}	X_{PE}	X_{GE}	$\widetilde{\beta}_{PE}$	$\widetilde{\beta}_{GE}$	r_{PE}	r_{GE}
1	4185.43	4185.44	25.00	25.00	0.83	0.83	1.38	1.38
1.05	4185.43	4020.04	26.25	25.00	0.83	0.77	1.38	1.44
1.10	4185.43	3865.51	27.50	25.00	0.83	0.73	1.38	1.49
1.15	4185.43	3721.02	28.75	25.00	0.83	0.70	1.38	1.54
1.20	4185.43	3585.79	30.00	25.00	0.83	0.67	1.38	1.58
1.25	4185.43	3471.36	31.12	25.00	0.83	0.64	1.38	1.61
k	U_{PE}	U_{GE}	X_{PE}	X_{GE}	$\widetilde{\beta}_{PE}$	$\widetilde{\beta}_{GE}$	r_{PE}	r_{GE}
1	4185.43	4185.44	25.00	25.00	0.83	0.83	1.38	1.38
1.05	4321.50	4203.75	25.85	25.00	0.82	0.78	1.38	1.42
1.10	4452.66	4219.42	26.68	25.00	0.81	0.74	1.38	1.46
1.15	4579.11	4232.84	27.48	25.00	0.80	0.71	1.38	1.49
1.20	4701.08	4244.33	28.25	25.00	0.79	0.68	1.38	1.51
1.25	4807.18	4253.25	28.92	25.00	0.78	0.66	1.38	1.54

Notes: The table presents outcomes of endogenous variables for different values of L and k. The following parameter values are chosen: $a = 100$, $b = 1$, $m = 2$, $e = 0.3$, $c = 30$, $\phi = 0.25$, $K_S = 1500$.

Policy implications The additional negative welfare channel of globalization is especially relevant if financial development is low and credit frictions are significant. Thus, from a policy perspective, our model implies that trade liberalization should be accompanied by financial reforms that aim to mitigate negative effects. To do so, our theoretical framework suggests two potential policy measures: an improvement in the quality of financial institutions ϕ or an increase in capital supply K_S. Both measures reduce price heterogeneity and hence dampen potential welfare losses, but work through different channels. An increase in ϕ alleviates credit frictions and induces a reallocation of market shares towards financially constrained producers (see the discussion in section 4.2). As a second measure, globalization should be accompanied by an increase in capital supply K_S to weaken the increase in borrowing costs which benefits all firms.

6 Model extension with free entry

Our model abstracts from endogenous entry and exit decisions of firms. In this section, we allow for free entry which endogenizes the number of firms m and show that the implications

of the model are robust to this extension. Therefore, we introduce an entry stage at which each firm pays a fixed cost f_E and draws a value for β which is uniformly distributed along the unit interval. Hence, before producers know their agency costs, expected profits $E\pi$ have to be equal to the entry costs:

$$E\pi = \int_0^{\widetilde{\beta}} \pi_U di + \int_{\widetilde{\beta}}^{\widehat{\beta}} \pi_C(\beta) di = f_E, \tag{32}$$

whereas $\widehat{\beta}$ is the agency cost parameter of the most credit-rationed firm in the market. This marginal producer is determined by $x_C\left(\widehat{\beta}\right) = 0$. Evaluating equation (9) at $\widehat{\beta}$ yields:

$$\widehat{\beta} = \frac{a - b'ekm\widetilde{x} - cr}{(1-\phi)\,cr}. \tag{33}$$

Conditions (32) and (33) determine the cutoff value $\widehat{\beta}$ and the number of firms m. Comparing equations (12) and (33) leads to the following relationship between the share of unconstrained firms and the cutoff value: $\widetilde{\beta} = \frac{\widehat{\beta}}{2-e}$. By using this property and evaluating equation (32), the cutoff value can be expressed as follows:

$$\widehat{\beta}^3 = \frac{6b' f_E\,(2-e)^3\,(1-e)}{\left[(1-\phi)\,cr\right]^2\left[e^2\,(6-e) + 5\,(2-3e)\right]}. \tag{34}$$

We analyze how globalization affects the economy with free entry and compare results to section 3.4. Analogous to equation (14), industry scale is now given by the average output of surviving firms:

$$\widetilde{x} = \frac{1}{\widehat{\beta}}\left[\int_0^{\widetilde{\beta}} x_U di + \int_{\widetilde{\beta}}^{\widehat{\beta}} x_C(\beta) di\right], \tag{35}$$

which can be expressed as a function of $\widehat{\beta}$:

$$\widetilde{x} = \frac{\widehat{\beta}\,(1-\phi)\,cr\left[e^2 + 3 - 4e\right]}{2b'\,(2-e)^2\,(1-e)}. \tag{36}$$

Hence, our equilibrium with free entry consists of three equations with the unknowns $\widetilde{x}$, $\widehat{\beta}$, and m. As before, globalization is modelled by an increase in the number of countries k. Allowing for free entry leads to a new channel of adjustment compared to section 3.4. Foreign competition forces producers with high agency costs to exit the market which is

captured by a decrease in the cutoff value $\widehat{\beta}$:

$$\frac{d\ln\widehat{\beta}}{d\ln k}<0. \tag{37}$$

Furthermore, the number of firms reacts to globalization as follows:

$$\frac{d\ln m}{d\ln k}=-1+\frac{a-cr}{3b'eX}\gtrless 0. \tag{38}$$

The net effect depends on the degree of competition. If the substitutability of products is high (large e), globalization reduces the number of domestic firms.

Proposition 8 *With free entry, globalization forces the most financially constrained producers to exit the market. The number of firms decreases if the degree of competition is sufficiently high.*

Proof. *See Appendix 8.3.* ■

Comparable to Proposition 2 in section 3.4, the dominating market size effect leads to an increase in average industry scale and a lower share of financially unconstrained producers:

$$\frac{d\ln\widetilde{x}}{d\ln k}>0,\ \frac{d\ln\widetilde{\beta}}{d\ln k}<0. \tag{39}$$

Hence, the effects of globalization are robust to free entry. In section 4.2, we introduce a capital market equilibrium and show that globalization leads to a higher within-industry variance of firm sales and prices. This effect is driven by an increase in capital demand which rises the interest rate. To show that this channel of adjustment is still present, capital demand has to increase even with free entry. As the number of domestic firms could fall after globalization (see Proposition 8), the effect on aggregate capital demand $cm\widetilde{x}$ might be reversed. Solving for the number of firms from equation (33) and multiplying with equation (36), leads to total output of domestic producers:

$$m\widetilde{x}=\frac{\left[a-cr-\widehat{\beta}\left(1-\phi\right)cr\right]L}{be}. \tag{40}$$

This expression only depends on the cutoff value $\widehat{\beta}$ which decreases with globalization. Hence, aggregate capital demand is clearly increasing with free entry. This implies that the driving force behind the rise in the interest rate remains when the number of firms is endogenous.

7 Conclusion

This paper has developed a new international trade model with firm-specific credit frictions and endogenous adjustments of capital costs in general equilibrium. A key element of our model is that credit constraints at the firm-level interact with capital market imperfections at the country-level. Credit frictions arise from a simple moral hazard problem, whereas firms differ in their exposure to financial constraints. Our model is consistent with new empirical patterns from enterprise surveys data of the World Bank. We show that the majority of variation in exposure to financial constraints is across firms within an industry. Furthermore, this paper highlights a positive relationship between the degree of product market competition and the share of financially constrained firms. Additionally, our framework rationalizes a positive relationship between measures of credit constraints both at the industry- as well as the country-level and the variance of sales.

We use this model to analyze the effects of globalization on firm performance and consumer welfare. The main idea is that aggregate implications of trade liberalization are very different if general equilibrium effects on capital costs are taken into account. In general equilibrium, we show that endogenous adjustments of capital costs represent an additional channel which reduces gains from trade. Trade liberalization increases capital demand which pushes the borrowing rate upwards. This general equilibrium effect induces a within-sector reallocation of profits towards unconstrained firms at the expense of financially constrained producers, and increases the share of credit-rationed producers. We show that these adjustments increase the variance of prices and reduce consumer welfare.

From a policy perspective, our model implies that trade liberalization could lead to negative welfare effects and should be accompanied by financial reforms to counteract an increase in within-industry heterogeneity across firms. This implication is especially relevant in developing countries where credit frictions are significant and financial development is low.

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8 Mathematical Appendix

8.1 Comparative statics in partial equilibrium

The partial equilibrium is characterized by two endogenous variables $\widetilde{\beta}$ and $\widetilde{x}$ in equations (12) and (15). Totally differentiating the two equilibrium conditions and writing the results in matrix notation yields:

$$\begin{bmatrix} (2-e)(1-e)+\left(2-e-\widetilde{\beta}\right)ekm & 0 \\ em & (1-\phi)(2-e)crL \end{bmatrix} \times \begin{bmatrix} b\widetilde{x}d\ln\widetilde{x} \\ \widetilde{\beta}d\ln\widetilde{\beta} \end{bmatrix} =$$

$$+\begin{bmatrix} (2-e)(1-e)+\left(2-e-\widetilde{\beta}\right)ekm \\ em \end{bmatrix}\widetilde{x}bd\ln L-\begin{bmatrix} \left(2-e-\widetilde{\beta}\right)k+(2-e)\left(1-\widetilde{\beta}\right)\mu_c'(1-\phi)k \\ 1+\widetilde{\beta}(1-\phi)(2-e) \end{bmatrix}crLd\ln r$$

$$+\begin{bmatrix} \widetilde{x}(2-e)(1-e)b \\ 0 \end{bmatrix}d\ln k+\begin{bmatrix} (2-e)\left(1-\widetilde{\beta}\right)\mu_c'k \\ \widetilde{\beta}(2-e) \end{bmatrix}crL\phi d\ln\phi-\begin{bmatrix} \left(2-e-\widetilde{\beta}\right)kb \\ b \end{bmatrix}em\widetilde{x}d\ln m$$

The determinant of the coefficient matrix is given by:

$$\Delta=(1-\phi)(2-e)crL\left[(2-e)(1-e)+\left(2-e-\widetilde{\beta}\right)ekm\right]>0.$$

In the following, we proof Proposition 2 in the main body and show partial equilibrium results for an exogenous change in the financial development parameter ϕ.

Proposition 2 (Interest rate effect) In partial equilibrium, we analyze the effects of an exogenous change in the interest rate r. The effect on average industry scale $\widetilde{x}$ is given by:

$$\frac{d\ln\widetilde{x}}{d\ln r}=-\frac{\left[\left(2-e-\widetilde{\beta}\right)+(2-e)\left(1-\widetilde{\beta}\right)\mu_c'(1-\phi)\right]cr}{\left[(2-e)(1-e)+\left(2-e-\widetilde{\beta}\right)ekm\right]b'\widetilde{x}}<0. \tag{41}$$

The effect on the cutoff $\widetilde{\beta}$ is given by:

$$\frac{d\ln\widetilde{\beta}}{d\ln r}=-\frac{1-e+(1-\phi)\left[(1-e)(2-e)\widetilde{\beta}+ekm\left((2-e)\widetilde{\beta}-\frac{1+\widetilde{\beta}^2}{2}\right)\right]}{(1-\phi)L\left[(2-e)(1-e)+\left(2-e-\widetilde{\beta}\right)ekm\right]\widetilde{\beta}}<0. \tag{42}$$

To derive the latter expression, note that $\left(1-\widetilde{\beta}\right)\mu_c' = \int_{\widetilde{\beta}}^{1}\beta_i di = \frac{1-\widetilde{\beta}^2}{2}$.

Proof. To show that $\frac{d\ln\widetilde{\beta}}{d\ln r} < 0$, it is sufficient to proof that $(2-e)\,\widetilde{\beta} - \frac{1+\widetilde{\beta}^2}{2} > 0$. As the latter expression increases in $\widetilde{\beta}$, inserting the lowest possible cutoff value $\widetilde{\beta}_l = \frac{1}{2-e}$ (see Condition 2 in the main body), we derive $\frac{(2-e)^2-1}{2(2-e)^2} > 0$. ■

Financial development For the sake of completeness, we present the results for an exogenous change in the parameter ϕ which are not discussed in the main body of the paper. The effect on average industry scale $\widetilde{x}$ is given by:

$$\frac{d\ln\widetilde{x}}{d\ln\phi} = \frac{(2-e)\left(1-\widetilde{\beta}\right)\mu_c' cr\phi}{\left[(2-e)(1-e)+\left(2-e-\widetilde{\beta}\right)ekm\right]b'\widetilde{x}} > 0. \tag{43}$$

The solution for the effect on the cutoff value is

$$\frac{d\ln\widetilde{\beta}}{d\ln\phi} = \frac{\phi}{1-\phi}\frac{(1-e)(2-e)\,\widetilde{\beta} + ekm\left((2-e)\,\widetilde{\beta} - \frac{1+\widetilde{\beta}^2}{2}\right)}{\left[(2-e)(1-e)+\left(2-e-\widetilde{\beta}\right)ekm\right]\widetilde{\beta}} > 0, \tag{44}$$

whereby the proof of Proposition 2 ensures that $\frac{d\ln\widetilde{\beta}}{d\ln\phi} > 0$.

8.2 Comparative statics in general equilibrium

In general equilibrium, we add the capital market clearing condition to our system of equations. The three endogenous variables $\widetilde{\beta}$, $\widetilde{x}$, and r are determined in equations (12), (15), and (20). Totally differentiating these expressions results in the following matrix equation:

$$\begin{bmatrix} b\left((2-e)(1-e)+\left(2-e-\widetilde{\beta}\right)ekm\right) & 0 & \left[2-e-\widetilde{\beta}+(2-e)\left(1-\widetilde{\beta}\right)\mu_c'(1-\phi)\right]k \\ bem & (1-\phi)(2-e)\,crL & 1+\widetilde{\beta}(1-\phi)(2-e) \\ cm & 0 & 0 \end{bmatrix} \times$$

$$\begin{bmatrix} \widetilde{x}d\ln\widetilde{x} \\ \widetilde{\beta}d\ln\widetilde{\beta} \\ cLrd\ln r \end{bmatrix} = \begin{bmatrix} \widetilde{x}b(2-e)(1-e) \\ 0 \\ 0 \end{bmatrix} d\ln k + \begin{bmatrix} \left(1-\widetilde{\beta}\right)\mu_c'k \\ \widetilde{\beta} \\ 0 \end{bmatrix}(2-e)\,crL\phi d\ln\phi + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} K_s d\ln K_s,$$

whereas the determinant of the coefficient matrix is given by:

$$\Delta_{GE} = -(1-\phi)(2-e)\left[\left(2-e-\widetilde{\beta}\right)+(2-e)\left(1-\widetilde{\beta}\right)\mu_c'(1-\phi)\right]rc^3L^2km < 0.$$

Proposition 3 (Globalization) In general equilibrium, a higher number of countries k increases the interest rate:

$$\frac{d\ln r}{d\ln k}=\frac{(2-e)(1-e)b'\widetilde{x}}{\left(2-e-\widetilde{\beta}\right)a-\left[(2-e)(1-e)+\left(2-e-\widetilde{\beta}\right)ekm\right]b'\widetilde{x}}>0. \tag{45}$$

The effect of globalization on the cutoff level $\widetilde{\beta}$ is given by:

$$\frac{d\ln\widetilde{\beta}}{d\ln k}=-\frac{(1-e)\left[1+\widetilde{\beta}(1-\phi)(2-e)\right]b'\widetilde{x}}{(1-\phi)\left[\left(2-e-\widetilde{\beta}\right)+(2-e)\left(1-\widetilde{\beta}\right)\mu_c'(1-\phi)\right]cr\widetilde{\beta}}<0. \tag{46}$$

Comparing the effects on $\widetilde{\beta}$ in partial and general equilibrium, as shown in equations (17) and (46), leads to:

$$\left|\frac{d\ln\widetilde{\beta}}{d\ln k}\right|_{GE}-\left|\frac{d\ln\widetilde{\beta}}{d\ln k}\right|_{PE}=$$

$$\frac{(2-e)\left[(1-e)\left[1+\widetilde{\beta}(1-\phi)(2-e)\right]+ekm(1-\phi)\left[\widetilde{\beta}(2-e)-\widetilde{\beta}^2-\frac{1-\widetilde{\beta}^2}{2}\right]\right]}{k\left[\left(2-e-\widetilde{\beta}\right)+(2-e)\left(1-\widetilde{\beta}\right)\mu_c'(1-\phi)\right]\left[(2-e)(1-e)+\left(2-e-\widetilde{\beta}\right)ekm\right]}>0, \tag{47}$$

whereas the proof in Proposition 2 ensures that the last term is positive.

Proposition 4 (Firm-level effects of globalization) Inserting the interest rate effect of globalization (45) into equations (25) and (26) leads to the following expressions:

$$\frac{d\ln x_U}{d\ln k}=1-\frac{\widetilde{x}}{x_U}\frac{1-e}{2-e-\widetilde{\beta}+(2-e)\left(1-\widetilde{\beta}\right)\mu_c'(1-\phi)}>0, \tag{48}$$

$$\frac{d\ln x_C(\beta)}{d\ln k}=1-\frac{\widetilde{x}}{x_C(\beta)}\frac{2-e+\beta(i)(1-\phi)(2-e)}{2-e-\widetilde{\beta}+(2-e)\left(1-\widetilde{\beta}\right)\mu_c'(1-\phi)}<0. \tag{49}$$

As $x_U>\widetilde{x}$ and $\frac{1-e}{2-e-\widetilde{\beta}+(2-e)\left(1-\widetilde{\beta}\right)\mu_c'(1-\phi)}<1$, the effect of globalization on unconstrained output (48) is clearly positive.

Proof. In the case of constrained firms, note that $x_C(\beta)<\widetilde{x}$. A sufficient condition for a negative effect of globalization on constrained output is that the last fraction of expression (49) is larger than one. This is the case if $\beta(i)>\frac{1-\widetilde{\beta}^2}{2}$. Evaluating this condition for the marginal firm with $\beta(i)=\widetilde{\beta}$ and inserting the lower bound $\widetilde{\beta}_l$ leads to: $\left(\frac{1}{2-e}\right)^2+\frac{e}{2-e}>0$.

Thus, the effect of globalization is negative for all firms with $\beta(i) \geq \widetilde{\beta}$. ■

Proposition 5 (Financial development) The effect of financial development on the cutoff level $\widetilde{\beta}$ is given by:

$$\frac{d\ln\widetilde{\beta}}{d\ln\phi} = \frac{\phi\left[(2-e)\,\widetilde{\beta} - \frac{1+\widetilde{\beta}^2}{2}\right]}{(1-\phi)\left[\left(2-e-\widetilde{\beta}\right) + (2-e)\left(1-\widetilde{\beta}\right)\mu_c'\,(1-\phi)\right]\widetilde{\beta}} > 0. \tag{50}$$

Following the proof in Proposition 2, the expression is clearly positive. Finally, the effect of an exogenous change in ϕ on the interest rate is given by:

$$\frac{d\ln r}{d\ln\phi} = \frac{(2-e)\left(1-\widetilde{\beta}\right)\mu_c'\phi}{\left(2-e-\widetilde{\beta}\right) + (2-e)\left(1-\widetilde{\beta}\right)\mu_c'\,(1-\phi)} > 0. \tag{51}$$

Proposition 6 (Firm-level effects of financial development) To show that the effect of financial development on constrained output (30) is unambiguously positive, we insert expression (51) resulting in:

$$\frac{d\ln x_i^C}{d\ln\phi} = \frac{cr\phi}{x_i^C b'\,(1-e)}\left[\frac{\left(2-e-\widetilde{\beta}\right) - (2-e)\left(1-\widetilde{\beta}\right)\mu_c'}{\left(2-e-\widetilde{\beta}\right) + (2-e)\left(1-\widetilde{\beta}\right)\mu_c'\,(1-\phi)}\right] > 0. \tag{52}$$

Proof. As the numerator of the term in brackets increases in $\widetilde{\beta}$, we insert the lower bound $\widetilde{\beta}_l = \frac{1}{2-e}$ which leads to: $\frac{(2-e)^2-1}{2(2-e)} > 0$. ■

8.3 Comparative statics with free entry

This section presents comparative statics results for a globalization shock (increase in number of countries k) in the case of free entry. The three endogenous variables m, $\widehat{\beta}$, and $\widetilde{x}$ are determined in equations (33), (34), and (36). We totally differentiate these expressions which leads to the following system of equations:

$$\begin{bmatrix} 2b'\left(2-e\right)^2\left(1-e\right) & -\left(1-\phi\right)cr\left(e^2+3-4e\right) & 0 \\ 0 & 3\left[\left(1-\phi\right)cr\right]^2\left[e^2\left(6-e\right)+5\left(2-3e\right)\right]\widehat{\beta}^2 & 0 \\ b'emk & \left(1-\phi\right)cr & b'ek\widetilde{x} \end{bmatrix}$$

$$\times \begin{bmatrix} \widetilde{x}d\ln\widetilde{x} \\ \widehat{\beta}d\ln\widehat{\beta} \\ md\ln m \end{bmatrix} = \begin{bmatrix} 2b'\widetilde{x}\left(2-e\right)^2\left(1-e\right) \\ -6b'f_E\left(2-e\right)^3\left(1-e\right) \\ 0 \end{bmatrix} d\ln k.$$

The determinant of the coefficient matrix is given by:

$$\Delta_{FE} = 6b'^2ek\widetilde{x}\left(2-e\right)^2\left(1-e\right)\left[\left(1-\phi\right)cr\right]^2\left[e^2\left(6-e\right)+5\left(2-3e\right)\right]\widehat{\beta}^2 > 0.$$

Proposition 8 The effect of globalization on the cutoff value $\widehat{\beta}$ can be written as:

$$\frac{d\ln\widehat{\beta}}{d\ln k} = -\frac{2b'f_E\left(2-e\right)^3\left(1-e\right)}{\left[\left(1-\phi\right)cr\right]^2\left[e^2\left(6-e\right)+5\left(2-3e\right)\right]\widehat{\beta}^3} < 0, \tag{53}$$

and the impact on the number of firms m is given by:

$$\frac{d\ln m}{d\ln k} = \frac{2f_E\left(2-e\right)^3\left(1-e\right)\left[3\widehat{\beta}\left(1-\phi\right)cr-2\left(a-cr\right)\right]}{\left[\left(1-\phi\right)cr\right]^2\left[e^2\left(6-e\right)+5\left(2-3e\right)\right]eX\widehat{\beta}^3} \lessgtr 0. \tag{54}$$

Combining expressions (33) and (34) with equation (54), leads to result (38) in Proposition 8. Furthermore, the impact of globalization on average industry scale is clearly positive:

$$\frac{d\ln\widetilde{x}}{d\ln k} = \frac{\left(2-e\right)\left(e^2+3-4e\right)f_E}{\left(1-\phi\right)cr\left[e^2\left(6-e\right)+5\left(2-3e\right)\right]\widetilde{x}\widehat{\beta}^2} > 0. \tag{55}$$

9 Empirical Appendix

9.1 Data Appendix

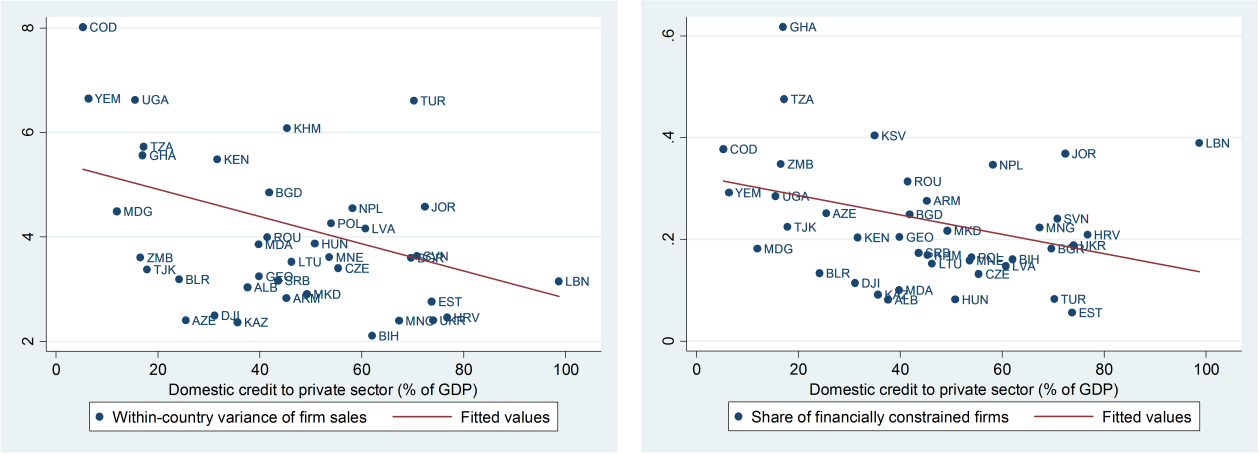

Figure 10: Financial development and within-country heterogeneity, cross-section 2013

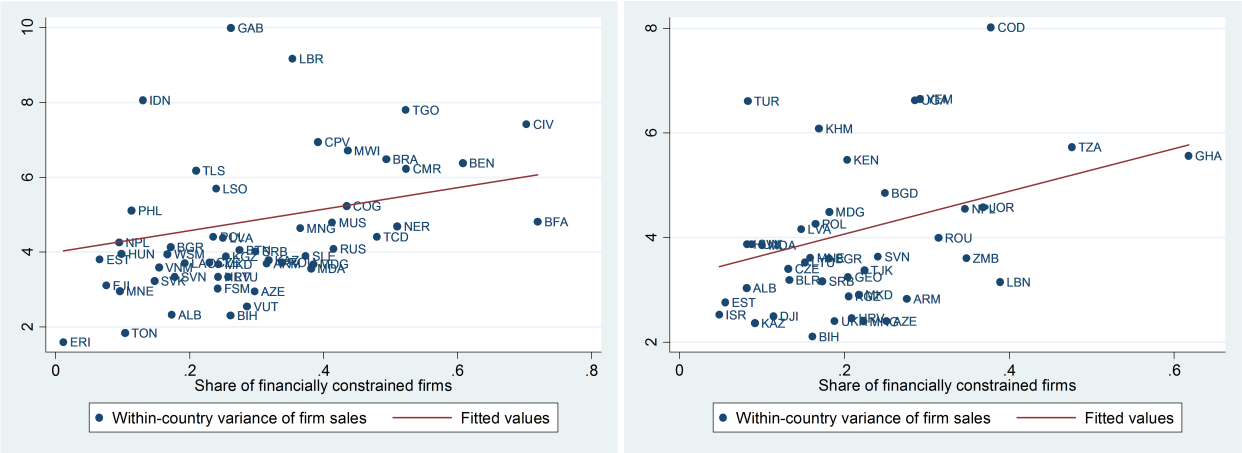

Figure 11: Credit constraints and variance of sales, for years 2009 (left) and 2013 (right)

Table 4: Description of variables

Variable	**Variable description**
Financial variables:	
TOA	Firm-level tangible assets / total assets, tangible assets=land and buildings
Access to finance	Access to finance is obstacle to business: 0=no obstacle, 1=minor obstacle, 2=moderate, 3=major, 4=very severe
Share constrained firms	Constrained=1 if firm answered Access to finance with 3 or 4.
Financial development	Domestic credit to private sector / GDP
Degree of competition	Expected effect of hypothetical 10% price increase of main product on demand: 1=no effect, 2=small decrease, 3=large decrease, 4=customers stop buying.
Firm-level controls:	
Size	Log number of workers
Labor productivity	Log sales / number of workers
Legal status	1=publicly listed, 2=private, 3=cooperative, 4=sole proprietorship, 5=partnership
Age	Number of years in business
Exporter	=1 if firm exports
Domestic private ownership	Percentage of firm owned by domestic private sector
Foreign private ownership	Percentage of firm owned by foreign private sector
Government ownership	Percentage of firm owned by government / state
Product innovation	=1 if firm developed a major new product line in last three years
Process innovation	=1 if firm introduced new production technology in last three years

Data source: WBES 2002-2005, 2009, 2013. Financial development: WDI World Bank. Variables reported in local currency units are converted to 2005 U.S. dollars. Database available at: http://www.enterprisesurveys.org.

Table 5: Summary statistics

Variable	Obs.	Mean	Median	S.D.	Min	Max
Cross section 2002-2005						
Tangible over total assets	13,267	0.21	0.14	0.22	0	1
Share of constrained firms	69,377	0.21	0.18	0.19	0	1
Degree of competition	28,620	2.63	3.00	1.08	1	4
Log sales	13,175	14.05	13.77	2.89	-2.16	28.79
Cross-section 2009						
Share of constrained firms	18,911	0.30	0	0.46	0	1
Log sales	16,903	12.84	12.82	2.56	0.27	22.65
Cross-section 2013						
Share of constrained firms	21,067	0.24	0	0.42	0	1
Log sales	16,737	12.28	12.20	2.38	-0.81	28.35

Source: Authors' own computations from the WBES.

Table 6: Within-industry and between-industry variation of TOA

		2-digit		3-digit		4-digit	
Country	Obs.	within	between	within	between	within	between
Chile	894	89.56	10.44	88.76	11.24	84.24	15.76
El Salvador	349	95.18	4.82	88.2	11.8	79.51	20.49
Guatemala	421	95.48	4.52	92.05	7.95	77.33	22.67
Honduras	401	90.86	9.14	81.63	18.37	76.45	23.55
Madagascar	123	91.46	8.54	80.64	19.36	78.11	21.89
South Africa	495	98.48	1.52	86.74	13.26	76.75	23.25
Thailand	718	93.14	6.86	92.37	7.63	91.26	8.74
Vietnam	1,048	98.52	1.48	97.92	2.08	83.68	16.32

Source: Authors' own computations from the WBES. Due to data availability, we restrict the analysis to a subsample of countries.

Table 7: Summary statistics at the country level, cross-section 2013

		2013						
Country	Obs.	FinDev	Con.	Var.	Country	Obs.	FinDev	Con.	Var.
Albania	357	37.58	0.08	3.04	Kosovo	198	34.94	0.40	-
Armenia	359	45.18	0.28	2.83	Latvia	332	60.70	0.15	4.16
Azerbaijan	390	25.46	0.25	2.40	Lebanon	558	98.64	0.39	3.15
Bangladesh	1,437	41.79	0.25	4.85	Lithuania	263	46.22	0.15	3.52
Belarus	353	24.15	0.13	3.19	Madagascar	336	11.92	0.18	-
Bosnia and Herzegovina	360	62.01	0.16	2.11	Moldova	350	39.74	0.10	3.86
Bulgaria	287	69.64	0.18	3.60	Mongolia	359	67.28	0.22	2.39
Cambodia	467	45.33	0.17	6.08	Montenegro	145	53.61	0.16	-
Croatia	359	76.72	0.21	2.46	Nepal	482	58.11	0.35	4.55
Czech	250	55.36	0.13	3.40	Poland	534	53.93	0.17	4.26
DRC	511	5.24	0.38	8.02	Romania	532	41.41	0.31	3.99
Djibouti	263	31.09	0.11	-	Serbia	358	43.56	0.17	3.17
Estonia	270	73.70	0.06	2.76	Slovenia	270	70.79	0.24	3.63
FYROM	359	49.21	0.22	2.90	Tajikistan	348	17.86	0.23	3.37
Georgia	357	39.85	0.20	3.24	Tanzania	771	17.21	0.48	5.73
Ghana	711	16.99	0.62	5.57	Turkey	1,319	70.19	0.08	-
Hungary	306	50.76	0.08	3.87	Uganda	736	15.52	0.29	6.63
Jordan	573	72.33	0.37	4.57	Ukraine	983	73.96	0.19	2.40
Kazakhstan	570	35.58	0.09	2.36	Yemen	353	6.34	0.29	6.65
Kenya	767	31.63	0.20	5.48	Zambia	704	16.54	0.35	3.60
					Mean		45.51	0.22	3.90

Source: Authors' own computations from the WBES. FinDev: credit to private sector in % of GDP; Con.: share of financially constrained firms; Var.: within-country variance of firm sales.

Table 8: Summary statistics at the country-level, cross-section 2009

					2009				
Country	Obs.	FinDev	Con.	Var.	Country	Obs.	FinDev	Con.	Var.
Albania	52	36.92	0.17	2.32	Latvia	264	104.55	0.25	4.38
Armenia	371	24.86	0.32	3.69	Lesotho	146	12.84	0.24	5.69
Azerbaijan	360	19.07	0.30	2.95	Liberia	147	12.20	0.35	9.17
Benin	148	22.47	0.61	6.38	Lithuania	268	69.73	0.26	3.33
Bhutan	244	32.42	0.27	4.06	Madagascar	434	11.52	0.39	3.67
Bosnia and Herzegovina	360	65.37	0.26	2.30	Malawi	149	13.38	0.44	6.71
Brazil	1,783	48.87	0.49	6.48	Mauritius	397	82.74	0.41	4.78
Bulgaria	274	73.11	0.17	4.13	Micronesia	62	21.30	0.24	3.02
Burkina Faso	393	17.02	0.72	4.81	Moldova	346	36.00	0.38	3.56
Cameroon	361	11.48	0.52	6.23	Mongolia	345	40.30	0.37	4.64
CapeVerde	148	57.96	0.39	6.94	Montenegro	115	76.54	0.10	2.95
Chad	148	3.93	0.48	4.40	Nepal	486	59.18	0.10	4.26
Congo	122	4.92	0.43	5.23	Niger	147	12.20	0.51	4.69
Croatia	99	66.71	0.24	3.34	Philippines	1,280	29.16	0.11	5.11
Czech	244	49.86	0.23	3.72	Poland	429	49.75	0.24	4.40
Ivory Coast	512	16.43	0.70	7.41	Romania	497	46.15	0.34	3.71
Eritrea	172	16.77	0.01	1.59	Russia	976	45.26	0.42	4.09
Estonia	259	105.11	0.07	3.80	Samoa	108	39.53	0.17	3.94
FYROM	362	43.87	0.24	3.67	Serbia	382	42.55	0.30	4.01
Fiji	159	89.62	0.08	-	Sierra Leone	150	8.22	0.37	3.89
Gabon	172	10.12	0.26	9.99	Slovenia	276	90.69	0.18	3.33
Hungary	285	68.04	0.10	3.95	Timor-Leste	148	12.66	0.21	6.18
Indonesia	1,314	27.66	0.13	8.06	Togo	153	19.75	0.53	7.80
Kazakhstan	532	50.27	0.32	3.78	Tonga	145	47.09	0.10	1.84
Kosovo	176	34.34	0.16	-	Vanuatu	126	62.98	0.29	2.54
Laos	358	17.24	0.19	3.70	Vietnam	1,024	103.32	0.15	3.59
					Mean		41.02	0.29	4.67

Source: Authors' own computations from the WBES. FinDev: credit to private sector in % of GDP; Con.: share of financially constrained firms; Var.: within-country variance of firm sales.

9.2 Robustness checks for empirical patterns

This part shows that the empirical patterns presented in section 2.2 are robust to the inclusion of controls at the firm- as well as the industry level. Table 4 describes the variables used in the empirical analysis. Empirical pattern 2 shows that industries with a higher degree of product competition are characterized by a larger fraction of financially constrained firms. We estimate the following equation:

$$Constrained_{ci} = \alpha + \beta Comp_{ci} + \gamma_f X_f + \upsilon_c + \upsilon_t + \varepsilon_{cif} \ , \tag{56}$$

whereas $Constrained_{ci}$ is the share of financially constrained firms within an industry i in country c. The variable $Comp_{ci}$ denotes the industry mean of the degree of competition (see Table 4). We control for a set of firm characteristics X_f and include country fixed effects υ_c and year dummies υ_t. Column (1) of Table 9 shows results for this specification and highlights that the positive relationship between competition and the share of financially constrained firms is robust. As a further robustness check, we use the firm-level variable for access to external finance instead of the industry share in regression (56). Column (2) shows that credit-rationing is positively associated with tougher competition. The advantage of the firm-level regression is that we further control for industry-fixed effects at the 4-digit level.

Empirical pattern 3 states that more financially constrained industries show a larger within-industry variance of sales. A major concern is that this relationship might be driven by firm heterogeneity with respect to productivity and size, or innovation activity. To address this issue, we run the following regression:

$$Variance_{ci} = \alpha + \beta TOA_{ci} + \gamma_f X_f + \upsilon_c + \upsilon_t + \varepsilon_{cif} \ , \tag{57}$$

whereas $Variance_{ci}$ is the within-industry variance of firm sales and TOA_{ci} denotes the industry-mean of tangible over total assets. Column (1) of Table 10 shows the results. In columns (2)-(3), we replace the industry-mean TOA_{ci} with financial development at the country-level for cross-sectional data in years 2009 and 2013. This specification allows us to include industry-fixed effects at the 4-digit level. Columns (4) and (5) show that the negative relationship between financial development and the variance of sales holds at the country-level, when we use the within-country variance of sales as dependent variable.

In a last step, we do a similar exercise for the effect of financial development $FinDev_c$

on the share of credit-rationed producers, as shown by the following regression:

$$Constrained_{ci} = \alpha + \beta FinDev_c + \gamma_f X_f + \upsilon_i + \varepsilon_{cif} \ . \tag{58}$$

The first two columns of Table 11 show the estimation results. Analogous to empirical pattern 2, we use the firm-level variable for access to external finance as dependent variable and show that the significantly negative relationship can be confirmed at the firm-level (see columns 3 and 4).

Table 9: Regression analysis credit constraints and degree of competition

	Share constrained	Access to finance
	(1)	(2)
Degree of competition	0.027***	0.060***
	(0.000)	(0.000)
Firm-level controls:		
Size	0.000	-0.023***
	(0.738)	(0.004)
Labor productivity	-0.005***	-0.023**
	(0.000)	(0.026)
Legal status	-0.001	0.003
	(0.277)	(0.779)
Age	0.000*	-0.003***
	(0.094)	(0.000)
Exporter	0.000	-0.004
	(0.912)	(0.896)
Domestic private ownership	0.000	0.000
	(0.235)	(0.736)
Foreign private ownership	0.000**	-0.005***
	(0.016)	(0.000)
Government ownership	0.000	-0.001
	(0.473)	(0.605)
Year fixed effects	Yes	Yes
Country fixed effects	Yes	Yes
Industry fixed effects	No	Yes
Observations	17,792	15,350
R-squared	0.797	0.193

Note: Cross-section 2002-2005; Industry fixed effects at 4-digit level.

Table 10: Regression analysis credit constraints and variance of sales

	Within-industry variance sales			Within-country variance sales	
	(1)	(2)	(3)	(4)	(5)
Industry Mean TOA	-1.142***				
	(0.000)				
Financial development		-0.012***	-0.018***	-0.019***	-0.025***
		(0.000)	(0.000)	(0.000)	(0.000)
Firm-level controls:					
Size	-0.011	0.031**	0.071***	-0.024***	0.004
	(0.346)	(0.043)	(0.000)	(0.009)	(0.699)
Labor productivity	0.006	-0.090***	0.013	-0.121***	-0.021***
	(0.502)	(0.000)	(0.208)	(0.000)	(0.001)
Legal status	0.022**	0.042**	0.261***	0.063***	0.341***
	(0.037)	(0.027)	(0.000)	(0.000)	(0.000)
Age	0.000	0.058***	0.067***	0.020	0.065***
	(0.339)	(0.006)	(0.001)	(0.115)	(0.000)
Exporter	0.079**	-0.356***	0.183***	-0.273***	0.272***
	(0.015)	(0.000)	(0.000)	(0.000)	(0.000)
Domestic private ownership	0.006	-0.009***	-0.011***	-0.008***	-0.007***
	(0.103)	(0.000)	(0.000)	(0.000)	(0.000)
Foreign private ownership	0.007**	-0.007***	-0.010***	-0.008***	-0.008***
	(0.047)	(0.000)	(0.000)	(0.000)	(0.000)
Government ownership	0.006*	-0.015***	-0.014**	-0.017***	-0.013***
	(0.096)	(0.000)	(0.015)	(0.000)	(0.000)
Product innovation	0.010***				
	(0.000)				
Process innovation	0.036				
	(0.197)				
Year fixed effects	Yes	No	No	No	No
Country fixed effects	Yes	No	No	No	No
Industry fixed effects	No	Yes	Yes	Yes	Yes
Observations	5,108	14,703	14,481	14,942	14,634
R-squared	0.688	0.188	0.218	0.282	0.319

Column (1): 2002-05; (2) & (4): 2009; (3) & (5): 2013. Industry fixed effects at 4-digit level.

Table 11: Regression analysis credit constraints and financial development

	Share constrained		Access to finance	
	2009	2013	2009	2013
Financial development	-0.002***	-0.001***	-0.008***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)
Firm-level controls:				
Size	0.001	-0.005***	-0.032***	-0.056***
	(0.368)	(0.000)	(0.000)	(0.000)
Labor productivity	0.004***	-0.009***	-0.034***	-0.051***
	(0.000)	(0.000)	(0.000)	(0.000)
Legal status	-0.005***	0.039***	-0.028**	0.175***
	(0.001)	(0.000)	(0.013)	(0.000)
Age	-0.006***	0.002	-0.027**	0.003
	(0.001)	(0.163)	(0.031)	(0.814)
Exporter	-0.033***	-0.006	-0.050	-0.058*
	(0.000)	(0.126)	(0.135)	(0.062)
Domestic private ownership	-0.001***	0.000**	-0.003***	0.002**
	(0.000)	(0.011)	(0.000)	(0.032)
Foreign private ownership	-0.001	0.000***	-0.007***	0.000
	(0.000)	(0.001)	(0.000)	(0.912)
Government ownership	-0.001	0.000*	-0.001	0.001
	(0.002)	(0.073)	(0.679)	(0.565)
Industry fixed effects	Yes	Yes	Yes	Yes
Observations	14,935	14,630	14,555	14,474
R-squared	0.193	0.235	0.074	0.076

Note: Industry fixed effects at 4-digit level.