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Abstract

This paper analyzes the effects of credit frictions in a trade model where heterogeneous firms select both into exporting and into two types of external finance. In our framework, small producers face stronger credit frictions, pay a higher borrowing rate and rely on bank finance, whereas large firms have access to cheaper bond finance. We show that an increase in credit frictions induces firms to select into bank finance, which attenuates the negative implications on product variety and welfare. In the open economy, the presence of effective financial intermediation increases the welfare gains from trade. In a counterfactual analysis, we exploit that our framework nests a model with credit frictions and one type of finance as a special case, and we show that endogenous selection into external finance is an important channel of adjustment.

JEL-Codes: F120, G320, L110.

Keywords: international trade, external finance, credit constraints, heterogeneous firms, moral hazard, bank and bond finance.

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1 Introduction

Credit frictions are one of the most important obstacles to business operations. Firms rely on external lenders to finance working capital and upfront costs. Typical reasons are the lack of internal funds and time lags between investments and the realization of sales. In particular small firms are most constrained by credit frictions, which are associated with higher borrowing costs and insufficient access to external finance (Beck et al., 2005, 2006). These barriers are also relevant in international trade, as exporting requires upfront investments and additional time to serve foreign markets (Hummels and Schaur, 2013; Feenstra et al., 2014). A large literature based on Melitz (2003) highlights that, in the presence of additional trade costs, only the most productive and largest firms select into exporting. If exporters rely on external finance for these additional costs, credit frictions have negative effects on export decisions, which has been shown by empirical studies (Berman and Héricourt, 2010; Minetti and Zhu, 2011; Manova, 2013; Muûls, 2015).

While selection into exporting is a central issue in trade theory, the literature on corporate finance stresses differences in the use of external credit across firms. Small firms rely stronger on bank credit, whereas large producers use more public debt and corporate bonds (Cantillo and Wright, 2000; Denis and Mihov, 2003; Faulkender and Petersen, 2006).[1] Empirical studies suggest that accounting for selection into different types of external credit is important to evaluate the effects of financial shocks. In particular, contractions in bank loan supply especially hurt small firms, and induce selection of larger producers into bond finance (Kashyap et al., 1993; Leary, 2009). Substitution from bank loans to public bonds and trade credit has also been shown during the financial crisis 2008-2009.[2] Recent work

[1] In the United States, the percentage of long-term debt held in publicly traded instruments is 32% among larger firms and 14% for smaller producers (Cantillo and Wright, 2000). In Spanish non-financial companies, public debt amounts to 10% (de Miguel and Pindado, 2001). Empirical studies suggest other firm variables that are positively related to bond finance, such as project quality, profitability, collateral, age and reputation (Cantillo and Wright, 2000; Denis and Mihov, 2003; Becker and Ivashina, 2014).

[2] See Adrian et al. (2013), Becker and Ivashina (2014), and Barraza et al. (2015) for evidence on substitution into public bonds among U.S. firms, as well as Iyer et al. (2014) for Portugal. Carbó-Valverde et al. (2016) and Coulibaly et al. (2013) document substitution into trade credit.

mainly focuses on one type of finance and analyzes the impact of credit frictions on firm-level outcomes and bilateral trade (Manova, 2013; Chaney, 2016), whereas the implications of endogenous selection into different types of external credit have received less attention.[3]

This paper develops a model with firm heterogeneity and credit frictions, that allows for both selection into exporting and into two types of external finance. We analyze how financial parameters, that determine the degree of credit frictions, endogenously affect entry and exit of firms, as well as the choice of external credit, and influence the decision to export. We assume that firms have to rely on external lenders to cover a share of fixed and variable production costs, whereas the credit contract is subject to moral hazard based on Holmstrom and Tirole (1997). The main feature of our analysis is a trade-off between two types of external finance with respect to accessibility and credit costs. While moral hazard leads to credit rationing for unmonitored finance like bonds, banks reduce agency costs through monitoring and hence facilitate access to credit, but charge a higher borrowing rate to recover additional monitoring costs.[4] This trade-off generates a sorting pattern of firms that is consistent with empirical evidence: small producers face stronger credit frictions, pay a higher borrowing rate and rely on bank finance, whereas larger firms can overcome moral hazard without banks and use cheaper bond finance.

The main contribution of our paper is to show that endogenous selection into external finance represents an additional channel of adjustment to credit frictions compared to existing models of trade and finance. For a counterfactual analysis, we exploit that our framework nests a model with credit frictions and one type of finance as a special case. In our setting with moral hazard, stronger frictions result from a larger scope of managerial misbehavior which weakens the enforcement of credit contracts, and is related to measures of creditor rights and investor protection used in the empirical literature on corporate finance.

[3]Examples for trade models with two types of finance are Egger and Keuschnigg (2015) and Cho et al. (2017) that are discussed in the literature review below.

[4]The trade-off between easier credit access and lower expected returns with bank finance is well established in the corporate finance literature (Repullo and Suarez, 2000; Agarwal and Elston, 2001; Blass and Yosha, 2003; Gorton and Winton, 2003).

We start with a closed economy and show that stronger credit frictions increase the relative advantage of bank finance as monitoring moderates the aggravated access to external funds. As a consequence, we observe an increase in the share of firms that use bank finance and a reallocation of market shares towards those producers. This endogenous selection effect attenuates the negative implications of credit frictions on product variety and welfare compared to a model with one type of finance. In general, credit frictions force the least productive firms to exit, which reduces the number of available products while increasing average productivity.[5] With endogenous selection into external credit, however, a larger fraction of producers uses more expensive bank finance, which increases the average price and hence lowers competitive pressure for the least productive firms. Consistent with evidence on banking shocks, we additionally show that an increase in borrowing costs leads to selection into cheaper bond finance. Hence, the consequences are contrary to the effects of credit frictions, as exit pressure on low productivity firms increases and losses in product variety and welfare are higher compared to a model with one type of finance.

In the open economy, credit frictions decrease the share of exporters and reduce the gains from trade if the external finance dependence of exporters is larger than of non-exporters. In particular, we show that endogenous selection into bank finance changes the welfare formula as shown in Arkolakis et al. (2012), as gains from trade do not only depend on the trade share but also on the reallocation of profits between exporters and non-exporters. Our counterfactual analysis highlights that endogenous selection into bank finance alleviates the negative effects of credit frictions on gains from trade, as financial intermediation allows more firms to benefit from exporting and reduces welfare losses from imperfect credit markets.

After presenting the analytical results, we develop a simulation of our model, whereas key parameters are chosen to match existing empirical estimates. We show that endogenous selection into external finance represents an important channel of adjustment for welfare effects in the closed and open economy. In our preferred closed economy scenario, the presence

[5] We show that the negative variety effect outweighs the productivity effect, which results in an overall welfare loss of credit frictions.

of bank credit increases welfare by 10% compared to a model with only one type of finance. The analysis shows that the role of banks in reducing credit frictions is especially important if the degree of product market competition is low, the distribution of firm productivity is less dispersed, and financing needs for fixed costs are large.

The most important implication of our results is that ignoring endogenous selection into external finance might overestimate the real effects of credit market imperfections. We further show that policy measures, aiming at reducing credit frictions, lead to very different effects across firms, depending on the source of finance. Related to this, broad measures of financial development, e.g. the ratio of private credit to GDP is endogenous in our framework and determined by financial parameters. We show that credit frictions reduce the credit to GDP ratio and lead to reallocation effects across producers.[6] Related to this, recent work shows that endowments and credit conditions determine financial development, which shapes comparative advantage and specialization patterns across sectors (Ju and Wei, 2011; Egger and Keuschnigg, 2017).

This paper is related to other recent research on firm heterogeneity and external finance. A common feature with Egger and Keuschnigg (2015) is that moral hazard based on Holmstrom and Tirole (1997) leads to credit frictions and monitoring facilitates access to finance. However, the focus of Egger and Keuschnigg (2015) is quite different as they analyze the role of venture capital versus bank credit in financing early-stage investments with little pledgeable income and high risk. Russ and Valderrama (2012) show in a closed-economy version of Ghironi and Melitz (2005) that larger firms select into bond finance. Cho et al. (2017) extend this model to a small open economy and highlight that trade liberalization induces switching from bank to bond finance which leads to additional gains from trade. Instead, we show that the negative impact of credit frictions on gains from trade is lower in a model with two types of finance relative to one type of credit. In contrast to Cho et al. (2017), this result is not driven by a financial switching channel, but rather by the positive impact

[6]For example, in our model, stronger investor protection which reduces moral hazard favors bond finance relative to bank finance.

of bank monitoring on the share of exporters in the presence of credit frictions.[7] De Fiore and Uhlig (2011) introduce selection of heterogeneous firms into bank versus bond finance in a dynamic general equilibrium model and calibrate it to replicate patterns of corporate finance in the US and the euro area.

In contrast to these studies, this paper analytically disentangles direct effects of credit frictions from endogenous selection into external finance. The presence of bank finance as additional source of credit leads to (i) level effects on aggregate outcomes, e.g. higher product variety and welfare, and (ii) changes the elasticity of aggregate variables with respect to financial shocks. Compared to the existing literature, the great advantage of our counterfactual analysis is that we can disentangle these different effects and quantify the additional impact of endogenous selection into external finance. We both theoretically and quantitatively compare the outcomes of our model in the closed and open economy to special cases with one type of finance and without credit frictions. Hence, we contribute to the existing literature on trade and financial frictions that typically focuses on one type of credit (Foellmi and Oechslin, 2010; Manova, 2013; von Ehrlich and Seidel, 2015; Chaney, 2016). These papers highlight a positive relation between financial development and the volume of exports. We additionally allow for different degrees of external finance dependence among exporters and non-exporters and show the implications for aggregate welfare. While focusing on endogenous selection into external finance, we maintain the assumption of perfect competition in credit markets. In contrast, Feenstra et al. (2014) show how credit constraints arise between firms and a monopolistic bank as the only source of credit.

The paper is organized as follows. Section 2 presents the closed economy equilibrium. Sections 3 and 4 analyze the effects of credit frictions in the closed and open economy. Section 5 shows extensions and further results of the model, and Section 6 concludes.

[7] Financial choice in Russ and Valderrama (2012) and Cho et al. (2017) is analogous to technology adoption (Lileeva and Trefler, 2010; Bustos, 2011), whereas bond finance is associated with higher fixed costs but lower marginal costs compared to bank finance. This paper features a different selection mechanism: bond finance is associated with a lower borrowing rate, both for fixed costs and variable production costs, but credit frictions aggravate access to credit.

2 Closed economy

This section introduces credit frictions and two types of external finance in a heterogeneous-firms model based on Melitz (2003). We start with the equilibrium of a closed economy, which is populated by L consumers.

2.1 Demand side

The representative consumer derives utility from the consumption of a continuum of varieties, indexed by $i \in \Omega$, according to the following CES function:

$$X = \left[\int_{i \in \Omega} x_i^{\frac{\sigma-1}{\sigma}} di \right]^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where $\sigma > 1$ is the constant elasticity of substitution and Ω is the set of varieties. Demand for one particular variety i is given by:

$$x_i = X \left(\frac{p_i}{P} \right)^{-\sigma}, \tag{2}$$

and the aggregate price index is defined as follows:

$$P = \left[\int_{i \in \Omega} p_i^{1-\sigma} di \right]^{\frac{1}{1-\sigma}}. \tag{3}$$

The following section describes the maximization problem of firms in the presence of credit frictions and two sources of external finance.

2.2 Firm behavior with credit frictions

As in Melitz (2003), there is a continuum of firms that are heterogeneous in productivity φ and offer one horizontally differentiated variety i. Labor is the only factor of production, whereas the wage is chosen as numeraire and set to one. At the entry stage, each firm pays a sunk cost f_e and draws a productivity parameter φ from a common probability distribution $g(\varphi)$.[8] Production involves both fixed costs f_d and variable costs that are inversely related to firm productivity.

We introduce credit frictions and two types of finance based on moral hazard as in Holmstrom and Tirole (1997). Throughout the paper, we distinguish between two types of finance that differ in accessibility and credit costs: bonds as unmonitored finance and bank credit as monitored finance, with index $k \in m, u$. After the entry stage, the timing of events is as follows. First, firms have to finance a fraction of fixed and variable costs before sales realize and hence sign a credit contract with an outside investor.[9] Second, after producers have received the loan, the success of investment projects depends on a project choice of the firm owner. This action is by assumption non-verifiable for external lenders and thus prone to moral hazard. Hence, investors have to ensure incentive compatibility to prevent misbehavior and potential losses from lending. This moral hazard problem creates credit rationing and selection into both types of external finance. To see this, we first consider the maximization problem of firms that sell only in the domestic market, denoted by the subscript d, whereas Section 4 extends the model to an open economy.

Empirical studies show that firms rely on external credit to finance a substantial part of fixed investments and production costs.[10] Following this evidence, we assume that firms have to sign a credit contract with an external lender to cover a fraction $\alpha_{df} \in [0, 1]$ of fixed costs, as well as a share of variable costs $\alpha_{dv} \in [0, 1]$. These shares are constant across firms and might capture a sector's external finance dependence based on differences in technology or capital intensity (Rajan and Zingales, 1995; Manova, 2013; Feenstra et al., 2014). Depending on the source of finance, the credit contract determines the gross interest rate $r_k > 1$, and the amount of credit repayment F_{dk}. We assume that firms possess no assets or wealth

[8]To solve the general equilibrium, we assume that productivity is Pareto distributed, see Section 2.3.

[9]We abstract from external finance of entry costs, whereas Bonfiglioli et al. (2018) analyze how financial frictions at the entry stage affect firm-level heterogeneity.

[10]See Rajan and Zingales (1995), Hall and Lerner (2010), among others. Evidence from the World Bank, reported in Table 4 shows that a considerable fraction of firms relies on external credit to finance new investments and working capital. We use this evidence to quantify our model in Section 3.2.

endowments to cover these costs, whereas the time lag until sales realize induces demand for external finance.[11] After having received the loan, each firm faces a positive probability of a bad shock which makes production impossible, whereas profits realize with $0 < \lambda < 1$. The maximization problem of firms can be written as:[12]

$$\begin{aligned} \max_{p_{dk}} \lambda \pi_{dk}(\varphi) &= \lambda \left[p_{dk}(\varphi) x_{dk}(\varphi) - (1-\alpha_{dv}) \frac{x_{dk}(\varphi)}{\varphi} - (1-\alpha_{df}) f_d - F_{dk}(\varphi) \right] & (4) \\ s.t \quad x_{dk}(\varphi) &= X P^{\sigma} p_{dk}^{-\sigma}(\varphi), & (5) \\ \lambda F_{dk}(\varphi) &\geq r_k \left[\alpha_{dv} \frac{x_{dk}(\varphi)}{\varphi} + \alpha_{df} f_d \right], & (6) \\ \lambda \pi_{dk}(\varphi) &\geq 0. & (7) \end{aligned}$$

If the project succeeds, firms realize sales, use their earnings to finance a fraction $(1-\alpha_{dv})$ of variable production costs, as well as a share $(1-\alpha_{df})$ of fixed costs, and they repay the amount F_{dk} to the lender. As a bad shock prevents production, firms do not realize sales and hence lenders receive no loan repayment. The participation constraint of lenders (6) ensures that expected loan repayments at least compensate for credit costs and implies that there is no alternative option of investments than lending to firms. Additionally, Eq. (7) ensures that firms will only be active if expected profits are non-negative.

We assume that there is perfect competition in credit markets such that Eq. (6) holds with equality. Solving the maximization problem leads to optimal prices which are set as a constant markup over marginal production costs:

$$p_{dk}(\varphi) = \frac{\sigma}{\sigma-1} \frac{\psi_{dkv}}{\varphi}, \tag{8}$$

where $\psi_{dkv} = 1 + \alpha_{dv} \frac{r_k - \lambda}{\lambda}$ increases in the need of external credit for variable costs α_{dv}, and

[11] Note that Holmstrom and Tirole (1997) consider wealth differences, whereas we focus on heterogeneity in firm productivity. Related to our work, Manova (2013) introduces credit frictions and credit needs for both variable production costs and fixed costs in a partial equilibrium Melitz (2003) model. Foellmi and Oechslin (2010) analyze wealth differences and credit frictions in general equilibrium. Both papers focus on one type of finance.

[12] See Appendix A.1 for a derivation of the firm's maximization problem.

in r_k. Note that the effective borrowing rate is given by $\frac{r_k}{\lambda}$, as the credit contract takes into account the success probability $\lambda < 1$. By inserting Eq. (8) into Eqs. (4)-(6), profits can be written as follows:

$$\pi_{dk}(\varphi) = \frac{s_{dk}(\varphi)}{\sigma} - \psi_{dkf} f_j, \tag{9}$$

where $\psi_{dkf} = 1 + \alpha_{df} \frac{r_k - \lambda}{\lambda}$, and sales are given by:

$$s_{dk}(\varphi) = p_{dk}(\varphi) x_{dk}(\varphi) = XP^{\sigma} \left(\frac{\sigma}{\sigma - 1} \frac{\psi_{dkv}}{\varphi} \right)^{1-\sigma}. \tag{10}$$

A higher borrowing rate r_k increases prices resulting in a reduction of sales and expected profits. In a next step, we describe the moral hazard problem that creates credit rationing and selection into external finance. After provision of the loan, a non-verifiable project choice determines the success probability. If the agent behaves diligently, profits realize with high success probability λ, as shown in the profit function (4). In case of shirking, we assume without loss of generality that the success probability is reduced to zero, whereas the firm owner can reap a non-verifiable private benefit $b_k > 0$. Hence, borrowers have incentives to pursue own advantages at the expense of project success, which can be interpreted as a disutility of effort. We further impose that private benefits are proportional to the fraction of fixed costs financed by external credit ($\alpha_{df} f_d b_k$). This assumption introduces access barriers to external finance, following the idea that larger investment projects might be more opaque and monitoring by external lenders becomes more difficult.[13] Hence, firm owners only behave diligently if the following incentive compatibility constraint is satisfied:

$$\lambda \pi_{dk}(\varphi) \geq \alpha_{df} f_d b_k. \tag{11}$$

As in Holmstrom and Tirole (1997), we assume that incentive compatibility differs for the two types of credit. On the one hand, banks are able to imperfectly monitor firms, which reduces

[13] For simplicity, we do not relate private benefits to variable production costs or firm profits. See Section 5 for a further discussion of the moral hazard approach and possible extensions.

the private benefit compared to unmonitored finance ($b_m = mb_u$, with $0 < m < 1$). Lower values of m imply a higher effectivness of monitoring, which facilitates access to external credit. On the other hand, monitoring is associated with additional costs, $c_m > 1$, leading to a higher borrowing rate ($r_m = c_m r_u > r_u$), which reduces profits (9) and thus aggravates incentive compatibility.

As profits increase in φ, the most productive firms have no incentive to shirk. However, low productivity firms might prefer to choose the bad project and reap private benefits if the expected profits of diligent behavior are not sufficiently high.[14] In equilibrium, lenders have to ensure that a credit contract satisfies condition (11) to prevent misbehavior and hence losses from lending. Note that incentive compatibility is more restrictive than the expected zero-profit requirement (7) as long as the private benefit is positive ($b_k > 0$). In this case, credit frictions prevent some low productivity firms to produce. Accordingly, incentive compatibility (11) leads to the following cutoff productivity for access to finance:

$$\varphi_{dk} = \frac{\sigma \psi_{dkv}}{\sigma - 1} \left(\frac{\sigma f_d}{QP^{\sigma}} \frac{\Omega_{dkf}}{\lambda} \right)^{\frac{1}{\sigma-1}} , \tag{12}$$

where $\Omega_{dkf} = \lambda \psi_{dkf} + \alpha_{df} b_k$ captures financial conditions consisting of credit costs and access barriers to finance. Hence, the required minimum productivity increases in credit costs ψ_{dkv} and in private benefits b_k. This result is consistent with empirical studies showing that obstacles to finance are associated with higher borrowing costs, as well as insufficient access to external credit, whereas these obstacles are especially relevant for smaller producers (Beck et al., 2005, 2006). If firms do not rely on external finance for production costs ($\alpha_{dv} = \alpha_{df} = 0$), Eq. (12) collapses to the zero-profit condition as in Melitz (2003). Comparing marginal access to finance for both types of credit leads to:

$$\frac{\varphi_{du}}{\varphi_{dm}} = \frac{\psi_{duv}}{\psi_{dmv}} \left(\frac{\Omega_{duf}}{\Omega_{dmf}} \right)^{\frac{1}{\sigma-1}} . \tag{13}$$

[14] See von Ehrlich and Seidel (2015) as well as Egger and Keuschnigg (2015) for a similar discussion of moral hazard with heterogeneous firms.

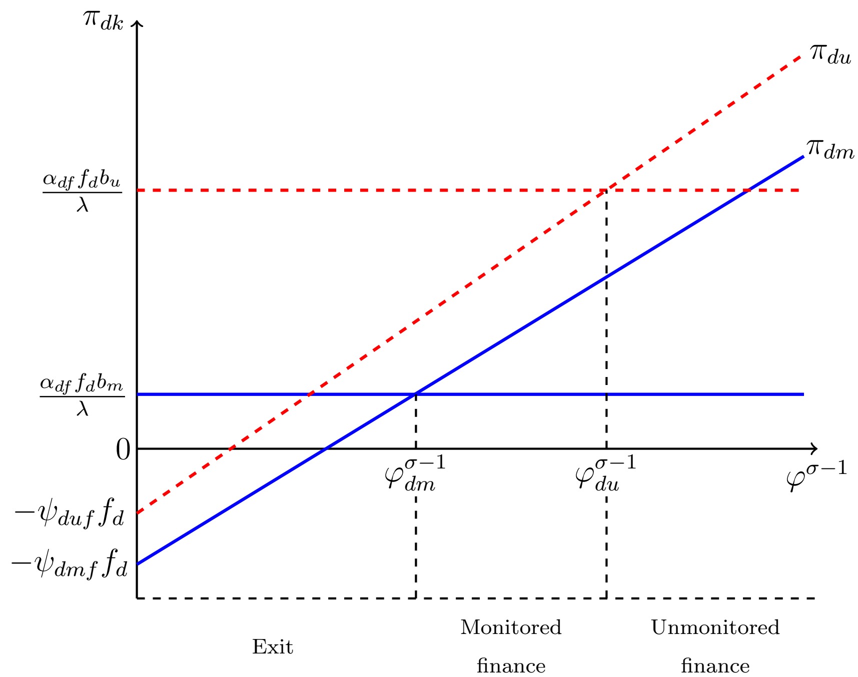

Figure 1: Selection of firms into external finance

Larger firms are more likely to raise funds directly from the financial market, such as public debt or corporate bonds, whereas smaller firms rely stronger on bank finance (Cantillo and Wright, 2000; Denis and Mihov, 2003). Consistent with this fact, we introduce a condition under which access to unmonitored finance is relatively more difficult:

Condition 1 $\varphi_{du} > \varphi_{dm}$ *if* $\frac{\psi_{duv}}{\psi_{dmv}} \left(\frac{\Omega_{duf}}{\Omega_{dmf}}\right)^{\frac{1}{\sigma-1}} > 1$

Intuitively, Condition 1 states that access to monitored finance is relatively easier if the benefit of financial intermediation (reduced moral hazard) outweighs additional borrowing costs. If the effectiveness of monitoring is very low (relatively large m) or monitoring costs c_m are very high, Condition 1 is violated and there is no selection into bank finance.

Lemma 1 *If Condition 1 holds, the most productive firms with* $\varphi \geq \varphi_{du}$ *use unmonitored finance. Producers with* $\varphi_{dm} \leq \varphi < \varphi_{du}$ *have to rely on more expensive monitored finance, while lower productivity firms* ($\varphi < \varphi_{dm}$) *cannot raise external finance at all and exit.*

Fig. 1 depicts the selection pattern of firms if Condition 1 holds, whereas a function of productivity $\varphi^{\sigma-1}$ is measured on the horizontal axis and profits are shown on the vertical axis. This selection pattern is different from models that introduce technology adoption with larger fixed costs and lower marginal production costs as in Bustos (2011). As monitored finance is associated with a higher borrowing rate for fixed costs and variable production costs, the intercept as well as the slope of the profit line π_{dm} is lower compared to unmonitored finance π_{du}. Hence, in the absence of credit frictions, unmonitored finance is always preferred to the more expensive type of credit. However, moral hazard leads to credit rationing, whereas access barriers to external funds are depicted as horizontal lines in Fig. 1. Only the most productive firms with $\varphi \geq \varphi_{du}$ obtain unmonitored finance. Producers in the intermediate range of the distribution are not able to overcome moral hazard and rely on more costly monitored finance with lower entry barrier, whereas the least productive firms have to exit.

Hence, compared to the marginal firm in the market, relative sales are determined by relative differences in productivity and borrowing costs:

$$\frac{s_{dm}(\varphi)}{s_{dm}(\varphi_{dm})} = \left(\frac{\varphi}{\varphi_{dm}}\right)^{\sigma-1}, \frac{s_{du}(\varphi)}{s_{dm}(\varphi_{dm})} = \left(\frac{\varphi}{\varphi_{dm}}\right)^{\sigma-1}\left(\frac{\psi_{dmv}}{\psi_{duv}}\right)^{\sigma-1}. \tag{14}$$

As Eq. (14) shows, firms that select into unmonitored finance have an additional advantage due to lower borrowing costs. Our selection pattern does not capture that firms use a mix of both types of finance.[15] Note that this result changes in the open economy as some exporters use both unmonitored and monitored credit (see the discussion in section 4). For the following analysis, we assume that Condition 1 is satisfied and hence both types of finance occur in equilibrium, as illustrated in Fig. 1.

[15] Note that relaxing this assumption would considerably complicate the analysis without additional significant insights. It would still hold that a larger share of unmonitored finance is associated with a competitive advantage compared to firms that rely more on bank finance. Hence, the presence of two types of finance would also lead to additional responses to changes in credit frictions, as analyzed below.

2.3 General equilibrium

In general equilibrium, free entry ensures that expected profits equal sunk entry costs:[16]

$$f_e = [1 - G(\varphi_{dm})]\, \lambda \bar{\pi}, \tag{15}$$

where $[1 - G(\varphi_{dm})]\, \lambda$ is the probability of successful entry. Domestic average profits $\bar{\pi}_d$ are given by:

$$\bar{\pi}_d = \gamma_{dm} \int_{\varphi_{dm}}^{\varphi_{du}} \pi_{dm}(\varphi)\mu_{dm}(\varphi)d\varphi + \gamma_{du} \int_{\varphi_{du}}^{\infty} \pi_{du}(\varphi)\mu_{du}(\varphi)d\varphi, \tag{16}$$

with conditional probabilities $\mu_{dm}(\varphi) = \frac{g(\varphi)}{G(\varphi_{du}) - G(\varphi_{dm})}$ and $\mu_{du}(\varphi) = \frac{g(\varphi)}{1 - G(\varphi_{du})}$. We define the shares of firms that use one type of finance as $\gamma_{dm} = \frac{G(\varphi_{du}) - G(\varphi_{dm})}{1 - G(\varphi_{dm})}$ and $\gamma_{du} = \frac{1 - G(\varphi_{du})}{1 - G(\varphi_{dm})}$. Average productivity for both groups of firms can be written as follows:

$$\bar{\varphi}_{dm} = \left[\int_{\varphi_{dm}}^{\varphi_{du}} \varphi^{\sigma-1} \mu_{dm}(\varphi) d\varphi \right]^{\frac{1}{\sigma-1}} ; \; \bar{\varphi}_{du} = \left[\int_{\varphi_{du}}^{\infty} \varphi^{\sigma-1} \mu_{du}(\varphi) d\varphi \right]^{\frac{1}{\sigma-1}} . \tag{17}$$

Using the access condition (12) and relative sales (14) allows to express average profits as:

$$\bar{\pi}_d = \frac{f_d \Omega_{dmf}}{\lambda} \left[\gamma_{dm} \left(\frac{\bar{\varphi}_{dm}}{\varphi_{dm}} \right)^{\sigma-1} + \gamma_{du} \left(\frac{\psi_{dmv}}{\psi_{duv}} \right)^{\sigma-1} \left(\frac{\bar{\varphi}_{du}}{\varphi_{dm}} \right)^{\sigma-1} \right] - \bar{f}_d, \tag{18}$$

where average fixed costs are given by $\bar{f}_d = (\gamma_{dm}\psi_{dmf} + \gamma_{du}\psi_{duf})\, f_d$. Additionally, market clearing implies that labor supply L is used for entry costs ($L_e = M_e f_e$), and for production of the two groups of firms: $L = L_e + \sum_k L_{dk}$. Analogous to Melitz (2003), we exploit that the mass of successful entrants is equal to the mass of firms that is forced to exit, which implies that $[1 - G(\varphi_{dm})]\, M_e = M$.[17] Labor market clearing determines the mass of active firms:

$$M_d = \frac{L}{\sigma\lambda \left(\bar{\pi}_d + \bar{f}_d \right)}. \tag{19}$$

[16] Appendix A.2 shows the general equilibrium in the open economy.

[17] For simplicity, we assume that the probability of the death shock is equal to 1.

Welfare can be measured as the inverse price index associated with Eq. (3):

$$W_d = \frac{1}{P} = \frac{\sigma - 1}{\sigma} \left(\frac{L}{\sigma f_d \Omega_{dmf}} \right)^{\frac{1}{\sigma-1}} \frac{\varphi_{dm}}{\psi_{dmv}}. \tag{20}$$

Welfare decreases in credit frictions related to fixed costs Ω_{dmf}, as access barriers to finance increase and hence product variety is reduced. There is an additional negative impact of credit costs for variable production ψ_{dmv}, driven by increasing prices. Finally, stronger credit frictions increase the cutoff productivity φ_{dm}, and hence reduce average prices, as the least productive firms have to exit. To show these effects analytically, we follow the literature and assume that firms draw productivity from a Pareto distribution with density $g(\varphi) = \xi \varphi^{-\xi-1}$ and positive support over $[1, \infty]$, whereas ξ is the shape parameter of the Pareto distribution. In this case, the shares of firms using monitored and unmonitored finance respectively are:

$$\gamma_{dm} = 1 - \left(\frac{\varphi_{du}}{\varphi_{dm}} \right)^{-\xi}; \ \gamma_{du} = \left(\frac{\varphi_{du}}{\varphi_{dm}} \right)^{-\xi}. \tag{21}$$

The number of firms in Eq. (19) can then be rewritten as:

$$M_d = \frac{\xi - \sigma + 1}{\xi \sigma} \frac{L}{f_d \Omega_{dmf} \left(1 + \Gamma_d\right)}. \tag{22}$$

Credit frictions aggravate access to external finance and hence enter Eq. (22) directly through Ω_{dmf}. Additionally, the difference in the two types of finance is captured by $\Gamma_d = \left(\frac{\psi_{duv}}{\psi_{dmv}} \right)^{-\xi} \left(\frac{\Omega_{duf}}{\Omega_{dmf}} \right)^{\frac{\sigma-1-\xi}{\sigma-1}} \frac{\psi_{dmv}^{\sigma-1} - \psi_{duv}^{\sigma-1}}{\psi_{dmv}^{\sigma-1}}$. This term increases both in variable credit costs ψ_{dmv} and access barriers for monitored finance Ω_{dmf} relative to unmonitored finance.

Special cases of model Note that the framework nests a model with only one type of finance as special case. If $c_m = m = 1$, differences in credit costs and accessibility between the two types of financce disappear, such that $r_u = r_m$ and $\Omega_{dmf} = \Omega_{duf}$. Consequently, the term Γ_d collapses to zero, such that there is only a direct negative effect of credit frictions on the number of firms (22).

As a second special case, we can shut down credit frictions if external finance dependence is zero ($\alpha_{df} = \alpha_{dv} = 0$), such that the model collapses to a Melitz (2003) framework.

These special cases allow us to disentangle the different effects of credit frictions on equilibrium outcomes. The number of firms compared to a model with only one type of external finance, denoted by the subscript 1, can be expressed as follows:

$$\frac{M_d}{M_{d1}} = \frac{\Omega_{duf}}{\Omega_{dmf}\left(1+\Gamma_d\right)}. \tag{23}$$

This comparison captures two differences between the models. On the one hand, financial intermediaries facilitate access to finance ($\Omega_{dmf} < \Omega_{duf}$), which increases the number of available varieties. On the other hand, the presence of two types of finance increases competitive pressure for lower productivity firms that use more expensive credit, which makes it more difficult to survive ($\Gamma_d > 0$) . Eq. (23) monotonically increases in the private benefit b. Hence, stronger credit frictions increase the relative advantage of monitored finance in terms of larger product variety. Relative welfare between the two cases is:

$$\frac{W_d}{W_{d1}} = \left(\frac{\Omega_{duf}}{\Omega_{dmf}}\right)^{\frac{1}{\sigma-1}} \frac{\varphi_{dm}\psi_{duv}}{\varphi_{dmo}\psi_{dmv}}. \tag{24}$$

Relatively larger product variety increases welfare, whereas additional costs of financial intermediation ($\psi_{dmv} > \psi_{duv}$) have a negative impact on the intensive margin. The relative productivity is determined by this trade-off as well:

$$\frac{\varphi_{dm}}{\varphi_{dm1}} = \left(\frac{\xi\Omega_{dmf}\left(1+\Gamma_d\right) - \left(\xi-\sigma+1\right)\lambda\left(\gamma_{dm}\psi_{dmf} + \gamma_{du}\psi_{duf}\right)}{\xi\Omega_{duf} - \left(\xi-\sigma+1\right)\lambda\psi_{duf}}\right)^{\frac{1}{\xi}}. \tag{25}$$

Monitored finance is associated with lower access barriers and higher average fixed costs. Both effects reduce average profits and hence the cutoff productivity compared to one type of finance. Hence, financial intermediation increases product variety, which is counteracted by an increase in average prices.

Proposition 1 *If credit frictions are sufficiently strong (large b) and monitoring effectiveness is high (low m), bank finance increases product variety and welfare compared to a model with only one type of finance.*

Proof. *See Appendix A.3.* ■

Proposition 1 shows that the positive effect of bank finance in increasing product variety outweighs the disadvantage of higher borrowing costs, in particular if firms face strong exposure to credit frictions. We use the discussed special cases when we disentangle the effects of credit frictions on the equilibrium in the following section.

3 Effects of credit frictions in closed economy

This section analyzes the effects of credit frictions on firm behavior and equilibrium outcomes. We show that selection into monitored finance represents an additional channel of adjustment compared to a model with only one type of credit. In a second step, we highlight the quantitative importance of our results, by comparing different counterfactual scenarios.

3.1 Comparative statics and selection effects

We consider an increase in private benefits b which reflects stronger credit frictions. A larger incentive to misbehave weakens the enforcement of credit contracts and increases access barriers for both types of finance in Eq. (12), which is shown by an upward shift of marginal-access lines in Fig. 2. Related to this, Antràs et al. (2009) introduce credit frictions by moral hazard and assume that private benefits are negatively related to the level of investor protection. In Section 3.2, we show that the private benefit is inversely related to private credit as a share of GDP, which is used as proxy for financial development in

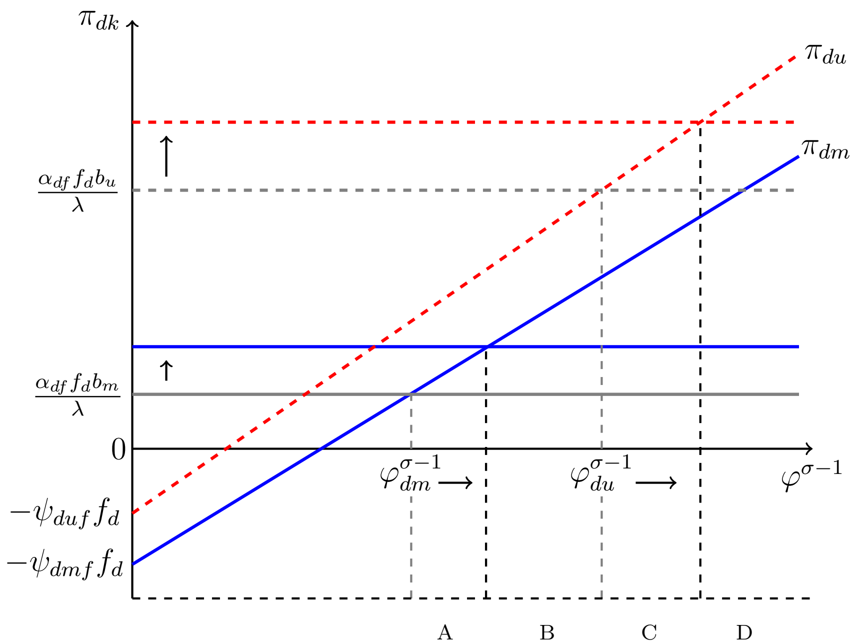

Figure 2: Effect of increase in credit frictions on firm selection

empirical studies, and is an endogenous outcome in our model.[18] Besides a change in b, credit conditions might be also influenced by changes in the borrowing rate. We discuss this alternative shock in section 5. Moreover, we highlight how the implications of financial shocks change with the effectiveness of financial intermediation, captured by the monitoring parameter m, and additional monitoring costs c_m.

Producers are affected very differently by stronger credit frictions, depending on their productivity. Firms in region A of Fig. 2 exit the market as they lose access to external finance. This reaction is consistent with existing studies that document strong negative effects of credit frictions on small firms (Beck et al., 2005, 2006). There is now a second channel of adjustment: firms in region C have to switch from unmonitored to monitored finance. This selection behavior leads to a direct negative effect on revenues and profits as switchers face larger borrowing costs, and hence set higher prices. Instead, firms in regions B and D do not change the source of external finance. Selection into monitored finance leads to a reallocation of market shares across firms, as the following proposition shows.

[18] For example, Antràs et al. (2009) and Manova (2013) use the amount of credit to the private sector relative to GDP, as well as indices of credit rights and contract enforcement as proxies for financial development.

Proposition 2 *Stronger credit frictions (reflected by a larger b) increase the fraction of firms that use monitored finance and raise their market share.*

Proof. *See Appendix A.3.* ■

Stronger credit frictions increase the relative access barrier to unmonitored funds, as monitoring reduces aggravated moral hazard. This relative benefit of financial intermediation leads to selection into monitored finance and gains in market shares of firms relying on banks. Note that larger private benefits increase the incentives to shirk, which implies that external lenders require more pledgeable income to prevent misbehavior and losses from lending. Hence, access to finance without monitoring becomes more difficult.

Following this, the impact of credit frictions on the number of active firms (22) can be separated into two effects:

$$\frac{dlnM_d}{dlnb} = -\underbrace{\frac{dln\Omega_{dmf}}{dlnb}}_{\text{Direct effect (+)}} - \underbrace{\frac{\Gamma_d}{1+\Gamma_d}\frac{dln\Gamma_d}{dlnb}}_{\text{Selection effect (-)}}. \tag{26}$$

The first term in Eq. (26) captures the exit of lowest productivity firms that lose access to external finance. The second term is a substitution effect that would not be present in a model with one source of external credit. If the private benefit b increases, a larger fraction of firms has to rely on more expensive monitored finance, which reduces the degree of competition and attenuates exit of low productivity firms.

Proposition 3 *Stronger credit frictions reduce the number of active firms if the effectiveness of monitoring is sufficiently low. The exit of firms is attenuated in the model with two types of finance compared to the special case with one type of finance.*

Proof. *See Appendix A.3.* ■

In case of perfect monitoring ($m = 0$), financial intermediation would fully eliminate credit frictions for the smallest firms, such that the negative effect in Eq. (26) disappears. However, in the presence of imperfect monitoring (with sufficiently low m), the direct effect outweighs the selection effect. There are two reasons for the smaller (negative) impact of credit frictions on product variety compared to a model with one type of finance, as shown in Proposition 3. First, monitoring of banks reduces the direct negative impact in Eq. (26). Second, selection into bank finance counteracts the negative effect.

As credit frictions increase access barriers to finance and hence prevent profitable firms from production, there is a direct negative effect on welfare. The exit of lower productivity firms counteracts this negative effect, shown by a productivity gain in the derivative of welfare (20):

$$\frac{dlnW_d}{dlnb} = \underbrace{-\frac{1}{\sigma-1}\frac{\alpha_{df}b_m}{\Omega_{dmf}}}_{\text{Direct effect}} + \underbrace{\frac{dln\varphi_{dm}}{dlnb}}_{\text{Productivity effect}} . \tag{27}$$

Proposition 4 *Stronger credit frictions reduce welfare due to a direct effect, which is counteracted by an increase in average productivity. The total welfare effect is always negative.*

Proof. *See Appendix A.3.* ■

Compared to a model with one type of finance, both welfare channels are affected by the presence of financial intermediation. Monitoring attenuates firm exit, but at the same time reduces the counteracting increase in average productivtiy in Eq. (27). In the following, we show the quantitative importance of these effects.

3.2 Quantitative results

To quantify the effects of credit frictions, we rely on standard values for the exogenous parameters from the existing literature. We follow Davis and Harrigan (2011) and set the elasticity of substitution between varieties $\sigma = 2$, and the Pareto shape parameter $\xi = 2$. Alternatively, we show results for $\sigma = 4$ and $\xi = 4.25$, as in Melitz and Redding (2015).[19] We normalize fixed entry costs f_e and domestic production costs f_d to one, which will only influence absolute values but not relative values and relative changes of outcome variables. Hence, our counterfactual analysis is not affected by this choice.

[19]The choice of $\sigma = 4$ is consistent with estimates for US plant-level trade data in Bernard et al. (2003).

To find reasonable values for the financial parameters, we exploit World Bank Enterprise Survey Data for the years 2002-2006. The sample consists of detailed firm-level data for developing countries, where credit frictions and access to external finance are highly relevant for production and investment. Table 3 shows summary statistics for credit conditions and financing choices of firms. One question asks firms to report the rate of interest for the most recent loan, which is on average 13.1%. Hence, we normalize $r_u = 1$ and choose $\lambda = 0.88$, such that borrowing costs $\frac{r_u}{\lambda} = 1.131$. As for the parameter choice of fixed costs above, this normalization will only affect levels of outcome variables, whereas we are interested in the relative difference between the two types of finance.

We further follow financial development indicators of the World Bank, as reported in Table 4 in Appendix B, to ensure that our model is in line with empirical estimates. For 2010, the average bank net interest rate margin across 203 countries in the world was 4.4%. Accordingly, we set additional monitoring costs of bank finance $c_m = 1.044$. This choice is consistent with the interest rate differential between low and high productivity firms of around 1.05, obtained from the World Bank Enterprise Surveys (see Table 3 in Appendix B). Note that low productivity firms select into more expensive monitored finance, such that our model is able to capture interest rate differentials across firms.

We are left with the choice of external finance dependence for fixed costs α_{df}, and variable production costs α_{dv}. We exploit that the share of total credit provided to firms relative to GDP is given by:

$$\frac{\text{Private Credit}}{\text{GDP}} = \frac{\sigma - 1}{\sigma\lambda} \frac{\alpha_{dv}}{\psi_{dmv}} \left(1 + \frac{\psi_{dmv} - \psi_{duv}}{\psi_{duv}} \frac{\gamma_{du}\bar{s}_{du}}{\bar{s}_d}\right) + \frac{\alpha_{df} f_d}{\lambda \bar{s}_d}. \tag{28}$$

Eq. (28) captures aggregate credit demand for variable costs and fixed costs respectively. The second term in brackets shows that firms using unmonitored finance face an interest rate advantage and hence demand more credit. Note that Eq. (28) shows a negative relationship between credit frictions b and financial development measured as private credit to GDP, as

$\frac{d(\gamma_{du}\bar{s}_{du}/\bar{s_d})}{db} < 0$, and $\frac{d\bar{s_d}}{db} > 0$. Stronger credit frictions increase access barriers to finance, which leads to higher average sales and reduces the market share of firms using unmonitored finance (see Proposition 2). Both effects reduce the demand for credit relative to GDP. Without credit frictions, Eq. (28) simplifies to $\frac{(\sigma-1)\alpha_{dv}}{\sigma\lambda\psi_{duv}} + \frac{(\xi-\sigma+1)\alpha_{df}}{\sigma\xi\lambda\psi_{duf}}$, which is clearly increasing in external finance dependence for both fixed costs and variable production costs. We set $\alpha_{dv} = 0.5 = \alpha_{df} = 0.5$, such that this expression is equal to 0.4, which is slightly above the observed world private credit to GDP ratio in 2010 (see Table 4). Starting from this average value, we analyze the effects of credit frictions and compare outcomes to a model with one type of finance.

Fig. 3 shows how the economy reacts to an increase in credit frictions, reflected by the private benefit b on the horizontal axis. To highlight the role of financial intermediation, we distinguish cases with high monitoring effectiveness ($m = 0.25$), low monitoring ($m = 0.5$), and only one type of finance (no monitoring). Starting from a case without credit frictions ($b = 0$), there is no difference between the models for very high levels of financial development. If b becomes sufficiently high, Condition 1 will be satisfied, and firms react to stronger credit frictions by selection into monitored finance (see Panel A). This reaction becomes stronger with higher effectiveness of monitoring (low m). Consequently, the increase in credit frictions is associated with a reduction of private credit to GDP in Panel B, whereas the ratio of bank to bond finance increases (C). This result captures that the availability of bond finance is larger in countries with more developed financial systems. As shown in Panels D-F, endogenous selection into monitored finance attenuates negative effects of credit frictions on product variety and welfare, especially if the effectiveness of monitoring is high.

We report results for different parameter choices in Table 1. Panel A shows outcomes for the benchmark case as described above and depicted in Fig. 3. All outcomes are evaluated for a level of agency costs $b = 1.7$. In case of high monitoring, this parameter choice implies that the share of firms using bank finance (0.5) and the credit to GDP ratio (0.37) correspond to the empirical counterparts for the world in 2010 reported in Table 4. Stronger credit

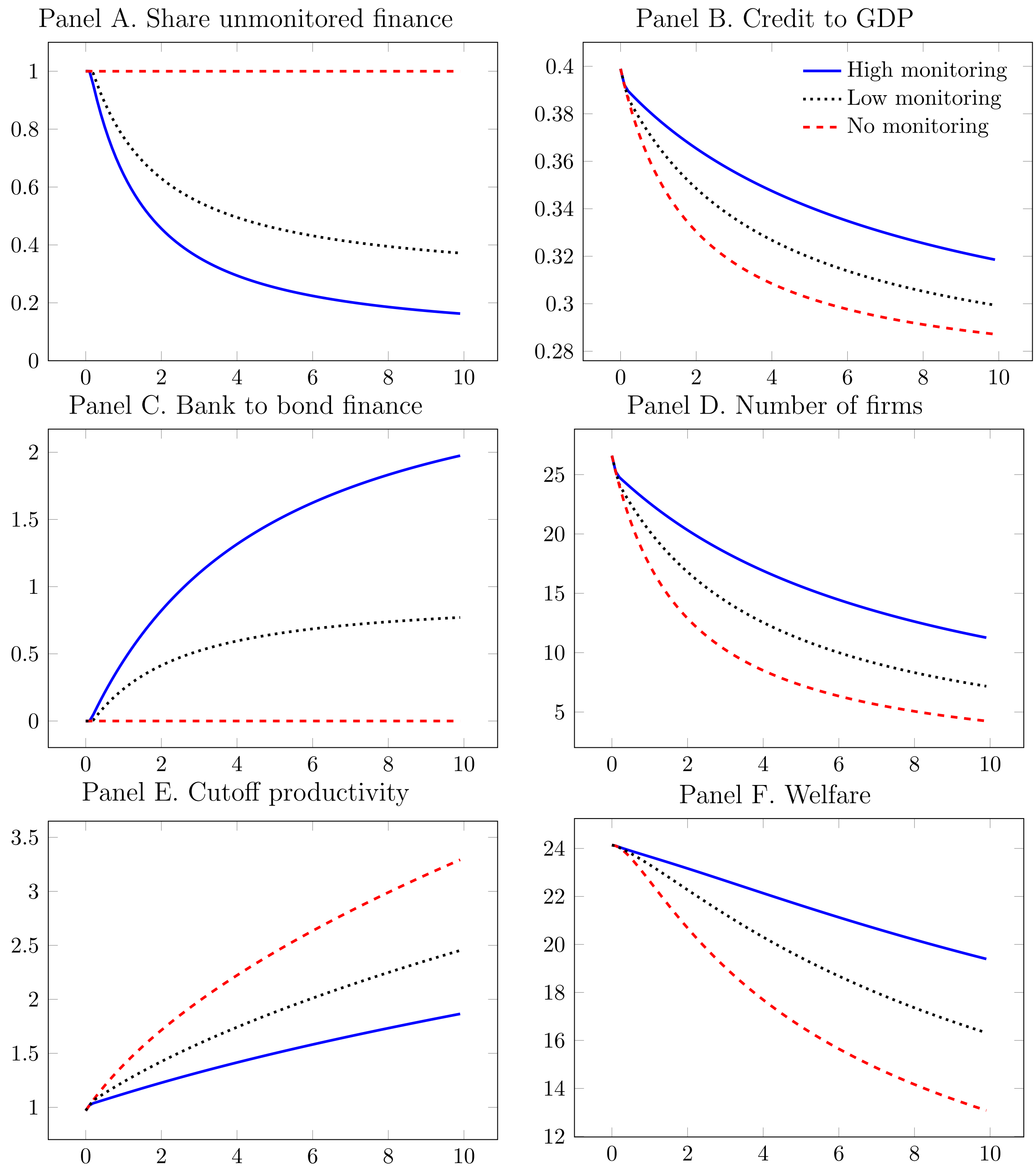

Figure 3: Effects of credit frictions in model with two types and one type of finance

frictions above this level lead to larger differences between the models as shown in Fig. 3.

We additionally report relative outcomes in columns 4-6 of Table 1. Compared to a case with only one type of finance, high monitoring increases the number of firms by 50% and welfare by 10%. The last two columns show differences to a model without credit frictions.

	Monitoring			Relative values		
	High	Low	None	High/None	High	None
A. Benchmark case, evaluated at $b = 1.7$						
Share unmonitored finance	0.50	0.66	1	-	-	-
Bank to bond finance ratio	0.72	0.37	0	-	-	-
Credit to GDP	0.37	0.35	0.34	1.08	0.93	0.85
Number of firms	20.96	17.70	13.97	1.50	0.78	0.53
Cutoff productivity	1.20	1.37	1.62	0.74	1.24	1.67
Welfare	23.32	22.59	21.24	1.10	0.97	0.88
B. With $\sigma = 4$, $\xi = 4.25$						
Share unmonitored finance	0.61	0.77	1	-	-	-
Bank to bond finance ratio	0.18	0.09	0	-	-	-
Credit to GDP	0.43	0.42	0.42	1.02	0.98	0.95
Number of firms	5.89	4.97	4.11	1.43	0.75	0.53
Cutoff productivity	1.32	1.39	1.47	0.90	1.09	1.21
Welfare	2.52	2.50	2.49	1.01	0.99	0.98
C. Only financing of fixed costs						
Share unmonitored finance	0.43	0.60	1	-	-	-
Bank to bond finance ratio	1.32	0.67	0	-	-	-
Credit to GDP	0.11	0.09	0.07	1.57	0.85	0.54
Number of firms	21.29	18.02	13.97	1.52	0.80	0.53
Cutoff productivity	1.18	1.35	1.62	0.73	1.22	1.67
Welfare	25.15	24.35	22.69	1.11	0.98	0.88

Table 1: Effects of credit frictions for different parameter choices

Without monitoring, credit frictions reduce the number of firms to 0.53 of the frictionless level, and welfare to 0.88. This welfare loss is considerably reduced to 0.97 in case of effective monitoring.

Panel B shows model outcomes for $\sigma = 4$ and $\xi = 4.25$ as in Melitz and Redding (2015). A larger σ reflects stronger product market competition, such that productivity differences across firms become more important in determining market success. A higher ξ inreases the skewness of the productivity distribution. In both cases, the relative disadvantage of low productivity firms compared to highly productive ones becomes more pronounced. Accordingly, the share of firms that use more expensive bank finance is reduced, which leads to a much lower bank to bond finance ratio. Stronger competition is also reflected by lower levels of product variety and welfare, whereas the cutoff productivity is higher. In this case, financial intermediation has a lower impact on the economy shown by smaller relative differences. As monitoring especially helps lower productivity firms to overcome credit frictions, this effect is now attenuated as these producers capture lower market shares.

We consider a special case with only financing of fixed costs ($\alpha_{df} = 0.5$, $\alpha_{dv} = 0$) in Panel C, which shuts down the effect of credit frictions on the intensive margin. Compared to the benchmark case, the lower need for credit is reflected in a reduced share of private credit to GDP and a higher fraction of firms that use more expensive bank finance. Accordingly, the bank to bond finance ratio is larger, more firms are active in the market, and welfare is increased. Relative values show that there is a larger advantage of bank finance in terms of product variety and welfare. In this case, effective monitoring reduces access barriers to finance, whereas the disadvantage of additional borrowing costs has a lower impact.

Policy implications Compared to the large literature on credit frictions and firm heterogeneity with one type of finance, our model highlights a more subtle concept of financial development. A common measure for financial development in empirical studies is the private credit to GDP ratio. In our framework, this measure is endogenously determined and can be increased by reducing credit frictions through agency costs b, or by enhancing monitoring effectiveness (lowering m). These policy measures, however, lead to very different effects across firms. Reducing agency costs b might correspond to measures that increase investor protection or creditor rights, as it reduces the scope for misbehavior. This policy measure leads to an increase in bond finance relative to bank finance and induces a reallocation of market shares towards the larger firms that already have or gain access to this type of credit (see Figure 3). In contrast, an increase in monitoring effectiveness favors bank finance and leads to a reallocation of market shares towards smaller firms.

The counterfactual analysis further shows that endogenous selection into monitored finance represents an important channel of adjustment which reduces the negative effects of credit frictions on product variety and welfare. The role of banks in reducing credit frictions is especially important if the degree of product market competition is low, the productivity distribution is less dispersed, and financing needs for fixed costs are large. Hence, the analysis implies that empirical work and policy evaluation should take into account selection into different types of finance, as changes in broad measures of financial development might not informative about different implications across firms and effects on aggregate outcomes.

In the following section, we show that selection into two types of finance also changes the gains from trade.

4 Open economy

In the open economy, active firms decide whether to additionally ship goods to an identical country. Exporting involves additional fixed costs f_x and iceberg trade costs, such that $\tau_x > 1$ units of a good have to be shipped for one unit to arrive. Moreover, we allow the external finance dependence to differ across exporters and non-exporters, captured by α_{xv} and α_{xf}. Analogous to Eq. (6), the budget constraint is given by $\lambda F_{xk}(\varphi) \geq r_k \left[\alpha_{xv} \frac{x_{xk}(\varphi)}{\varphi} + \alpha_{xf} f_x\right]$. Taking into account this cost structure, profit maximization yields the export price $p_{xk}(\varphi) = \frac{\sigma}{\sigma-1} \frac{\tau_x \psi_{xkv}}{\varphi}$, whereas $\psi_{xkv} = 1 + \alpha_{xv} \frac{r_k - \lambda}{\lambda}$. Following Eq. (11) in the closed economy, moral hazard restricts access to external finance for exports, whereas incentive compatibility is achieved whenever $\lambda \pi_{xk}(\varphi) \geq \alpha_{xf} f_x b_k$. As in the closed economy, we assume that the private benefits is positively related to fixed costs, which implies that larger projects require more effort of firm owners, or are more opaque for external lenders.[20]

Compared to the closed economy equilibrium, the selection pattern in the open economy is determined both by credit conditions and trade costs. As in Section 2.2, we assume that Condition 1 holds among exporters as well, such that $\frac{\psi_{xuv}}{\psi_{xmv}} \left(\frac{\Omega_{xuf}}{\Omega_{xmf}}\right)^{\frac{1}{\sigma-1}} > 1$. Hence, access to unmonitored finance is more difficult ($\varphi_{xu} > \varphi_{xm}$), and only the most productive firms can use the cheaper source of credit to finance export costs. We derive a second condition in the open economy by comparing the cutoff productivity for monitored finance and exporting

[20] Appendix A.2 describes the open economy equilibrium in more technical detail.

φ_{xm} with the access barrier for non-exporters that use unmonitored finance φ_{du}:

Condition 2 $\varphi_{xm} > \varphi_{du}$ *if* $\frac{\tau_x \psi_{xmv}}{\psi_{duv}} \left(\frac{f_x}{f_d} \frac{\Omega_{xmf}}{\Omega_{duf}} \right)^{\frac{1}{\sigma-1}} > 1$

This second condition is satisfied whenever trade costs and the external finance dependence of exporters compared to non-exporters are sufficiently large.

Lemma 2 *If Conditions 1 and 2 hold, the selection of firms is described by the following sorting of cutoff productivities:* $\varphi_{dm} < \varphi_{du} < \varphi_{xm} < \varphi_{xu}$.

For the following analysis, we assume that Conditions 1-2 hold.[21] The corresponding selection pattern is depicted in Fig. 4. In line with Melitz (2003), only the most productive firms with $\varphi > \varphi_{xm}$ export. Analogous to the closed economy, firms with $\varphi \geq \varphi_{du}$ have access to unmonitored finance for domestic sales. Firms with productivity $\varphi_{xm} \leq \varphi < \varphi_{xu}$ use unmonitored finance for domestic production, but have to rely on more expensive monitored finance for exporting. Note that this result is based on Condition 2. If trade costs are large and/or exporters have to finance a substantial fraction of additional trade costs by external credit, they become more prone to moral hazard. In this case, expected profits from exporting are lower compared to private benefits from shirking, and it will be more difficult to achieve incentive compatibility. Hence, only the most productive firms with $\varphi \geq \varphi_{xu}$ finance both domestic production and exports by unmonitored credit. The selection pattern is based on the assumption that external finance is raised for exports and non-exports separately. In an earlier working paper version, we show that selection effects are still present if firms need external credit for endogenous investments that are not separable across markets.[22]

[21] We neglect the possibility that Condition 2 is violated as this will only be the case for very low levels of trade costs. Our parameter choice below, with reasonable values for trade costs, is in line with Condition 2.

[22] If financing decisions are non-separable for domestic sales and exports, there might be an additional trade-off for intermediate productivity firms as additional export profits are only possible with more expensive bank finance for all investments, see Unger (2016) for details. Related to this, Eckel and Unger (2016) analyze how credit frictions affect endogenous innovations in processes and quality. Cho et al. (2017) show that trade liberalization leads to switching from bank credit to bonds which is associated with higher fixed costs, but lower marginal costs. Note that changes in trade costs do not influence the relative share of bond finance versus bank credit among exporters in our model. Instead, we show how the presence of bank finance changes the welfare response to credit frictions.

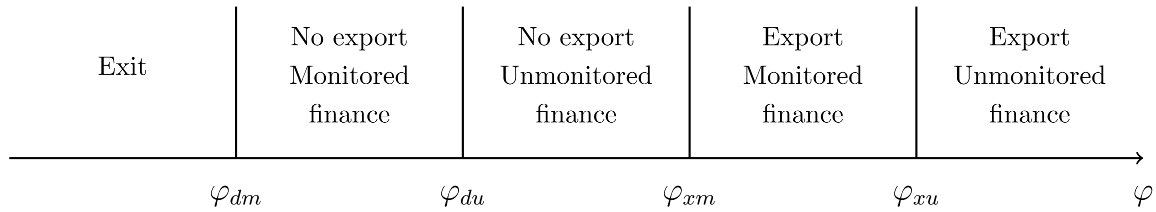

Figure 4: Selection of firms in the open economy

In the following, we analyze how the gains from trade change in the presence of credit frictions and two types of external finance. Arkolakis et al. (2012) show for a wide class of trade models that welfare gains can be expressed as a function of the domestic expenditure share, defined as the proportion of domestic sales in total sales. In our case, however, this convenient formula does not capture differences in fixed costs that arise with credit frictions and two types of finance. Instead, welfare gains from trade depend negatively on the share of domestic profits in total profits, which can be expressed as follows:[23]

$$\frac{W_T}{W_A} = \left(1 + \frac{\gamma_x \bar{\pi}_x}{\bar{\pi}_d}\right)^{\frac{1}{\xi}}, \tag{29}$$

where $\bar{\pi}_j = \bar{s}_j - \sum_k \gamma_{jk}\psi_{jkf} f_j$, with $j \in d, x$, denotes average profits of (non-)exporters, and average sales are $\bar{s}_j = \frac{\sigma\xi\Omega_{jmf} f_j (1+\Gamma_j)}{(\xi-\sigma+1)\lambda}$. The share of exporters can be written as:

$$\gamma_x = \left(\frac{\tau_x \psi_{xmv}}{\psi_{dmv}}\right)^{-\xi} \left(\frac{f_x}{f_d}\frac{\Omega_{xmf}}{\Omega_{dmf}}\right)^{\frac{-\xi}{\sigma-1}}, \tag{30}$$

which depends not only on trade costs, but also on relative access barriers to finance and credit costs of exporters compared to non-exporters. The effect of credit frictions on relative welfare in Eq. (29) can be separated into three channels:

$$\frac{dln\left(\frac{W_T}{W_A}\right)}{dlnb} = \frac{\gamma_x \bar{\pi}_x}{\xi\bar{\pi}} \left(\underbrace{\frac{dln\gamma_x}{dlnb}}_{<>0} + \underbrace{\frac{dln\bar{\pi}_x}{dlnb}}_{>0} - \underbrace{\frac{dln\bar{\pi}_d}{dlnb}}_{>0}\right). \tag{31}$$

[23]See Appendix A.2 for a derivation of welfare in the open economy.

$\bar{\pi} = \bar{\pi}_d + \gamma_x \bar{\pi}_x$ denotes total average profits. The first effect in Eq. (31) captures the change in the share of exporters, which is negative whenever exporters have to finance a larger fraction of fixed costs compared to non-exporters ($\alpha_{xf} > \alpha_{df}$), and vice versa. The change in welfare gains is further determined by the relative response of average profits of exporters compared to non-exporters. Credit frictions increase access barriers to finance, force least productive firms to exit and hence average profits increase. Gains from trade are affected whenever there is a reallocation of average profits between non-exporters and exporters, which will be the case if the external finance dependence differs across these two groups.

There are two different views how credit frictions should affect exporters compared to non-exporters. Empirical studies document a negative correlation between firm size and credit frictions (Beck et al., 2005, 2006). As only the largest firms select into international markets, we should expect that exporters are less constrained compared to smaller non-exporters. A different perspective is taken by Feenstra et al. (2014) showing that credit constraints increase with firms' export share, driven by the longer time needed for transportation of exports. This result is consistent with the focus on external finance dependence of exporters in Manova (2013) and Chaney (2016). We follow this literature and discuss welfare implications when exporters are relatively more dependent on external finance, but provide results for alternative parameter choices below. Note that our model also captures that among (non-)exporters firm size is negatively correlated with credit frictions.

As in Melitz (2003), trade liberalization leads to a higher share of exporters, reallocates market shares towards the largest firms and forces the least productive firms to exit the market. Consequently, average productivity increases which leads to welfare gains from trade. If exporters have to finance a larger fraction of fixed costs compared to non-exporters, credit frictions aggravate this selection effect. Compared to a model without credit frictions, trade liberalization induces a smaller increase in the share of exporters. As the reallocation effect is attenuated, more domestic firms survive, and average productivity increases by less. Hence, the welfare gains in Eq. (31) are reduced. In a model with two types of finance, financial intermediation alleviates negative effects of credit frictions, which allows more firms to benefit from trade. To disentangle the different effects, we compare gains from trade with two special cases. If there is only one type of finance, relative welfare gains from trade simplify to:

$$\frac{W_{T1}}{W_{A1}} = \left(1 + \gamma_{x1} \frac{f_x}{f_d} \frac{\xi \Omega_{xuf} - (\xi - \sigma + 1)\, \lambda \psi_{xuf}}{\xi \Omega_{duf} - (\xi - \sigma + 1)\, \lambda \psi_{duf}}\right)^{\frac{1}{\xi}}, \tag{32}$$

with $\gamma_{x1} = \left(\frac{\tau_x \psi_{xuv}}{\psi_{duv}}\right)^{-\xi} \left(\frac{f_x}{f_d}\frac{\Omega_{xuf}}{\Omega_{duf}}\right)^{\frac{-\xi}{\sigma-1}}$. In this case, gains from trade are determined by trade costs and differences in financial conditions between exporters and non-exporters. We also consider the case without credit frictions, such that Eq. (29) collapses to:

$$\frac{W_{T2}}{W_{A2}} = \left(1 + \left(\frac{\tau_x \psi_{xuv}}{\psi_{duv}}\right)^{-\xi} \left(\frac{f_x}{f_d}\frac{\psi_{xuf}}{\psi_{duf}}\right)^{\frac{\sigma-1-\xi}{\sigma-1}}\right)^{\frac{1}{\xi}}, \tag{33}$$

which implies that welfare gains depend only on the cost difference between exporters and non-exporters. Note that Eq. (33) nests the welfare expression of Arkolakis et al. (2012) as a special case if $\alpha_{jv} = \alpha_{jf} = 0$, such that $\psi_{juv} = \psi_{juf} = 1$. Hence, the term in brackets captures the inverse domestic trade share (domestic trade in proportion to total sales), whereas Eq. (29) shows that welfare gains in the full model are a function of the domestic profit share.[24]

We summarize the discussion in the following proposition.

Proposition 5 *If exporters have to externally finance a larger fraction of fixed costs compared to non-exporters, stronger credit frictions reduce (i) the share of exporters, and (ii) lead to a decrease in the gains from trade. Compared to a model with one type of finance, banks reduce negative effects of credit frictions on trade if monitoring is sufficiently effective.*

Proof. *See Appendix A.3.* ■

We use Eqs. (29)-(33) to quantify the gains from trade and disentangle the different channels related to credit frictions and selection into two types of finance. We choose the

[24] Note that the Melitz case would also be present if borrowing costs are the same for exporters and non-exporters, $\psi_{duv} = \psi_{xuv}$ and $\psi_{duf} = \psi_{xuf}$.

same parameter values as in Section 3.2, and compare welfare when moving from autarky to trade in the cases of monitoring, no monitoring and without frictions.

In the open economy, we additionally have to set parameter values for iceberg trade costs, fixed export costs, and the external finance dependence of exporters. We follow Melitz and Redding (2015) and set iceberg trade costs $\tau = 1.83$. We further choose export fixed costs $f_x = 1.1$, which implies that the share of exporters is equal to 0.25 in the special case of Melitz (2003). Empirical evidence further shows that exporters need additional external finance relative to non-exporters.[25] The literature provides various reasons for this finding as larger upfront investments related to exports and product customization, additional risk in foreign markets, considerable time lags between investments and the realization of sales or transit times. Following this, we set $\alpha_{xv} = \alpha_{xf} = 0.75$. We will discuss the robustness of our results to different parameter choices below.

Fig. 5 shows how the open economy reacts to changes in credit frictions, reflected by private benefits b on the horizontal axis. As discussed in Proposition 5, Panel A depicts that the share of exporters decreases with credit frictions (higher b), because exporters are more dependent on external finance compared to non-exporters. This decline is more pronounced in a model with only one type of finance. Banks reduces access barriers to finance through monitoring, which especially benefits exporters with higher external finance dependence.

Panel B of Fig. 5 depicts welfare gains from trade, as described in Eqs. (29)-(33), whereas Panel D shows substantial differences in the trade elasticity of welfare across models relative to Melitz (2003). Compared to one type of finance, banks facilitate the realization of gains from trade in the presence of credit frictions, which leads to a stronger reallocation of market shares towards exporters, and hence a decrease in the number of domestic firms relative to autarky (Panel C).

Analogous to Section 3.2, Table 4 shows model outcomes for $b = 1.7$, which corresponds to the world average of financial development. At this level, the share of exporters is 0.18,

[25] See Foley and Manova (2015) for an overview of the trade and finance literature. Manova (2013) analyzes the effects of credit frictions on exports in a partial equilibrium model of trade with one type of finance.

which is equal to the estimate obtained for US data by Bernard et al. (2007). Without monitoring, this fraction becomes 3 percentage points lower (see Panel A). In the absence of credit frictions, it increases to 0.22, shown by the dotted horizontal line in Fig. 5, which is still below the value in a Melitz world. This difference is due to borrowing costs arising from a success probability $\lambda < 1$. Panel A further shows that the welfare elasticity is reduced to 0.83 of the Melitz level without monitoring. Bank finance increases responses to trade liberalization, whereas the difference in the export share rises to about 6 percentage points for very high levels of credit frictions, when b is around 10. Note that welfare differences across models are quantitatively smaller due to the counteracting effects shown in Eq. (31).

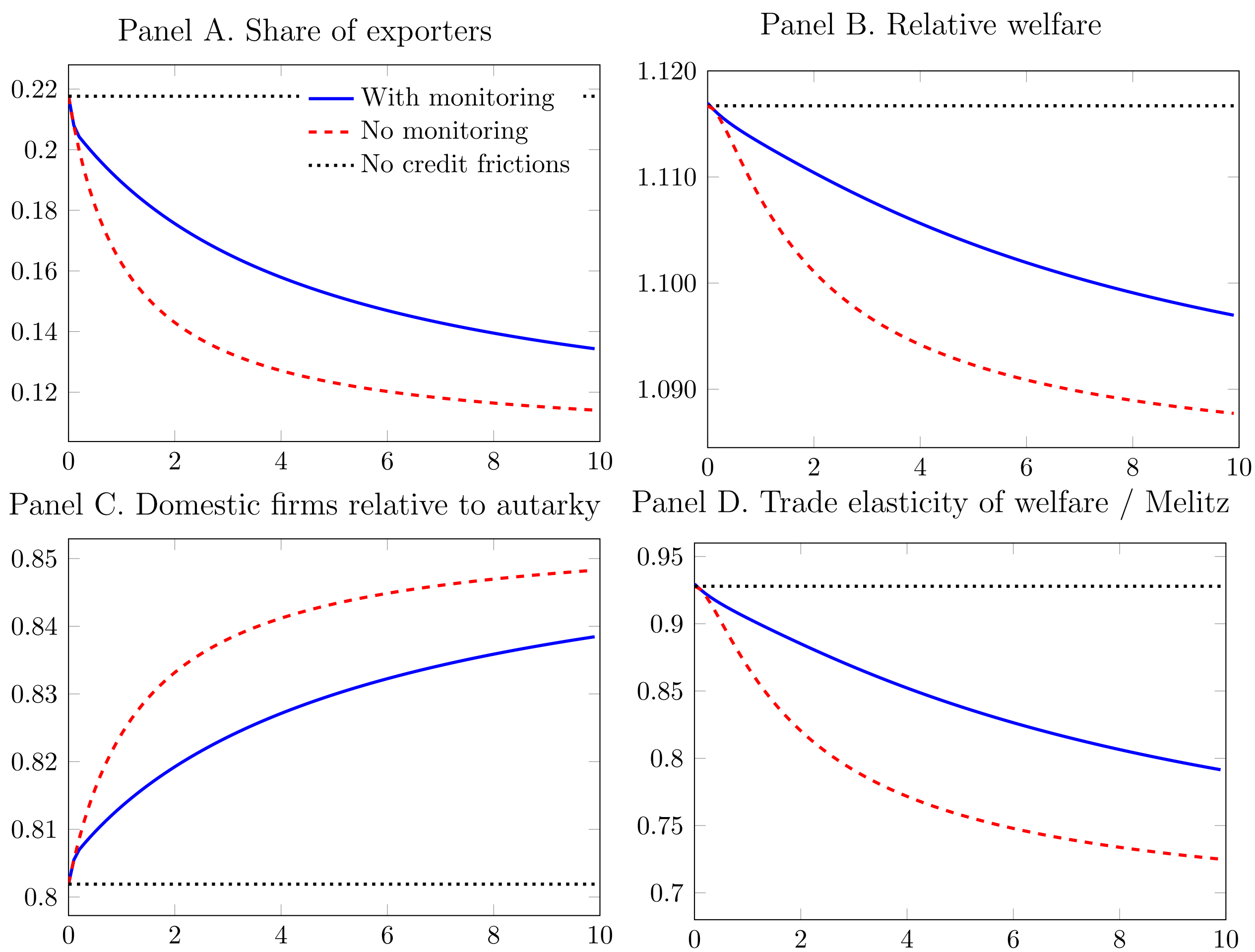

Figure 5: Effects of credit frictions on gains from trade liberalization

Panel B of Table 4 shows results for low trade costs $\tau = 1.15$, such that the share of

	With monitoring	No monitoring	No credit frictions	Melitz
A. Benchmark case				
Share of exporters	0.18	0.15	0.22	0.25
Relative welfare	1.111	1.103	1.117	1.128
Welfare elasticity	0.190	0.178	0.198	0.214
Welfare elasticity / Melitz	0.891	0.832	0.928	1
Relative domestic firms	0.818	0.831	0.802	0.786
B. Low trade costs with $\tau = 1.15$				
Share of exporters	0.55	0.45	0.67	0.76
Relative welfare	1.286	1.266	1.299	1.325
Welfare elasticity	0.395	0.376	0.408	0.431
Welfare elasticity / Melitz	0.918	0.873	0.947	1
Relative domestic firms	0.617	0.638	0.592	0.569
C. With high external finance of exporters				
Share of exporters	0.15	0.09	0.22	0.25
Relative welfare	1.112	1.092	1.120	1.128
Welfare elasticity	0.192	0.161	0.203	0.214
Welfare elasticity / Melitz	0.899	0.754	0.951	1
Relative domestic firms	0.826	0.861	0.797	0.786

Table 2: Gains from trade for different parameter values

exporters is 0.55 in the model with two types of finance, and increases to 0.67 without credit frictions. Both absolute gains from trade and the relative differences between the models become larger. The advantage of banks in reducing credit frictions becomes larger, as firms can reap higher market shares and the reallocation towards exporters is stronger.

Empirical evidence suggests that firms rely on external finance for fixed up-front costs and investments, especially in international trade.[26] In Panel C, we report results for $\alpha_{dv} = \alpha_{xv} = 0$, whereas $\alpha_{df} = 0.25$ and $\alpha_{xf} = 0.75$. As exporters have relatively high credit needs for fixed costs, both their share and absolute gains from trade decrease. However, the differences between model outcomes are larger as financial intermediation becomes more important in reducing credit frictions for exporters.

Our analysis in the open economy shows that accounting for selection into different types of finance is crucial to evaluate the effects of credit frictions on trade. By considering only one type of capital, the negative effects of financial frictions on trade might be overestimated. Financial intermediaries help to overcome access barriers to finance, especially in countries with low financial development. Hence, the effectiveness of these institutions in re-

[26]See e.g. Manova (2013), Feenstra et al. (2014), as well as Muûls (2015), among others.

ducing agency problems plays a key role and increases the positive effect on gains from trade compared to a model without financial intermediation. As in the closed economy, our counterfactual analysis shows that broad measures of financial development are not informative about selection effects across firms, but rather the effectiveness of financial intermediation relative to unmonitored finance shapes gains from trade and helps to mitigate distortions of exports. Importantly, endogenous selection into two types of finance changes the welfare formula based on Arkolakis et al. (2012) compared to a model with one type of finance, as financial shocks lead to additional reallocation effects of profits across firms.

5 Discussion and extensions

After presenting the effects of credit frictions in the closed and open economy, this section discusses implications and possible extensions of the model.

Increase in borrowing rate Besides the impact of credit frictions shown above, we consider the effects of a change in credit costs on the closed economy equilibrium. A higher borrowing rate r_u increases both fixed costs and variable production costs, and hence induces firms to set higher prices, which results in lower sales and profits.[27] In Fig. 1, profit lines shift downwards and become flatter. Comparable to an increase in private benefits b, access barriers to finance in Eq. (12) rise as well. However, selection effects work in the opposite direction, as an increase in the interest rate r_u especially hurts firms that rely on financial intermediation due to additional monitoring costs (compare Proposition 2).

Proposition 6 *A higher borrowing rate r_u increases the share of firms that use unmonitored finance and raises their market share. This selection behavior reinforces the negative effect of credit costs on the number of firms and leads to a stronger increase in average productivity.*

Proof. *See Appendix A.3.* ■

[27] Note that this shock is similar to a decrease in the success probability λ.

In contrast to changes in credit frictions, selection into unmonitored finance further reduces the average price and hence increases competition in general equilibrium. As a consequence, there is stronger exit of low productivtiy firms that have to use more expensive monitored finance, and average productivtiy increases to a larger extent compared to a model with one type of credit. Hence, an increase in credit costs affects welfare through three channels:

$$\frac{dlnW}{dlnr_u} = -\frac{1}{\sigma - 1}\frac{\alpha_{df} r_m}{\Omega_{dmf}} - \frac{\alpha_{dv} r_m}{\lambda \psi_{dmv}} + \frac{dln\varphi_{dm}}{dlnr_u}. \tag{34}$$

Analogous to Eq. (27), the first term captures the negative effect of credit costs on the extensive margin, and the last term reflects the increase in average productivity due to exit of least productive firms. As credit costs lead to higher prices, there is an additional negative effect on the intensive margin, which is shown by the second term in Eq. (34). In an earlier working paper version, we additionally show how the model can be extended to an endogenous borrowing rate, see Unger (2016).

Moral hazard and external finance dependence. Our model allows to shut down financing of variable production costs whenever $\alpha_{jv} = 0$. In this case, the reaction of credit costs on the intensive margin in Eq. (34) disappears. If a fraction of variable production costs has to be financed by external credit, there is an additional negative effect on the intensive margin, which hurts in particular low productivity firms that use more expensive monitored finance. Hence, the absence of variable cost financing favors financial intermediation (see Panel C of Table 1), and increases gains from trade, especially for lower productvity exporters (see Panel C of Table 4).

Whereas credit costs immediately affect prices and sales, there is no direct impact of private benefits b on the intensive margin. This result is based on the assumption that moral hazard is only related to fixed costs (see Section 2.2). Alternatively, private benefits could depend on the variable part of credit demand as well. However, this assumption considerably complicates the analysis, as it would not be possible to derive closed-form solutions of aggregate variables.[28] In contrast, our model allows to analytically disentangle different effects of credit frictions while remaining highly tractable. Importantly, differences in credit costs and hence effects on the intensive margin arise as a result of endogenous selection into external finance.

Effects of credit frictions in the open economy In the open economy, credit frictions induce reallocations of resources among non-exporters and exporters. The effect of private benefits b on the number of active firms is given by:[29]

$$\frac{dlnM}{dlnb} = -\frac{dln\Omega_{dmf}}{dlnb} - \frac{\Gamma_d \frac{dln\Gamma_d}{dlnb} + \gamma_x \Gamma_x \frac{f_x \Omega_{xmf}}{f_d \Omega_{dmf}} \left[\frac{dln\Gamma_x}{dlnb} + \frac{1+\Gamma_x}{\Gamma_x} \left(\frac{dln\gamma_x}{dlnb} + \frac{dln\left(\frac{\Omega_{xmf}}{\Omega_{dmf}}\right)}{dlnb} \right) \right]}{1 + \Gamma_d + \frac{\gamma_x f_x \Omega_{xmf}}{f_d \Omega_{dmf}} (1 + \Gamma_x)}. \quad (35)$$

The first effect is the same as in Eq. (26) for the closed economy and captures the exit of least productive non-exporters. This negative impact on the extensive margin is reduced as both non-exporters and exporters react to stronger credit frictions by selection into monitored finance ($\frac{dln\Gamma_j}{dlnb} < 0$, for $j \in d, x$). Moreover, the last two terms in Eq. (35) capture reallocation effects between exporters and non-exporters. If exporters have to finance a larger fraction of fixed costs by external credit ($\alpha_{xf} > \alpha_{df}$), then the share of exporters γ_x decreases in b (see Proposition 5), whereas the average productivity among exporters increases, shown by $\frac{\Omega_{xmf}}{\Omega_{dmf}}$. Note that the extensive margin effect always outweighs the intensive margin effect, which leads to the following result.

Proposition 7 *In the open economy, stronger credit frictions induce both non-exporters and exporters to select into monitored finance. If exporters need more external credit for fixed costs than non-exporters, there is a reallocation of market shares towards non-exporters. Both*

[28] By assuming only one type of finance, Irlacher and Unger (2018) develop a trade model with non-CES preferences and firm-specific credit frictions. This leads to an endogenous share of credit-rationed producers that is determined by the quality of financial institutions and industry characteristics. Related to this work, Altomonte et al. (2018) analyze the effects of firm-level credit constraints on productivity and markups.

[29] This derivative follows from the fact that $M = \frac{L}{\lambda \bar{s}}$, whereas average sales $\bar{s}$ in the open economy are defined in Eq. (A5), Appendix A.2.

effects reduce competition in equilibrium and hence attenuate the direct negative impact of credit frictions on the number of active firms.

Proof. *See Appendix A.3.* ■

If there is only one type of finance, selection effects into monitored finance disappear, such that Eq. (35) simplifies to:

$$\frac{dlnM}{dlnb} = -\frac{dln\Omega_{duf}}{dlnb} - \frac{bf_x}{f_d\Omega_{duf} + \gamma_x f_x \Omega_{xuf}} \left[\Omega_{xuf} \frac{d\gamma_x}{db} + \gamma_x \Omega_{duf} \frac{d\left(\frac{\Omega_{xuf}}{\Omega_{duf}}\right)}{db} \right]. \tag{36}$$

Reallocation effects between non-exporters and exporters vanish in the special case of same credit needs for fixed costs ($\alpha_{df} = \alpha_{xf}$). Hence, only the first effect remains in Eq. (36).

6 Conclusion

This paper analyzes the effects of credit frictions in a model where heterogeneous firms select into two types of external finance. Consistent with empirical evidence, our model captures that smaller producers face access barriers to credit, pay higher borrowing costs and rely on bank finance, whereas larger firms use cheaper bond finance. Using theoretical comparative statics, we show that endogenous selection of heterogeneous firms into external finance represents an additional channel of adjustment to changes in financial conditions. Stronger credit frictions increase the share of firms using banks that reduce aggravated access to finance through monitoring. This selection effect reallocates resources away from firms that use cheaper bond finance and hence reduces the competitive pressure in general equilibrium. Consequently, the direct negative effects of credit frictions on product variety and welfare are reduced compared to a model with one type of finance.

In the open economy, our model features selection of the most productive firms into exporting. We show that the presence of bank finance reduces negative effects of credit frictions on gains from trade. Compared to existing work, the main advantage of our model is that it nests special cases with one type of finance and without credit frictions. This allows us to theoretically disentangle the different margins of credit frictions in a heterogeneous firm model with endogenous selection into exporting and external finance. We exploit these benchmark scenarios to quantify the implications on welfare and trade.

Our results suggest that accounting for these selection effects is crucial to evaluate the role of financial frictions for aggregate outcomes. One important implication of our analysis is that the effects of credit frictions might be overestimated when endogenous selection into different types of finance is ignored. The analysis leaves some open questions for future research. We evaluate the impact of credit frictions on equilibrium outcomes and do not consider dynamic adjustment effects. Moreover, the framework builds on perfect competition in credit markets. The role of competition among banks and non-bank lenders might shape the selection of firms into external finance. While our model remains highly tractable and offers closed-form solutions for aggregate variables, it does not allow producers to use a mix of both types of finance. In this case, substitution between different sources of capital will occur not only across firms but also within firms. Additionally, we do not consider asymmetric effects across countries which might be an interesting issue to explain differences in financial choice and heterogeneous aggregate implications across borders.

A Appendix

A.1 Maximization problem of firm

Analogous to the closed economy in Section 2.2, profit maximization of a firm with export status $j \in d, x$ and external finance $k \in m, u$, leads to the following first-order condition:

$$\frac{\partial \lambda \pi_{jk}(\varphi)}{\partial p_{jk}(\varphi)} = \lambda (1-\sigma) p_{jk}(\varphi)^{-\sigma} X P^{\sigma} + \sigma \left[(1-\alpha_{jv}) \lambda + \alpha_{jv} r_k\right] \frac{\tau_j}{\varphi} X P^{\sigma} p_{jk}(\varphi)^{-\sigma-1} = 0,$$

where $\tau_d = 1$ and $\tau_x > 1$. Solving for the optimal price immediately leads to Eq. (8) in case of $j = d$. Profits (9) are obtained by inserting Eq. (8) into the objective function (4) and taking into account constraints (5) and (6). From Eq. (11) follows that incentive compatibility is just satisfied whenever $s_{jk}(\varphi_{jk}) = \frac{\sigma f_j \Omega_{jkf}}{\lambda}$, with $\Omega_{jkf} = \lambda \psi_{jkf} + \alpha_{jf} b$. Inserting optimal sales (10) leads to the cutoff productivity in Eq. (12).

A.2 General equilibrium in the open economy

Analogous to Eq. (16), average profits in the open economy can be written as:

$$\bar{\pi} = \sum_j \left[\gamma_{jm} \int_{\varphi_{jm}}^{\varphi_{ju}} \pi_{jm}(\varphi) \mu_{jm}(\varphi) d\varphi + \gamma_{ju} \int_{\varphi_{ju}}^{\infty} \pi_{ju}(\varphi) \mu_{ju}(\varphi) d\varphi\right]. \tag{A1}$$

We insert profits (9) into Eq. (A1), and express firm sales relative to the marginal non-exporter that uses monitored finance with $s_{dm}(\varphi_{dm}) = \frac{\sigma f_d \Omega_{dmf}}{\lambda}$, which leads to:

$$\begin{aligned}
\bar{\pi} &= \frac{f_d \Omega_{dmf}}{\lambda} \left[\gamma_{dm} \int_{\varphi_{dm}}^{\varphi_{du}} \left(\frac{\varphi}{\varphi_{dm}}\right)^{\sigma-1} \mu_{dm}(\varphi) d\varphi + \gamma_{du} \int_{\varphi_{du}}^{\infty} \left(\frac{\psi_{dmv}}{\psi_{duv}} \frac{\varphi}{\varphi_{dm}}\right)^{\sigma-1} \mu_{du}(\varphi) d\varphi\right] \\
&+ \frac{f_d \Omega_{dmf}}{\lambda} \left[\gamma_{xm} \int_{\varphi_{xm}}^{\varphi_{xu}} \left(\frac{\psi_{dmv}}{\tau_x \psi_{xmv}} \frac{\varphi}{\varphi_{dm}}\right)^{\sigma-1} \mu_{xm}(\varphi) d\varphi + \gamma_{xu} \int_{\varphi_{xu}}^{\infty} \left(\frac{\psi_{dmv}}{\tau_x \psi_{xuv}} \frac{\varphi}{\varphi_{dm}}\right)^{\sigma-1} \mu_{xu}(\varphi) d\varphi\right] \\
&- \sum_j \left[\gamma_{jm} \psi_{jmf} + \gamma_{ju} \psi_{juf}\right] f_j,
\end{aligned}$$

where conditional probabilities $\mu_{jk}(\varphi)$ and shares of firms γ_{jk} are defined analogous to Section 2.3. Using the definitions of average productivity

$$\bar{\varphi}_{jm} = \left[\int_{\varphi_{jm}}^{\varphi_{ju}} \varphi^{\sigma-1}\mu_{jm}(\varphi)d\varphi\right]^{\frac{1}{\sigma-1}}; \ \bar{\varphi}_{ju} = \left[\int_{\varphi_{ju}}^{\infty} \varphi^{\sigma-1}\mu_{ju}(\varphi)d\varphi\right]^{\frac{1}{\sigma-1}}, \tag{A2}$$

allows to rewrite average profits analogous to the closed economy case in Eq. (18):

$$\bar{\pi} = \frac{\bar{s}}{\sigma} - \sum_{j} \left(\gamma_{jm}\psi_{jmf} + \gamma_{ju}\psi_{juf}\right) f_j, \tag{A3}$$

where average sales are given by:

$$\bar{s} = \frac{\sigma\Omega_{dmf}f_d}{\lambda\varphi_{dm}^{\sigma-1}}\left[\gamma_{dm}\bar{\varphi}_{dm}^{\sigma-1} + \gamma_{du}\left(\frac{\psi_{dmv}\bar{\varphi}_{du}}{\psi_{duv}}\right)^{\sigma-1} + \gamma_{mx}\left(\frac{\psi_{dmv}\bar{\varphi}_{xm}}{\tau_x\psi_{xmv}}\right)^{\sigma-1} + \gamma_{ux}\left(\frac{\psi_{dmv}\bar{\varphi}_{xu}}{\tau_x\psi_{xuv}}\right)^{\sigma-1}\right].$$

Labor market clearing Labor requirements of a single firm with export status j and source of finance k are given by $l_{jk}(\varphi) = \frac{\psi_{jkv}\tau_j}{\varphi}x_{jk}(\varphi) + \psi_{jkf}f_j$, which can be written in terms of sales (10), such that $l_{jk}(\varphi) = \frac{\sigma-1}{\sigma}s_{jk}(\varphi) + \psi_{jkf}f_j$. We express labor requirements relative to the marginal non-exporter with productivity φ_{dm} and aggregate over all firms M. Labor market clearing in the open economy requires that $L = M_e f_e + \lambda\sum_j (L_{jm} + L_{ju})$, whereas $[1 - G(\varphi_{dm})]\, M_e = M$, and aggregate labor demand by group is defined as:

$$L_{jm} = M_{jm}\int_{\varphi_{jm}}^{\varphi_{ju}} l_{jm}(\varphi)\mu_{jm}(\varphi)d\varphi; \ L_{ju} = M_{ju}\int_{\varphi_{ju}}^{\infty} l_{ju}(\varphi)\mu_{ju}(\varphi)d\varphi. \tag{A4}$$

After some modifications, we obtain $L_{jk} = M_{jk}\left(\frac{\sigma-1}{\sigma}\bar{s}_{jk} + \psi_{jkf}f_j\right)$, whereas $\bar{s}_{jk}$ denotes average sales of firms with export status j and type of finance k. Finally, aggregation over the total number of firms leads to $L = \lambda M\bar{s}$.

Pareto distribution As described in Section 2.3, we assume that productivity φ is Pareto distributed with density function $g(\varphi) = \xi\varphi^{-\xi-1}$. Whereas the shares of non-exporters are still given by Eq. (21), the share of exporters is:

$$\gamma_x = \left(\frac{\tau_x \psi_{xmv}}{\psi_{dmv}}\right)^{-\xi} \left(\frac{f_x}{f_d}\frac{\Omega_{xmf}}{\Omega_{dmf}}\right)^{\frac{-\xi}{\sigma-1}}.$$

The share of exporters that use (un)monitored finance is given by:

$$\gamma_{xu} = \left(\frac{\varphi_{xu}}{\varphi_{dm}}\right)^{-\xi} = \left(\frac{\tau_x \psi_{xuv}}{\psi_{dmv}}\right)^{-\xi} \left(\frac{f_x}{f_d}\frac{\Omega_{xuf}}{\Omega_{dmf}}\right)^{\frac{-\xi}{\sigma-1}},$$

$$\gamma_{xm} = \left(\frac{\varphi_{xm}}{\varphi_{dm}}\right)^{-\xi} - \left(\frac{\varphi_{xu}}{\varphi_{dm}}\right)^{-\xi} = \gamma_x - \gamma_{xu}.$$

We can write average sales in the open economy as:

$$\bar{s} = \frac{\xi\sigma\Omega_{dmf} f_d \left[1 + \Gamma_d + \gamma_x \frac{f_x}{f_d}\frac{\Omega_{xmf}}{\Omega_{dmf}}\left(1+\Gamma_x\right)\right]}{\left(\xi - \sigma + 1\right)\lambda}, \tag{A5}$$

where $\Gamma_j = \left(\frac{\psi_{juv}}{\psi_{jmv}}\right)^{-\xi} \left(\frac{\Omega_{juf}}{\Omega_{jmf}}\right)^{\frac{\sigma-1-\xi}{\sigma-1}} \frac{\psi_{jmv}^{\sigma-1} - \psi_{juv}^{\sigma-1}}{\psi_{jmv}^{\sigma-1}}$. Note that this term collapses to the closed economy case as described in Section 2.3, if trade costs are prohibitively high such that $\gamma_x = 0$. We assume that $\xi > \sigma - 1$, to ensure a well-defined equilibrium.

Under the assumption of Pareto distributed productivity, free entry (15) implies that $\varphi_{dm} = \left(\frac{\lambda\bar{\pi}}{f_E}\right)^{\frac{1}{\xi}}$, which leads to an explicit solution for φ_{dm} in combination with Eq. (A3) and (A5).

Welfare in the open economy From Eq. (20) follows that welfare in autarky is $W_A = \frac{\sigma-1}{\sigma}\left(\frac{L}{\sigma f_d \Omega_{dmf}}\right)^{\frac{1}{\sigma-1}} \frac{\varphi_{dmA}}{\psi_{dmv}}$. Analogously, welfare under trade is $W_T = \frac{\sigma-1}{\sigma}\left(\frac{L}{\sigma f_d \Omega_{dmf}}\right)^{\frac{1}{\sigma-1}} \frac{\varphi_{dmT}}{\psi_{dmv}}$. Hence, welfare relative to autarky can be written as:

$$\frac{W_T}{W_A} = \frac{\varphi_{dmT}}{\varphi_{dmA}}. \tag{A6}$$

By taking into account free entry (15), we can rewrite welfare as in Eq. (29). Inserting the expressions of average profits as defined in the text, leads to:

$$\frac{W_T}{W_A} = \left(1 + \frac{f_x}{f_d}\frac{\gamma_x \xi \Omega_{xmf}\left(1+\Gamma_x\right) - \left(\xi - \sigma + 1\right)\lambda\left(\gamma_{xm}\psi_{xmf} + \gamma_{xu}\psi_{xuf}\right)}{\xi \Omega_{dmf}\left(1+\Gamma_d\right) - \left(\xi - \sigma + 1\right)\lambda\left(\gamma_{dm}\psi_{dmf} + \psi_{duf}\gamma_{du}\right)}\right)^{\frac{1}{\xi}}. \tag{A7}$$

Applying the special cases to Eq. (A7) immediately leads to Eqs. (32) and (33) in the main text.

A.3 Proofs

Proof of Proposition 1. From Eq. (23) follows immediately that $M_d > M_{d1}$ if $\Omega_{duf}/\Omega_{dmf} > 1 + \Gamma_d$. As $\frac{d(\Omega_{duf}/\Omega_{dmf})}{db} > 0$ and $\frac{d\Gamma_d}{db} < 0$, this condition is satisfied whenever the private benefit is sufficiently large. With respect to Eq. (25), $\varphi_{dm} < \varphi_{do}$ if

$$\xi\left[\Omega_{duf} - \Omega_{dmf}\left(1+\Gamma_d\right)\right] + \left(\xi - \sigma + 1\right)\lambda\gamma_{dm}\left(\psi_{dmf} - \psi_{duf}\right) > 0,$$

which is again satisfied as long as $\Omega_{duf}/\Omega_{dmf} > 1+\Gamma_d$, since $\psi_{dmf} > \psi_{duf}$. Hence, for relative welfare (24) holds that $W_d > W_{d1}$ if

$$\left(\frac{\Omega_{duf}}{\Omega_{dmf}}\right)^{\frac{\xi}{\sigma-1}}\left(\frac{\psi_{duv}}{\psi_{dmv}}\right)^{\xi} > \frac{\xi\Omega_{duf} - \left(\xi-\sigma+1\right)\lambda\psi_{duf}}{\xi\Omega_{dmf}\left(1+\Gamma_d\right) - \left(\xi-\sigma+1\right)\lambda\left(\gamma_{dm}\psi_{dmf} + \gamma_{du}\psi_{duf}\right)}.$$

Note that this condition is more restrictive than Condition 1, and is satisfied whenever the private benefit is sufficiently large. ■

Proof of Proposition 2. The derivative of Eq. (21) with respect to b is:

$$\frac{dln\gamma_{dm}}{dlnb} = \xi\frac{dln\left(\frac{\varphi_{du}}{\varphi_{dm}}\right)}{dlnb} = \xi\frac{\alpha_{df} b\lambda\left(\psi_{dmf} - \psi_{duf} m\right)}{\left(\sigma-1\right)\Omega_{dmf}\Omega_{duf}} > 0,$$

where $\frac{dln\gamma_{du}}{dlnb} = -\frac{dln\gamma_{dm}}{dlnb}$. We define revenue-based market shares for firms that use type of finance k as $\eta_{dk} = \frac{\gamma_{dk}\bar{s}_{dk}}{\bar{s}_d}$, whereas average sales per group are:

$$\gamma_{dm}\bar{s}_{dm} = \frac{\xi\sigma\Omega_{dmf}f_d}{(\xi-\sigma+1)\lambda}\left[1-\left(\frac{\psi_{duv}}{\psi_{dmv}}\right)^{\sigma-1-\xi}\left(\frac{\Omega_{duf}}{\Omega_{dmf}}\right)^{\frac{\sigma-1-\xi}{\sigma-1}}\right], \tag{A6}$$

$$\gamma_{du}\bar{s}_{du} = \frac{\xi\sigma\Omega_{dmf}f_d}{(\xi-\sigma+1)\lambda}\left(\frac{\psi_{duv}}{\psi_{dmv}}\right)^{-\xi}\left(\frac{\Omega_{duf}}{\Omega_{dmf}}\right)^{\frac{\sigma-1-\xi}{\sigma-1}}, \tag{A7}$$

and domestic average sales can be written as:

$$\bar{s}_d = \gamma_{dm}\bar{s}_{dm} + \gamma_{du}\bar{s}_{du} = \frac{\xi\sigma\Omega_{dmf}f_d(1+\Gamma_d)}{(\xi-\sigma+1)\lambda}. \tag{A8}$$

Taking derivatives of Eqs. (A6)-(A8) with respect to b leads to:

$$\frac{dln(\gamma_{dm}\bar{s}_{dm})}{dlnb} = \frac{dln\Omega_{dmf}}{dlnb} + \frac{\xi-\sigma+1}{\sigma-1}\frac{\psi_{duv}^{\sigma-1}\Gamma_d}{\psi_{dmv}^{\sigma-1}-\psi_{duv}^{\sigma-1}(1+\Gamma_d)}\frac{dln\left(\frac{\Omega_{duf}}{\Omega_{dmf}}\right)}{dlnb},$$

$$\frac{dln(\gamma_{du}\bar{s}_{du})}{dlnb} = \frac{dln\Omega_{dmf}}{dlnb} - \frac{\xi-\sigma+1}{\sigma-1}\frac{dln\left(\frac{\Omega_{duf}}{\Omega_{dmf}}\right)}{dlnb},$$

$$\frac{dln\bar{s}_d}{dlnb} = \frac{dln\Omega_{dmf}}{dlnb} - \frac{\xi-\sigma+1}{\sigma-1}\frac{\Gamma_d}{1+\Gamma_d}\frac{dln\left(\frac{\Omega_{duf}}{\Omega_{dmf}}\right)}{dlnb}.$$

with $\frac{dln\Omega_{dmf}}{dlnb} = \frac{\alpha_{df}mb}{\Omega_{dmf}} > 0$, and $\frac{dln\left(\frac{\Omega_{duf}}{\Omega_{dmf}}\right)}{dlnb} = \frac{\alpha_{df}\lambda b(\psi_{dmf}-\psi_{duf}m)}{\Omega_{dmf}\Omega_{duf}} > 0$. Exploiting that $\frac{dln\eta_{dk}}{dlnb} = \frac{dln(\gamma_{dk}\bar{s}_{dk})}{dlnb} - \frac{dln\bar{s}_d}{dlnb}$ leads to:

$$\frac{dln\eta_{dm}}{dlnb} = \frac{\xi-\sigma+1}{\sigma-1}\left(\frac{\psi_{duv}^{\sigma-1}\Gamma_d}{\psi_{dmv}^{\sigma-1}-\psi_{duv}^{\sigma-1}(1+\Gamma_d)} + \frac{\Gamma_d}{1+\Gamma_d}\right)\frac{dln\left(\frac{\Omega_{duf}}{\Omega_{dmf}}\right)}{dlnb} > 0,$$

$$\frac{dln\eta_{du}}{dlnb} = -\frac{\xi-\sigma+1}{\sigma-1}\frac{1}{1+\Gamma_d}\frac{dln\left(\frac{\Omega_{duf}}{\Omega_{dmf}}\right)}{dlnb} < 0.$$

■

Proof of Proposition 3. The derivative (26) follows immediately from Eq. (22), whereas the direct effect is given by $\frac{dln\Omega_{dmf}}{dlnb} = \frac{\alpha_{df}bm}{\Omega_{dmf}} > 0$, and the selection effect can be written as:

$$\frac{dln\Gamma_d}{dlnb} = \frac{\sigma - 1 - \xi}{\sigma - 1} \frac{\alpha_{df}\lambda b\left(\psi_{dmf} - \psi_{duf}m\right)}{\Omega_{duf}\Omega_{dmf}} < 0. \tag{A9}$$

The overall effect of an increase in b on the number of firms is negative as long as $\frac{dln\Omega_{dmf}}{dlnb} > -\frac{\Gamma_d}{1+\Gamma_d}\frac{dln\Gamma_d}{dlnb}$, which leads to the following condition:

$$\frac{\left(1+\Gamma_d\right)m\Omega_{duf}}{\lambda\Gamma_d} > \frac{\xi - \sigma + 1}{\sigma - 1}\left(\psi_{dmf} - \psi_{duf}m\right).$$

This conditions imposes a minimum level on the private benefit, as the LHS increases in b, whereas the RHS does not depend on b. Note further that the LHS increases in m, whereas the RHS decreases in m, such that lower monitoring effectiveness leads to a stronger impact of the direct negative effect. If there is only one type of finance, $\frac{dlnM}{dlnb} = -\frac{\alpha_{df}b_u}{\Omega_{duf}}$, which is more negative than the reaction in Eq. (26), as $\psi_{dmf} > m\psi_{duf}$. ■

Proof of Proposition 4. The derivative of welfare (27) follows immediately from Eq. (20), whereas the change in the cutoff productivity is given by:

$$\frac{dln\varphi_{dm}}{dlnb} = \frac{\alpha_{df}b\xi f_d}{\xi\bar{\pi}\Omega_{dmf}}\left[\frac{m\left(1+\Gamma_d\right)}{\left(\xi - \sigma + 1\right)\lambda} - \frac{\psi_{dmf} - \psi_{duf}m}{\sigma - 1}\left(\frac{\Gamma_d\Omega_{dmf}}{\Omega_{duf}} + \frac{\lambda\left(\psi_{dmf} - \psi_{duf}\right)\gamma_{du}}{\Omega_{duf}}\right)\right].$$

The first term is positive and captures that low productivity firms exit the market, which increases the cutoff productivity φ_{dm}. There are two counteracting negative effects, summarized by the second term, as selection into more expensive monitored finance (i) reduces average productivity, and (ii) increases average fixed costs.

The total welfare effect is negative as long as $\frac{1}{\sigma-1}\frac{\alpha_{df}bm}{\Omega_{dmf}} > -\frac{dln\varphi_{dm}}{dlnb}$, which can be simplified to the following condition:

$$\Omega_{dmf}\left[\frac{1+\Gamma_d}{\lambda} + \frac{\left(\psi_{dmf} - \psi_{duf}m\right)\Gamma_d}{m\Omega_{duf}}\right] + \left(\psi_{dmf} - \psi_{duf}\right)\gamma_{du}\left[1 + \frac{\left(\psi_{dmf} - \psi_{duf}m\right)\lambda}{m\Omega_{duf}}\right] > \psi_{dmf}.$$

Note that $\Omega_{dmf}\frac{1+\Gamma_d}{\lambda} > \psi_{dmf}$ is always satisfied for $b > 0$, such that $\frac{dlnW}{dlnb} < 0$. ■

Proof of Proposition 5. Taking the derivative of Eq. (30) immediately leads to

$$\frac{dln\gamma_x}{dlnb} = -\frac{\xi}{\sigma-1}\frac{dln\left(\frac{\Omega_{xmf}}{\Omega_{dmf}}\right)}{dlnb} = -\frac{\xi\lambda mb}{\sigma-1}\frac{\alpha_{xf}-\alpha_{df}}{\Omega_{dmf}\Omega_{xmf}}, \tag{A10}$$

which is negative whenever $\alpha_{xf} > \alpha_{df}$. The impact of monitoring m on Eq. (A10) is:

$$\frac{dln\gamma_x}{dlnbdm} = -\frac{\xi\lambda b\left(\alpha_{xf}-\alpha_{df}\right)}{\sigma-1}\frac{1-\frac{\alpha_{df}bm}{\Omega_{dmf}}-\frac{\alpha_{xf}bm}{\Omega_{xmf}}}{\Omega_{dmf}\Omega_{xmf}},$$

which is positive whenever $\frac{\alpha_{df}bm}{\Omega_{dmf}}+\frac{\alpha_{xf}bm}{\Omega_{xmf}} < 1$, i.e. monitoring effectiveness is sufficiently high (low m). Taking the derivative of Eq. (32) with respect to private benefits b leads to:

$$\frac{dln\left(\frac{W_{t1}}{W_{d1}}\right)}{dlnb} = \frac{1}{\xi}\frac{dln\left(1+\gamma_{x1}\frac{f_x}{f_d}\frac{\xi\Omega_{xuf}-(\xi-\sigma+1)\lambda\psi_{xuf}}{\xi\Omega_{duf}-(\xi-\sigma+1)\lambda\psi_{duf}}\right)}{dlnb},$$

which after some modifications can be written as

$$\frac{d\left(\frac{W_{t1}}{W_{d1}}\right)}{db} = -\frac{\left(\alpha_{xf}-\alpha_{df}\right)\lambda\chi}{\left(\sigma-1\right)\Omega_{duf}\Omega_{xuf}}\left(1-\frac{\left(\sigma-1\right)^2\Omega_{duf}\Omega_{xuf}}{\left(\xi\alpha_{df}b+\left(\sigma-1\right)\lambda\psi_{duf}\right)\left(\xi\alpha_{xf}b+\left(\sigma-1\right)\lambda\psi_{xuf}\right)}\right),$$

where $\chi = \frac{\left(\frac{W_{t1}}{W_{d1}}\right)^{\xi}-1}{\left(\frac{W_{t1}}{W_{d1}}\right)^{\xi-1}}$. In case of no credit frictions ($b = 0$), the term in brackets is zero, and hence $\frac{d\left(\frac{W_{t1}}{W_{d1}}\right)}{db} = 0$. For $b > 0$, we show that $\left(\xi\alpha_{df}b+\left(\sigma-1\right)\lambda\psi_{duf}\right)\left(\xi\alpha_{xf}b+\left(\sigma-1\right)\lambda\psi_{xuf}\right)-\left(\sigma-1\right)^2\Omega_{duf}\Omega_{xuf} > 0$. To see this, we take the derivative of this condition with respect to b, which after some modifications leads to

$$2\alpha_{df}\alpha_{xf}b\left[\xi^2-\left(\sigma-1\right)^2\right]+\left(\sigma-1\right)\left(\xi-\sigma+1\right)\lambda\left(\alpha_{df}\psi_{xuf}+\alpha_{xf}\psi_{duf}\right) > 0.$$

This implies that $\frac{d\left(\frac{W_{t1}}{W_{d1}}\right)}{db} < 0$ whenever $b > 0$ and $\alpha_{xf} > \alpha_{df}$. For the case of two types of finance, taking the derivative of Eq. (29) leads to:

$$\frac{d\left(\frac{W_t}{W_d}\right)}{db}=\frac{\left(\frac{W_t}{W_d}\right)^{\xi}-1}{\left(\frac{W_t}{W_d}\right)^{\xi-1}}\left(-\frac{\lambda m\left(\alpha_{xf}-\alpha_{df}\right)}{\left(\sigma-1\right)\Omega_{dmf}\Omega_{xmf}}+\frac{d\Theta_x}{db}-\frac{d\Theta_d}{db}\right).$$

The direct negative impact of credit frictions is reduced by monitoring, captured by $m<1$ in the first term in brackets. Credit frictions further lead to a reallocation of market shares across exporters ($j=x$) and non-exporters ($j=d$), captured by

$$\frac{d\Theta_j}{db}=\alpha_{jf}\frac{m\left(1+\Gamma_j\right)-\frac{(\xi-\sigma+1)\lambda\left(\psi_{jmf}-\psi_{juf}m\right)}{(\sigma-1)\Omega_{juf}}\left(\Gamma_j+\frac{\gamma_{ju}}{\gamma_j}\frac{\lambda\left(\psi_{jmf}-\psi_{juf}\right)}{\Omega_{jmf}}\right)}{\xi\Omega_{jmf}\left(1+\Gamma_j\right)-\left(\xi-\sigma+1\right)\lambda\left(\psi_{jmf}-\frac{\gamma_{ju}}{\gamma_j}\left(\psi_{jmf}-\psi_{juf}\right)\right)}.$$

We additionally express the share of domestic firms with trade compared to autarky as

$$\frac{M}{M_d}=\frac{\bar{s}_d}{\bar{s}}=\frac{1+\Gamma_d}{1+\Gamma_d+\gamma_x\frac{f_x}{f_d}\frac{\Omega_{xmf}}{\Omega_{dmf}}\left(1+\Gamma_x\right)}. \tag{A11}$$

With one type of finance, this ratio simplifies to

$$\frac{M_1}{M_{d1}}=\frac{1}{1+\gamma_{x1}\frac{f_x}{f_d}\frac{\Omega_{xuf}}{\Omega_{duf}}}. \tag{A12}$$

Taking the derivative of Eq. (A12) with respect to b leads to

$$\frac{dln\left(\frac{M_1}{M_{d1}}\right)}{dlnb}=\frac{\xi-\sigma+1}{\sigma-1}\frac{\left(\alpha_{xf}-\alpha_{df}\right)\lambda b\gamma_{x1}f_x}{\Omega_{duf}\left(f_d\Omega_{duf}+\gamma_{x1}f_x\Omega_{xuf}\right)},$$

which is positive whenever $\alpha_{xf}>\alpha_{df}$. The derivative of Eq. (A11) can be written as

$$\frac{dln\left(\frac{M}{M_d}\right)}{dlnb}=\frac{\xi-\sigma+1}{\sigma-1}\frac{\gamma_x\left(1+\Gamma_x\right)f_x\lambda b\Xi}{f_d\Omega_{dmf}\left(1+\Gamma_d\right)+\gamma_xf_x\Omega_{xmf}\left(1+\Gamma_x\right)}.$$

with $\Xi=\frac{m\left(\alpha_{xf}-\alpha_{df}\right)}{\Omega_{dmf}}+\frac{\alpha_{xf}\Gamma_x\left(\psi_{xmf}-\psi_{xuf}m\right)}{\Omega_{xuf}(1+\Gamma_x)}-\frac{\alpha_{df}\left(\psi_{dmf}-\psi_{duf}m\right)\Omega_{xmf}\Gamma_d}{\Omega_{duf}\Omega_{dmf}(1+\Gamma_d)}$. Compared to Eq. (A12), monitoring reduces the direct effect, as $m<1$. Selection of exporters into monitored finance leads to a positive effect on the relative firm number, whereas selection of non-exporters has a negative impact, shown by the second and third terms of Ξ respectively. ■

Proof of Proposition 6. Taking the derivative of Eq. (21) with respect to r_u leads to:

$$\frac{dln\gamma_{du}}{dlnr_u}=\frac{\xi r_u}{\lambda}\left(\frac{\alpha_{dv}\left(1-\alpha_{dv}\right)\left(c_m-1\right)}{\psi_{duv}\psi_{dmv}}+\frac{\lambda\alpha_{df}}{\sigma-1}\frac{c_m\Omega_{duf}-\Omega_{dmf}}{\Omega_{dmf}\Omega_{duf}}\right)>0.$$

Following the proof of Proposition 2, the effect of credit costs on the market share of firms with unmonitored finance is given by:

$$\frac{dln\left(\gamma_{du}\bar{s}_{du}\right)}{dlnr_u}=\frac{dln\Omega_{dmf}}{dlnr_u}-\xi\frac{dln\left(\frac{\psi_{duv}}{\psi_{dmv}}\right)}{dlnr_u}-\frac{\xi-\sigma+1}{\sigma-1}\frac{dln\left(\frac{\Omega_{duf}}{\Omega_{dmf}}\right)}{dlnr_u}>0,$$

with $\frac{dln\Omega_{dmf}}{dlnr_u}=\frac{\alpha_{df}r_m}{\Omega_{dmf}}>0$, $\frac{dln\left(\frac{\psi_{duv}}{\psi_{dmv}}\right)}{dlnr_u}=\frac{\alpha_{dv}r_u(1-\alpha_{dv})(1-c_m)}{\lambda\psi_{duv}\psi_{dmv}}<0$, $\frac{dln\left(\frac{\Omega_{duf}}{\Omega_{dmf}}\right)}{dlnr_u}=\frac{\alpha_{df}r_u\left(\Omega_{dmf}-\Omega_{duf}c_m\right)}{\Omega_{dmf}\Omega_{duf}}<0$. Analogous to Eq. (26), the impact of r_u on the number of active firms can be derived as:

$$\frac{dlnM}{dlnr_u}=-\frac{dln\Omega_{dmf}}{dlnr_u}-\frac{\Gamma_d}{1+\Gamma_d}\frac{dln\Gamma_d}{dlnr_u}, \tag{A16}$$

where the selection effect is:

$$\frac{dln\Gamma_d}{dlnr_u}=\left(\xi+\frac{\left(\sigma-1\right)\psi_{duv}^{\sigma\text{-}1}}{\psi_{dmv}^{\sigma\text{-}1}-\psi_{duv}^{\sigma-1}}\right)\frac{\alpha_{dv}r_u}{\lambda}\frac{\left(1-\alpha_{dv}\right)\left(c_m-1\right)}{\psi_{duv}\psi_{dmv}}+\frac{\xi-\sigma+1}{\sigma-1}\frac{\alpha_{df}r_u\left(c_m\Omega_{duf}-\Omega_{dmf}\right)}{\Omega_{dmf}\Omega_{duf}}>0.$$

The effect of r_u on the cutoff productivity φ_{dm} in Eq. (34) is

$$\frac{dln\varphi_{dm}}{dlnr_u}=\frac{1}{\xi}\frac{\xi\Omega_{dmf}f_d\left(1+\Gamma_d\right)\left(\frac{dln\Omega_{dmf}}{dlnr_u}+\frac{dln\Gamma_d}{dlnr_u}\frac{\Gamma_d}{1+\Gamma_d}\right)-\left(\xi-\sigma+1\right)r_u\lambda\frac{d\tilde{f}_d}{dr_u}}{\xi f_d\Omega_{dmf}\left(1+\Gamma_d\right)-\left(\xi-\sigma+1\right)\lambda\tilde{f}_d},$$

where the change in average fixed costs is $\frac{d\tilde{f}_d}{dr_u} = (1-\gamma_{du})\frac{d\psi_{dmf}}{dr_u} + \gamma_{du}\frac{d\psi_{duf}}{dr_u} - \frac{d\gamma_{du}}{dr_u}(\psi_{dmf} - \psi_{duf})$, with $\frac{d\psi_{dkf}}{dr_u} > 0$ and $\frac{d\gamma_{du}}{dr_u} > 0$. Hence, selection into unmonitored finance, captured by $\frac{dln\Gamma_d}{dlnr_u} > 0$ reinforces the negative impact of credit costs on the extensive margin, and leads to a stronger increase in average productivity. ■

Proof of Proposition 7. The elasticity in Eq. (35) follows from the derivative of Eq. (A5) in Appendix A.2, and by taking into account that $M = \frac{L}{\lambda\bar{s}}$. As shown in the proof of Proposition 3, $\frac{dln\Omega_{dmf}}{dlnb} = \frac{\alpha_{df}bm}{\Omega_{dmf}} > 0$ and $\frac{dln\Gamma_d}{dlnb} < 0$, see Eq. (A9). Analogously, selection of exporters into monitored finance is captured by:

$$\frac{dln\Gamma_x}{dlnb} = \frac{\sigma - 1 - \xi}{\sigma - 1}\frac{\alpha_{xf}\lambda b\left(\psi_{xmf} - \psi_{xuf}m\right)}{\Omega_{xuf}\Omega_{xmf}} < 0.$$

The effects of reallocation between non-exporters and exporters in Eq. (35) are given by $\frac{dln\gamma_x}{dlnb} = -\frac{\xi\lambda mb\left(\alpha_{xf}-\alpha_{df}\right)}{(\sigma-1)\Omega_{dmf}\Omega_{xmf}}$, see Eq. (A10), and $\frac{dln\left(\frac{\Omega_{xmf}}{\Omega_{dmf}}\right)}{dlnb} = \frac{mb\lambda\left(\alpha_{xf}-\alpha_{df}\right)}{\Omega_{dmf}\Omega_{xmf}}$. If $\alpha_{xf} > \alpha_{df}$, the combined effect $\frac{dln\gamma_x}{dlnb} + \frac{dln\left(\frac{\Omega_{xmf}}{\Omega_{dmf}}\right)}{dlnb}$ is clearly negative as $\xi > \sigma - 1$. ■

B Financial development indicators

	Obs.	Mean	St. Dev.	Min.	Max.
A. Annual rate of interest of most recent loan					
All firms	18,638	13.10	10.70	0	100
Exporters	4,930	12.13	9.99	0	100
Non-exporters	13,486	13.50	10.94	0	100
High productivity firms	11,852	12.88	11.43	0	100
Low productivity firms	6,786	13.49	11.43	0	100
Large firms	9,384	12.37	10.95	0	100
Small firms	9,254	13.85	10.39	0	100
B. Constrained access to external finance					
All firms	66,810	0.21	0.41	0	1
Exporters	13,313	0.23	0.42	0	1
Non-exporters	52,324	0.20	0.40	0	1
High productivity firms	37,283	0.18	0.38	0	1
Low productivity firms	29,527	0.25	0.43	0	1
Large firms	30,976	0.22	0.41	0	1
Small firms	35,834	0.20	0.40	0	1

Table 3: Firm-level credit constraints, Source: World Bank Enterprise Surveys, 2002-2006.
Notes: Credit constraints are based on a question whether access to finance is an obstacle to business: 0=no obstacle, 1=minor obstacle, 2=moderate, 3=major, 4=very severe. A firm faces constrained access if it reports 3 or 4. Classification of large firms is based on a value of log number of workers above the sample mean. Analogously, high productivity firms have a value of labor productivity above the mean.

Financial indicator	World	Developing countries
2010		
Private credit by deposit money banks to GDP (%)	38.2	24.2
Private bank credit / private debt securities	1.04	1.95
Firms with bank loan / line of credit (%)	49.0	46.6
Firms using banks to finance investments (%)	32.7	31.0
Firms using banks to finance working capital (%)	40.5	39.2
Bank net interest margin (%)	4.4	5.3
2015		
Private credit by deposit money banks to GDP (%)	44.5	31.7
Private bank credit / private debt securities	1.00	1.65
Firms with bank loan / line of credit (%)	32.8	32.8
Firms using banks to finance investments (%)	29.3	29.3
Firms using banks to finance working capital (%)	32.0	32.0
Bank net interest margin (%)	3.6	4.4

Table 4: Financial development indicators, Source: World Bank

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