Financial Constraints and Exports

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December 2, 2015

Abstract

How do firms' financial constraints, which restrict their borrowing, dynamically impact exports? This paper finds that after controlling for the endogeneity of financial constraints, constrained firms are less likely to export, and relaxing financial constraints leads to an increase in exports. In the model, imperfect contract enforceability restricts firms' borrowing. Firms use retained earnings to accumulate capital, relax financial constraints, and start exporting. Variations in firm age and financial environments can be used to solve the endogeneity problem of financial constraints. Using a firm-level data set in 26 developing countries between 2001 and 2013, we empirically find that constrained firms are 61.5% less likely to export, constrained exporters export 74.2% less, and relaxing financial constraints increases firms' exports. These results suggest that developing countries need to improve financial environments in ways besides currently used export-stimulating policies.
JEL Classifications: F12, F14, F15, F17, F36, F60

Keywords: Financial constraint, Export, Imperfect contract enforceability, Firm growth, Financial development

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1 Introduction

As the world becomes more globalized, exports in developing countries have grown dramatically. From 1990 to 2008, this increase was approximately 350%.[1] Recent literature, including Manova (2013) and other papers[2], points out that financial frictions affect firms' exports. Complementing the literature regarding the static impacts of financial frictions on exports, this paper explores how firms' financial constraints *dynamically* affect their exports. Firms are financially constrained if they cannot borrow as much as they would in the complete financial market. Unveiling the dynamic impacts of financial constraints on exports helps to understand export growth at the firm level.

The endogeneity of firms' financial constraints and exports presents a challenge when exploring the dynamic impacts of financial constraints on exports. Given productivity and the financial environment, firms choose their financing and exports to maximize profits. Because of this, simply regressing firms' export growth on their financial constraint status does not help to identify the causal relationship between firms' financial constraints and exports.

To correctly estimate the dynamic impacts of financial constraints on firms' exports, this paper first proposes a theoretical explanation on how exogenous variations in firm age and financial environment may impact firms' relaxation of financial constraints and further export dynamics. In the model, entrepreneurial firms in the heterogenous good sector use labor and capital to produce. Firms are heterogeneous in productivity and receive idiosyncratic productivity shocks. In order to start production, entrepreneurs need to borrow the initial setup costs from a financial intermediatory, and enter into a contract that specifies future investments, repayments, and dividends. Financial frictions arise because entrepreneurs may deviate with a portion of capital. Imperfect contract enforceability leads the financial inter-

[1] The author's calculation from World Trade Organization Millennium Development Goals.

[2] For example, see Beck (2002), Matsuyama (2005), Do and Levchenko (2007), Ju and Wei (2011), Manova (2013) and Chaney (2013) for theoretical models, and Berman and Hericourt (2010), Minetti and Zhu (2011), Amiti and Weinstein (2011) for empirical evidence.

mediatory to design a contract in which entrepreneurs have incentives to stay in production. With the additional contract enforcement constraint, entrepreneurial firms may not reach the optimal capital level immediately. Instead, firms use retained earnings to invest until they reach the optimal capital level. Firms start to export when their capital and production grow and consequently lead to variable profits being large enough to cover fixed export costs. When firms reach their optimal capital level, their export volumes become stabilized.

The model implies that the relaxation of financial constraints and export status of firms are both endogenous. There are two exogenous variations that may affect firms' financial constraints and consequently exports. First, firm age, or how long they have accumulated capital, impacts the financial constraints of firms. Second, variations in the financial environment generate different degrees of imperfect contract enforceability, and consequently affect firms' financial constraints and further their exports. We derive two testable propositions. The first proposition states that given productivity, older firms and/or firms in better financial environments are less financially constrained and export more at both extensive and intensive margins. The second proposition states that firms may start to export even when they were previously constrained; the probabilities of starting to export are higher when firms' financial constraints become relaxed; the growth rate of export volume is higher when firms are financially constrained.

In order to estimate the impacts of financial constraints on exports, we employ firm-level data in 26 Eastern European and Central Asian countries between 2001 and 2013, jointly collected by the European Central Bank and the World Bank. There are two advantages to this data set. First, the data set provides a direct measure of firm-level financial constraints. Second, firms are located in different countries and face different financial environments, which generates variations in contract enforceability and therefore helps us to solve the endogeneity problem of financial constraints. We empirically define firms as financially constrained if they had incentives to borrow more but were rejected by a financial intermediary,

or if they did not apply for loans at all because the cost of the loans was prohibitive. We employ the instrument variable method to test the two propositions. The instruments are a legal rights index and a depth of credit information index of countries from the World Bank. These two variables proxy the financial development of countries, and other than affecting firms' financial constraints, are not correlated with firms' exports. After correcting the endogeneity problem of financial constraints, an average firm with financial constraints is 61.5% less likely to export. Within exporters, an average firm with financial constraints exports less by 74.2%. We also empirically confirm that relaxing financial constraints stimulates firms to exports and that export growth rates are higher when firms are financially constrained. Results are robust to industry variations in external finance reliance and to firm-level variations in legal enforcement.

This paper contributes empirically and theoretically to the dynamic impacts of financial constraints on firms' exportation. The empirical findings complement previous supporting evidence for the impacts of financial constraints on firms' exportation in a variety of countries and time spans, as seen in Berman and Hericourt (2010), Minetti and Zhu (2011), Amiti and Weinstein (2011), Bellone et al. (2010), Fan et al. (2015), Chan and Manova (2015), and Muuls (forthcoming).[3] In the theory, Manova (2013) develops a static model to show that firms in sectors with higher external finance dependence in financially developed countries are more likely to export; Chaney (2013) theoretically shows that liquidity shocks may prevent firms from exporting; Besedes, et al. (2014) develops a dynamic model in which exports of financially constrained firms with riskier projects grow faster. In contrast to that model, this paper provides a dynamic model in which limited contract enforcement leads to firms' financial constraints, and variations in financial environments result in different dynamic relaxations of financial constraints and therefore different export dynamics of firms. This paper is different from Besedes, et al. (2014) in two dimensions. First, this paper focuses on the export dynamics at both extensive and intensive margins, while Besedes, et al. (2014)

[3]Greenway et al. (2007) find no impacts of firms' financial conditions on exports using United Kingdom firm-level data.

focuses only on the intensive margin of exports. This paper can examine both extensive and intensive margins of exports because of its modeling. It models how firms accumulate capital to relax financial constraints, and then begin exporting when they are able to cover the fixed costs of exporting. Then firms' export volume grows until they reach the optimal capital level. In contrast, Besedes, et al. (2014) models export dynamics as being a result of lower risks for experienced exporters. Because they compare project risks between new and experienced exporters, they focus on the intensive margin of export only. Second, this paper explains export dynamics as a part of firm dynamics. We find the empirical supporting evidence that exporters are less constrained and accumulate more fixed assets (the empirical proxy of capital). The empirical findings are consistent with our model that firms accumulate capital and grow in order to relax financial constraints, and then start exporting. In contrast, Besedes, et al. (2014) explains export dynamics as a result of the product-level project risk decrease with export duration. Actually, Besedes, et al. (2014) shuts down the capital growth mechanism by assuming that retained profits of firms cannot be carried over to subsequent periods.

This paper also complements two other trends of literature—firm dynamics theory and the impacts of legal and financial systems on firms. In the trend of firm dynamics theory, Albuquerque and Hopenhayn (2004), Cooley et al. (2004), and Arellano et al.(2010) develop models to show how financial frictions affect firm growth. This paper adds to the firm growth theory by showing that variations in financial environments across countries result in different export dynamics of firms. This paper also contributes to literature regarding the impacts of legal and financial systems on firm performance. Beck et al. (2005) finds that small firms are most constrained by financial and legal system problems; Banerjee and Duflo (2014) estimates firms' financial constraints by using variations in access to a targeted lending program; Ju and Wei (2011) theoretically proves that the quality of a financial system can be a comparative advantage of international trade.[4] Following this trend of

[4]For more evidence, see Demirguc-Kunt and Maskimovic (1998) and Chan and Manova (2015).

literature, this paper models that the variations in financial environments lead firms to have different paths to relax their constraints and therefore will have different export growth paths. It theoretically proves and empirically confirms that young firms are more financially constrained because they have not accumulated capital to the optimal level and therefore have not reached the optimal export volume, which is consistent with results in Beck et al. (2005).

The remainder of the paper is organized as follows: Section 2 specifies the model, derives testable propositions, and provides a numerical example. Section 3 describes data, characterizes estimation strategies, and displays benchmark results and robustness checks. Section 4 concludes.

2 Model

Time is discrete and the time horizon is infinite. There are two symmetrical countries, home and foreign. We focus on the home country and variables for the foreign country are denoted with an accent ($\hat{}$). Consumers consume homogeneous and heterogeneous goods. The homogenous good sector is under perfect competition and has no financial friction. The homogeneous good is freely traded and therefore serves as numeraire. Labor is the only factor used and we assume one unit of labor can produce one unit of homogeneous good. As a result, the wage is determined as $w = 1$. The second sector under monopolistic competition produces a continnum of differentiated goods and faces financial frictions. We focus on the heterogenous good sector below.

2.1 Preference

Consumers in the home country consume C, an aggregate of the homogeneous good q_0 and differentiated goods $q(\omega)$ indexed by ω: $C = q_0^{1-\psi}\big[\int_{\omega\in\Omega} q(\omega)^{\frac{\sigma-1}{\sigma}} d\omega\big]^{\frac{\sigma}{\sigma-1}\psi}$, where ψ is the cost share of heterogeneous goods, Ω is the set of available heterogeneous goods, and σ is

the elasticity of substitution for heterogeneous goods. The price index in the differentiated sector is $P = \left[\int_{\omega\in\Omega} p(\omega)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$. If the total expenditure on the differentiated goods is R, the demand for the product with price $p(\omega)$ is

$$q(\omega) = \frac{p(\omega)^{-\sigma}R}{P^{1-\sigma}}. \tag{1}$$

2.2 Production and Financing Frictions in the Heterogeneous Good Sector

General Picture

There is a continuum of entrepreneurial firms[5] in the heterogeneous good sector. In every period, existing firms may become un-productive and exit with probability ξ, and all their assets evaporate. Meanwhile, a mass ξ of new firms enter the market. Consequently the total mass of firms is time-invariant. New firms, endowed with an initial capital stock k_e, have to pay an initial setup cost I_0 before they start to produce.[6] Then firms need to sign contracts with the financial intermediatory to finance their initial setup cost. However, they have limited commitment on contracts and may deviate. Therefore, the financial intermediatory may not lend firms as much as they would in the frictionless market. After firms start to produce, they maximize profits by either serving the domestic market only, or by serving both domestic and foreign markets.

In this subsection, we first describe the firms' production function, then specify their financing frictions, and finally characterize the dynamic problem for firms.

Production

The productivity for a firm is z, which is a product of a parameter $\tilde{z}$ and an idiosyncratic shock ϵ_z: $z = \tilde{z}\epsilon_z$. The productivity parameter $\tilde{z}$ is initially drawn from a distribution $f(\tilde{z})$ with support $[\underline{z}, \bar{z}]$ when the firm enters, and then constant as long as the firm survives. The idiosyncratic shock ϵ_z satisfies $E\epsilon_z = 1$, and $\tilde{z}$ and ϵ_z are independent, therefore $Ez = \tilde{z}$.

[5] Through this paper the terms "entrepreneur" and "firm" are used interchangeably.

[6] The initial capital is relatively small in comparison with the optimal capital level defined later, and the initial setup cost I_0 is large enough to make the problem non-trivial. We specify the condition for I_0 in the appendix.

The setup of productivity allows us to incorporate the heterogeneity of productivity $\tilde{z}$, and the individual productivity shock ϵ_z. The structure of productivity z is consistent with that in Arellano et al. (2012).

The firm employs capital and labor to produce goods:

$$y = zk^{\alpha}l^{1-\alpha},$$

where k and l are capital and labor demands respectively, and α is the cost share of capital: $\alpha \in (0, 1)$. The firm chooses to serve the domestic market only, or to serve the domestic market and export to maximize their profit. Deviating from Melitz (2003), we introduce capital into production to explain the dynamics of the firm's exports. In the model below, the firm accumulates capital to overcome financial frictions.

Financing Frictions

Assume the firm enters the market in period t. In order to finance the initial setup cost I_0, the entrepreneur obtains external financing from a financial intermediary. Both the entrepreneur and the financial intermediary know the firm's productivity distribution when signing a contract. The contract specifies sequences of repayment to the financial intermediary $\{s_{t+j}\}_{j=0}^{\infty}$, firm investment $\{i_{t+j}\}_{j=0}^{\infty}$, and dividends $\{d_{t+j}\}_{j=0}^{\infty}$.[7] Capital depreciates at rate δ and the law of motion for capital is:

$$k_{t+j+1} = (1-\delta)k_{t+j} + i_{t+j},\ j = 0, 1, 2, \cdots, \infty$$

A contract is feasible (i) if dividends are non-negative: $d_{t+j} \geq 0$, because the entrepreneur cannot finance production through negative dividends, and (ii) if the sum of dividends and repayments to the financial intermediary do not exceed the firm's profits π net of investments:

$$d_{t+j} + s_{t+j} \leq \pi(k_{t+j}; z) - i_{t+j}, \quad j = 0, 1, 2, \cdots, \infty.$$

[7] Alternatively, dividends can be explained as the risk-neutral entrepreneur's consumption.

The financial intermediary has full commitment to the contract but the firm may deviate. If the entrepreneur diverts, he obtains a private return according to:

$$D(k_t) = \lambda k_t, \tag{2}$$

where λ is a parameter that reflects the financial environment, $\lambda \in (0, 1)$. A higher λ implies that firms can default with more capital, therefore it indicates a worse financial environment.

In summary, figure 1 depicts the time line of firms' entrance, contract signing, production, defaulting, and exit in period t, and the following periods $t, t+1, t+2, \cdots$ repeat period t.

The Dynamic Problem

We show how the financial intermediatory designs the contract to prevent the firm from deviation in the dynamic problem. We specify the problem in two steps. We first describe how the firm maximizes profits given capital, which is determined by investment in the contract. Then we specify how the financial intermediatory designs the contract, taking into account how the firm maximizes profits after signing the contract. In the first step, the firm may serve the domestic market only with no fixed cost, or it can serve the domestic market and export with fixed cost f_x. Iceberg costs also arise—in order to guarantee 1 unit of good arrive at the foreign country, the firm produces and ships τ ($\tau > 1$) units of good, as $(\tau - 1)$ units of good are lost during transportation. From (1), the firm's domestic demand is $q^d = \frac{(p^d)^{-\sigma} R}{P^{1-\sigma}}$, and the foreign demand is $q^x = \frac{(p^x)^{-\sigma} \hat{R}}{\hat{P}^{1-\sigma}}$, where $\hat{P}$ and $\hat{R}$ are the foreign country's aggregate price and expenditure of heterogeneous goods. Given productivity z and capital stock k, the firm maximizes profit by choosing labor demand l, domestic sale q^d, export decision dummy x, and foreign sale q^x

$$\begin{aligned} \pi(k; z) = \max_{l, q^d, x, q^x} & \; p^d q^d + x p^x q^x - wl - x f^x \\ \text{s.t. } & \; q^d + x\tau q^x = y. \end{aligned} \tag{3}$$

In the second step, in a competitive financial market, a financial intermediary provides a contract that maximizes the firm's discounted sum of dividends. Otherwise the entrepreneur can walk away to another lender who offers a better contract. The optimal contract problem is:

$$\max_{d_{t+j},s_{t+j},i_{t+j}} E_t\big(\sum_{j=0}^{\infty}\beta^j d_{t+j}\big) \tag{4}$$

$$\text{s.t. } d_{t+j} = \pi(k_{t+j};z) - i_{t+j} - s_{t+j} \geq 0 \tag{5}$$

$$k_{t+j+1} = (1-\delta)k_{t+j} + i_{t+j} \tag{6}$$

$$D(k_{t+j}) \leq E_{t+j}\big(\sum_{m=1}^{\infty}\beta^m d_{t+j+m}\big) \text{ for } j = 0,1,2,\cdots \tag{7}$$

$$I_0 \leq E_t\big(\sum_{j=0}^{\infty}\beta^j s_{t+j}\big), \tag{8}$$

where the firm's discount factor β is the product of consumers' discount factor $\tilde{\beta}$ and its survival rate $(1-\xi)$: $\beta = \tilde{\beta}(1-\xi)$. Constraint (5) is the budget constraint combined with non-negative dividends, and constraint (6) is the law of motion for capital. Constraint (7) is the contract enforcement constraint that considers the possibility of deviation. Specifically, in period $t+j$, the entrepreneur receives $D(k_{t+j})$ if he diverts; alternatively, the entrepreneur receives the discounted sum of dividends $E_{t+j}\big(\sum_{m=1}^{\infty}\beta^m d_{t+j+m}\big)$ if he continues to produce; the entrepreneur will never deviate if the return of production is greater than that of deviation. Constraint (8) is the financial intermediary' break-even constraint.

2.3 Optimal Contracts

In this subsection, we first re-write the optimal contract problem into a recurve problem. Then we derive three lemmas and two propositions to characterize the problem. Lemmas 1 to 3 guarantee that we can characterize the patterns of dividends and capital for a firm, compare firms in different financial environments, and derive the patterns of export status

and volume. Proposition 1, using the results from lemmas, provides a framework to jointly identify firms' financial constraints and exports. Proposition 2 describes the dynamics of a firm's export.

Reshaping (4) into a recursive problem helps to characterize the optimal contract and the firm's optimal behavior. In order to write (4) into a recursive problem, we need to write the re-payment schedule in (8) into a recursive equation. We follow Spear and Strivastava (1987) and Schmid(2012) in assuming that the entrepreneur promises a total transfer ν to a financial intermediatory

$$\nu_t = E_t\big(\sum_{j=0}^{\infty} \beta^j s_{t+j}\big),$$

and re-write (8) recursively as

$$\nu_t = s_t + E_t\big(\sum_{j=1}^{\infty} \beta^j s_{t+j}\big) = s_t + \beta E_t\big(\nu_{t+1}\big),$$

and $\nu_t \geq I_0$. Then we re-write the optimal contract problem as

$$V(k,\nu;z) = \max_{k',s,\nu'} d + \beta EV(k',\nu';z) \tag{9}$$

$$d = \pi(k;z) - i - s \geq 0 \tag{10}$$

$$k' = (1-\delta)k + i \tag{11}$$

$$D(k) \leq \beta EV(k',\nu';z), \tag{12}$$

$$\nu = s + \beta E\nu' \tag{13}$$

and the initial conditions $k_0 = k_e$ and $\nu_0 \geq I_0$. Constraints (10), (11), and (12) are the budget constraint combined with the requirement of non-negative dividends, the law of motion for capital, and the contract enforcement constraint respectively, corresponding to (5), (6), and (7). Constraint (13) is the promised repayment constraint based on the financial intermediatory's break-even constraint (8).

The recursive problem (9) has a special characteristic that the value function V is contained in its constraint (12). It is then difficult to verify the contract mapping without knowing the value function in the constraint. Therefore, the contract mapping method cannot be directly applied to solve (9). In order to solve such a problem, we follow Thomas and Worrall (1994) and define a first-best problem that is identical to (9) but without the contract enforcement constraint:

$$V^{fb}(k,\nu;z) = \max_{k',s,\nu'} d + \beta E V^{fb}(k',\nu';z) \tag{14}$$
$$\text{s.t. (10), (11), (13).}$$

Define k^{fb} as the solution to the first-best problem (14). We also define the contract mapping T as

$$(TV)(k,\nu;z) = \max_{k',s,\nu'} d + \beta E V(k',\nu';z),$$

subject to (10), (11), (12) and (13). We futher define $f^0 = V^{fb}$ and $f^n = T(f^{n-1})$.

According to lemmas 1, 4 and 7 in Thomas and Worrall (1994), f^n converges to V pointwise; V is concave almost everywhere and differentiable almost everywhere. The characteristics of V suggests that (i) we can numerically solve the problem by value function iteration with the starting point of V^{fb}. We will show an numerical example in the next sub-section. (ii) We can take first order conditions and envelop conditions for (9). We assume μ as the multiplier for the budget constraint (10), γ for the contract enforcement constraint (12), and χ for the promised repayment constraint (13). Substituting the law of motion for capital

(11) into the recursive problem (9) and taking the first order conditions for s, k', and ν' yield

$$\chi = 1 + \mu \tag{15}$$

$$(1+\gamma)\beta E V_{k'}(k', \nu'; z) = 1 + \mu \tag{16}$$

$$(1+\gamma) E V_{\nu'}(k', \nu'; z) + \chi = 0. \tag{17}$$

The envelopment conditions for k and ν are

$$V_k(k, \nu; z) = (1+\mu)\big[\pi_k(k; z) + 1 - \delta\big] - \gamma D_k(k) \tag{18}$$

$$V_\nu(k, \nu; z) = -\chi. \tag{19}$$

Details are in the appendix.

Next, lemma 1 describes the change in dividends and capital derived from (15) to (19) in two scenarios, one in which the constraint is binding and another in which the constraint is relaxed.

Lemma 1. *(Characteristics of capital and dividends) Given productivity and all else constant, (i) when the contract enforcement constraint is binding $\gamma > 0$, the firm has zero dividends $d = 0$, the return rate of capital is $\pi_k(k; z) = (1/\beta - 1 + \delta + \gamma\lambda/\chi)$, and capital k grows.*

(ii) When the contract enforcement constraint strictly holds $\gamma = 0$, the firm starts to pay dividends $d > 0$, the return rate of capital is $\pi_k(k; z) = (1/\beta - 1 + \delta)$, and capital k reaches the optimal level k^*, $k^* = k^{fb}$.

Proof. See the appendix. □

Lemma 1 implies that as firm age grows, the firm accumulates capital from its retained earnings until the optimal capital level. The optimal capital level in the frictional market is the same as that in the frictionless market, because the firm's contract enforcement constraint

becomes relaxed. Therefore, a firm is less constrained when its age grows. The results in lemma 1 are consistent with Cooley et al. (2004) and the age effects in Albuquerque and Hopenhayn (2004).

Furthermore, because the contract enforcement constraint multiplier γ directly determines if the firm is constrained by its financial conditions and thus below its optimal capital level, we use γ to measure the firm's financial constraints.

Definition 1. A firm is financially constrained if the contract enforcement constraint multiplier $\gamma > 0$, or if its capital is below the optimal level $k < k^*$. The firm is not financially constrained if $\gamma = 0$, or if its capital reaches the optimal level $k = k^*$.

After comparing the different statuses of financial constraint for a firm at different ages, we notice that in the model, another parameter λ, the degree of financial environment, may also impact a firm's financial constraint. Lemma 2 proves that worse financial environments have negative impacts on a firm's financial constraint.

Lemma 2. *(Financial environment and firms' financial constraints) Given productivity and all else constant, (i) a firm has a more stringent financial constraint, or the capital accumulation is slower if the financial environment is worse.*

(ii) The financial environment has no impacts on a firm when its financial constraint is relaxed $\gamma = 0$.

Proof. See the appendix. □

After describing how the firm's financial constraint may change with its age and the financial environment, we investigate how the financial constraint may affect the firm's marginal costs and exportation decisions. Lemma 3 summarizes these results. A necessary condition for lemma 3 is that the elasticity of substitution cannot be too small.

Assumption 1. *The elasticity of substitution σ satisfies $\sigma > 1$.*

Lemma 3. *(Financial constraints and exports) All else constant, (i) a firm's marginal cost is high when financially constrained $\gamma > 0$. The firm reaches its lowest marginal cost when $\gamma = 0$, or not financially constrained.*

(ii) The cutoff productivity for exporting, $\underline{z}^x$, is consistent with that in the case of perfect contract enforcement.

(iii) (Extensive margin of export) Given $z \geq \underline{z}^x$, a firm is more likely to export when it is not financially constrained.

(iv) (Intensive margin of export) Denote the export volume of a firm as $R^x = p^x q^x$. The export volume of a firm with $z \geq \underline{z}^x$ is higher when it is less constrained, or when the firm has accumulated more capital. The firm reaches its maximum export volume when not constrained: $\gamma = 0$.

Proof. See the appendix. □

Discussion We emphasize two points regarding the firm's export behavior derived from lemma 3. First, lemma 3 states that given its productivity, a firm is more likely to export when it accumulates capital to overcome its financial constraint, the marginal rate of return to capital decreases, and therefore its marginal cost decreases. The trend change in marginal rate of return to capital is consistent with Banerjee and Duflow (2014). Second, the essential difference between the model and the case of perfect commitment, like in Melitz (2003), is that a firm may need time to reach its maximum export volume, even though the maximum export volume is the same as in the perfect commitment case.

Proposition 1. *Given productivity and all else constant, older firms and firms in better financial environments are less financially constrained. When less financially constrained, firms are more likely to export and their export volumes will be larger.*

Proof. By lemma 1, when firms become older, they accumulate capital until the contract enforcement constraint strictly holds. By lemma 2, firms are less constrained in countries

with better financial environments. By lemma 3, firms are more likely to export and their export volumes are larger. □

Discussion Proposition 1 summarize results from lemmas 1, 2, and 3. Specifically, it first points out that given productivity, a firm's financial constraint is impacted by two factors that are exogenous to its decision process: firm age and financial environment. In a market with imperfect commitment, a firm needs time to accumulate capital in order to relax financial constraints as its age grows. The capital accumulation process cannot be accelerated by the firm, because the optimal contract structure has already determined the firm's capital (in expectation) in every period. The financial environment impacts a firm's financial constraint by shaping the structure of the optimal contract. A worse financial environment leads to slower accumulation of capital for a firm, and therefore slower export dynamics to its optimal level. The financial constraint also impacts a firm's export dynamics as discussed in lemma 3. Even though both financial constraints and exportation are endogenous for a firm, proposition 1 provides a framework to solve the endogeneity problem and identify the role of financial constraint in a firm's export decision. The exogenous factors, firm age and financial environment, generate variations in financial constraints, given productivity. Variations in firm age and financial environments result in changes in financial constraints of firms, and therefore changes in export performance.

Proposition 2 describes firms' export dynamics with the relaxation of financial constraints.

Proposition 2. *(i) (Change in the extensive margin of export) Given $z \geq \underline{z}^x$, firms are likely to start to export even when they were previously financially constrained. With the relaxation of financial constraints, firms are more likely to export.*

(ii) (Change in the intensive margin of export) For exporters, the growth rate of export volume is larger when firms are financially constrained.

Proof. (i) By lemma 3, firms with productivity $z \geq \underline{z}^x$ export eventually. In such a group,

all firms start to export as long as they can cover the fixed costs of export, even though they were financially constrained. With the relaxation of financial constraints, all firms with $z \geq \underline{z}^x$ export.

(ii) By lemma 3, the export volume of firms grow when they are financially constrained, and reach the optimal level when no longer constrained. Therefore, the growth rate of export volume is positive when firms are financial constrained, and zero when firms are no longer financially constrained. □

Discussion While proposition 1 discusses comparisons in export status and volume between firms that are financially constrained and are not, proposition 2 describes how firms' financial constraints are dynamically relaxed and the impacts of financial constraints on firms' dynamics of export. It predicts that even though they were financially constrained, firms start to export as long as they cover the fixed cost of export; the growth in export volume is higher when firms are constrained. An alternative hypothesis to proposition 2 is that firms' constraints are permanent and therefore firms never start to export. Under such an alternative hypothesis, we would not observe the relaxation of financial constraints, and we would not observe that firms start to export if they were previously constrained. In summary, proposition 2 emphasizes the dynamics of financial constraint relaxation and its impacts on export dynamics; the supporting evidence for proposition 2 will reject the alternative hypothesis that firms are permanently constrained and never change their export status.

Final Remark Finally, we want to point out that assuming that entrepreneurial firms have limited commitment and that entrepreneurial firms can use retained earnings to accumulate capital jointly generate the endogenous financial constraints. This is a key mechanism in explaining the dynamic impacts of financial constraints on firms' exports. The endogenous and dynamic financial constraints are different from their static counterparts, like in Manova (2013). There are also alternative models that can generate endogenous

financial constraints, for example, assuming that entrepreneurial firms have moral hazard as in Clementi and Hopenhayn (2006). However, our current model setting is the simplest way to generate the dynamic relaxation of financial constraints, and therefore the export dynamics. Moreover, under the assumption of limited commitment, we can empirically use the difference in financial environment across countries to solve the endogeneity problem of firms' financial constraints, as in lemma 2. The empirical identification will be discussed in section 3.

2.4 Example

In this subsection, we calibrate the model, solve the model numerically, and use a numerical example to show how a firm accumulates capital to relax financial constraints and start exporting.

We first calibrate the model to the average level of firms in 26 East European and Central Asian countries between 2001 and 2008, for which panel sample will be described in detail in the next section.[8] Given the real interest rate is 6% and firms' exit rate is 6% in data, we set $\beta = (1 - 6\%) * (1 - 6\%) = 0.88$. Iceberg cost τ is set as 1.14 to match the ratio of exports over domestic sales. We estimate the logged productivity of the average firm in the data by using an AR(1) model. We then discretize the estimated productivity into a two-state Markov process with two values z_H and z_L, where $z_H = \tilde{z}\epsilon_z^H$ and $z_L = \tilde{z}\epsilon_z^L$, and the initial productivity draw $\tilde{z}$ is normalized to $\tilde{z} = 1$. The transition matrix of two states is $[\rho\ 1-\rho; 1-\rho\ \rho]$. The estimated values of the discrete productivity process are $z_H = 1.37$, $z_L = 0.73$, and $\rho = 0.96$.

We set the capital share as $\alpha = 0.33$, elasticity of substitution as $\sigma = 2$, the capital depreciation rate as $\delta = 0.05$, and fixed cost of export as $f_x = 0.47$ following the literature. The details of calibration are explained in the appendix.

[8] We use the panel sample, not the whole sample because we need to estimate the time series productivity shocks. Details of the whole and panel samples are in the next section.

We solve the model numerically using value function iteration. We first solve the model with no contract enforcement constraint, and use firm value from the case of perfect contract enforceability as the starting point. We generate grids for state variables capital k and the promised transfer ν, and find out the policy functions for k' and ν' under different shocks of productivity z. Other variables can be solved using k, ν, z, k', and ν'.

We then depict the simulated growth paths of capital and export volume under different values of λ, the parameter that reflects financial environment. Recall that a higher value of λ implies that a firm can default with a higher portion of capital, and therefore it indicates a worse financial environment. Figures 2 and 3 show the simulated results of capital and export volume under $\lambda = 0.5$, the benchmark, and $\lambda = 0.8$.[9] The initial period is set as $t = 0$. Note that figures 2 and 3 compare firms with the identical productivity but under different financial environments. Therefore, different growth paths result from different degrees of contract enforceability.

Figures 2 and 3 explicitly demonstrate lemmas 1 to 3 and propositions 1 and 2. Before we explain how these two figures graphically present the model implications, we first describe the key periods for the growth of capital and export volume on these two figures. In the benchmark ($\lambda = 0.5$), capital grows until its optimal level in period 10; the firm starts exporting from period 6 and reaches its optimal level in period 10. In the case of $\lambda = 0.8$, capital grows until its optimal level in period 16 and the firm starts exporting from period 10 and reaches its optimal level in period 16.

We then describe how figures 2 and 3 graphically demonstrate the model in detail. First, in figure 2, as in lemma 1, the firm accumulates capital when financially constrained, and reaches its optimal level when no longer constrained. The firm's age increases during the capital accumulation process. Second, as in lemma 2, figure 2 also depicts that in a worse financial environment ($\lambda = 0.8$), the firm has a more stringent constraint and therefore it

[9]The export volume is measured as the value of export, not export quantity because of two reasons. First, export price is not a constant but decreases, because the firm's return rate of capital decreases and thus its marginal cost decreases. Second, export volume in the data is measured as the value of exports, even though it is deflated and PPP adjusted.

reaches the optimal capital level later than the benchmark case. However, the worse financial environment has no impact as long as the firm reaches its optimal capital. Given productivity, the firm reaches the same optimal capital level irrelevant to financial environment. Third, in figure 3, when financially constrained, the firm may start to export, but under the optimal level. When no longer financially constrained, the firm reaches its optimal export volume. A worse financial environment causes the firm to begin exporting later. However, the firm reaches the same optimal export volume when no longer financially constrained. Fourth, these two figures jointly demonstrate proposition 1 on the firm's financial constraint status and growth path of capital and export volume, at different ages and under different financial environments, given productivity. Figure 3 demonstrates proposition 2. The firm starts to export when it is still financially constrained: period 6 in the case of $\lambda = 0.5$ and period 10 in the case of $\lambda = 0.8$. Its export volume grows until it is no longer constrained: period 10 in the case of $\lambda = 0.5$ and period 16 in the case of $\lambda = 0.8$.

3 Empirical Results

3.1 Data

We empirically examine the model implications by using the data from Business Environment and Enterprise Performance Survey (BEEPS) in East European and Central Asian countries, jointly collected by the European Central Bank[10] and Enterprise Surveys, The World Bank[11]. We clean the raw data and construct two data sets—a whole cross-sectional data set and a panel sub-data set. The details of the data cleaning procedure can be found in the appendix. The whole data set contains as many observations as possible to test proposition 1 and the panel sub-sample set is used to check firms' export dynamics in proposition 2. The whole data set includes 5,358 firm-year observations between 2001 and 2013[12] in 26 Eastern European

[10] http://ebrd-beeps.com

[11] http://www.enterprisesurveys.org

[12] Here we refer to data year, not survey year. Because the questionnaire asks firms' performance one year before the survey, data year=survey year-1.

and Central Asian countries in 21 industries[13]. The data set is strengthened with country-level financial development measures from the World Development Indicators, the World Bank. All nominal variables are deflated at 2005 dollars.

The second panel data set is a sub-sample of the first whole data set, which contains 2,463 firm-year observations between 2001 and 2008. BEEPS assigns panel identification numbers to firms that have been surveyed multiple times during the time span and constructs the panel data set. Specifically, each firm has been surveyed every three years, in total two or three times, according to survey schedules in different countries. Note that such a panel data structure is similar to the US firm-level data used in Bernard, Jensen and Schott (2006), in which firms have been surveyed every five years.

3.2 Empirical Strategy and Statistics

This subsection first describes the empirical measure of financial constraint, then specifies the estimation equations based on propositions, and finally presents the summary statistics of variables used in estimations.

In the data, we cannot observe if firms' constraints are binding or not, nor can we observe the difference between current and optimal capital of firms, therefore we cannot directly measure firms' financial constraints following the definition in the model. Instead, we measure firms' financial constraints based on their answers to the survey question "did the establishment apply for new loans/lines of credit?" Firms are defined as financially constrained if they answer that they applied for loans but were rejected, or they did not apply for loans at all because the cost of loans was prohibitive. Otherwise firms are defined as not financially constrained. The empirical measure of financial constraint is consistent with the definition in the model, because the financial intermediary will reject firms' financing requirement if

[13]These countries include Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Mongolia, Poland, Romania, Russia, Slovak, Slovenia, Tajikistan, Turkey, Ukraine, and Uzbekistan. Twenty one manufacturing industries are food, textiles, garments, tanning and leather, wood, paper and paper products, publishing, chemicals, plastic and rubber, non-metallic mineral products, basic metals, fabricated metal products, machinery and equipment, electronics, communication equipment, precision instruments, motor vehicles, other transport equipment, furniture, recycling, and other manufacturing industries.

it is more than the financing that guarantees no default of firms. Generally, as long as the financing is beyond the no-default amount in the optimal contract, the cost of financing will be higher than firms can endure. Minetti and Zhu (2011) and Banerjee and Duflow (2014) have similar empirical measures of financial constraint for Italian and Indian firms respectively. Moreover, consistent with Minetti and Zhu (2011), the measure of financial constraint is from a survey completed by a third party, and is not used to make operational decisions or evaluate firm performance. Therefore, even though the measure is self-reported, firms have no incentive to manipulate their answers in order to obtain more financing.

Proposition 1 points out that firms' financial constraints, given productivity, are affected by their age and the financial environment. Financial constraints, productivity, and firm age have further impacts on their exportations. We employ the instrument variable method to solve the endogeneity of firms' financial constraint. The instrument variables measures countries' financial development: "strength of legal rights index" and "depth of credit information index". The first instrument "strength of legal rights index" measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders. It ranges from zero to twelve, with higher scores indicating better collateral and bankruptcy laws. The legal right index directly measures the degree of contract enforceability in a country. The second instrument "depth of credit information index" is a proxy that measures rules affecting "the scope, accessibility, and quality of credit information." It ranges from zero to eight, again with higher scores indicating better depth of credit information. Demirguc-Kunt and Maksimovic (1998) describe how differences in legal systems affect firms' external financing. An effective legal system protects the creditors' rights, which is exactly consistent with the role of the deviation parameter λ in the model. Beck, et al. (2005) use similar indicators, quality and efficiency of courts, and credit/financial information on customers, to measure financial and legal constraints of firms.

In the instrument variable regression, the first stage estimates how these instruments, and

other control variables, impact firms' financial constraints; the second stage estimates how the fitted financial constraints, and other control variables, determine firms' exportations.

$$
\begin{aligned}
fc_{ijct} &= \alpha^f + \beta^f Z_c + \gamma^f X_{ijct} + d_j + d_t + \epsilon^f_{ijct} \\
prob_{ijct} &= 1[\alpha^p + \beta^p fc_{ijct} + \gamma^p X_{ijct} + d_j + d_t + \epsilon^p_{ijct} > 0],
\end{aligned} \tag{20}
$$

where fc_{ijct} is the firm's financial constraint, the subscripts i refers to firm, j industry, c country, and t year respectively. The vector Z_c is the vector of instruments that includes the legal rights index and the depth of credit information index: $Z_c = \left[legal_c, depth_c\right]$. The coefficient vector β^f includes coefficients on these two instrument:$\beta^f = \left[\beta^f_l, \beta^f_d\right]$. The control variable vector X_{ijct} consists of three variables. The first variable is firm age: age_{ijct}. We set firm age as a control variable because of its double roles in estimating (20): as in proposition 1, firm age measures how long firms have accumulated capital to relax financial constraints; firm age may also impact exportation through other channels such as learning-by-doing. The second variable is firms' total factor productivity relative to the industry mean: $prod_{ijct}$, which is comparable across industries. The third variable fdi_{ijct} is a foreign ownership dummy that is 1 if a firm has at least 10 % of foreign ownership, following Javorcik (2004). Foreign ownership may provide additional channels for FDI firms to acquire financing and may facilitate those firms' exportation. The coefficient vector γ^f includes coefficients on all control variables: $[\gamma^f_a, \gamma^f_p, \gamma^f_{fdi}]$. Dummies d_j and d_t are industry and year fixed effects respectively. Note that two instruments are at the country level and values of these two instruments for most countries are constant over the time span of the data. Therefore the country dummies cannot be included. The dependent variable $prob_{ijct}$ is a dummy that is 1 if firm i exports, 0 if not. Finally, ϵ^f_{ijct} and ϵ^p_{ijct} are residuals.

We estimate (20) in the whole data to test two hypotheses in proposition 1. The first hypothesis states that a firm, given its productivity, has a less stringent financial constraint if it is in an environment with better contract enforceability and/or it is older. By the

first hypothesis, we expect negative signs in front of β_l^f, β_d^f for instruments and γ_a^f for firm age in the first stage regression. The second hypothesis states that a firm is more likely to export when its financial constraint is less severe. By the second hypothesis, we expect a negative sign in front of β^p for the instrumented financial constraints after correcting for the endogeneity.

Next we examine the impacts of financial constraints on firms' intensive margin of export, export volume.

$$\begin{aligned} fc_{ijct} &= \alpha^f + \beta^f Z_c + \gamma^f X_{ijct} + d_j + d_t + \epsilon_{ijct}^f \\ log(v_{ijct}) &= \alpha^v + \beta^v fc_{ijct} + \gamma^v X_{ijct} + d_j + d_t + \epsilon_{ijct}^v, \end{aligned} \tag{21}$$

where $log(v_{ijct})$ is the logged real export volume and ϵ_{ijct}^v is the residual. We use firms with positive export volume only in the whole data to estimate (21) because we explore the impacts of financial constraints on the intensive margin of exports. Again we expect the negative signs of coefficients for instruments $legal_c$, $depth_c$ and firm age age_{ijct}. Moreover, by proposition 1, we have the hypothesis that a firm exports more when its financial constraint is less stringent. Therefore, we expect $\beta^v < 0$.

In order to test proposition 2 in the panel data, the impacts of financial constraints on changes in firms's export, we first follow Bernard, Jensen and Schott (2006) and revise (20) to

$$\begin{aligned} fc_{ijct} &= \alpha^f + \beta^f Z_c + \gamma^f X_{ijct} + d_j + d_t + \epsilon_{ijct}^f \\ prob_{ijc,t+3} &= 1[\alpha^{p'} + \beta^{p'} fc_{ijct} + \gamma^{p'} X_{ijct} + d_j + d_t + \epsilon_{ijct}^{p'} > 0], \end{aligned} \tag{22}$$

where $prob_{ijc,t+3}$ is firms' probability of exportation in the next period, $t+3$, as firms are surveyed every three years. Because proposition 2 implies that firms may start to export as long as they can cover fixed costs of export, even though they were financially constrained,

we expect $\beta^{p'} > 0$. If $\beta^{p'} < 0$, it indicates that firms do not export if they were financially constrained. This may be because the firms' financial constraints are constant over time ($fc_{ijc,t+3} = fc_{ijct}$) and firms therefore cannot cover fixed costs of export.

Alternatively, and more directly, we test whether relaxation of financial constraints improves firms' likelihood of starting export as

$$\begin{aligned} relaxfc_{ijc,t+3} &= \alpha^f + \beta^f Z_c + \gamma^f X_{ijct} + d_j + d_t + \epsilon^f_{ijct} \\ startex_{ijc,t+3} &= 1[\alpha^{p'} + \beta^{p'} relaxfc_{ijc,t+3} + \gamma^{p'} X_{ijct} + d_j + d_t + \epsilon^{p'}_{ijct} > 0], \end{aligned} \tag{23}$$

where $relaxfc_{ijc,t+3}$ is a dummy that indicates the relaxation of financial constraints, which equals one if firms are constrained in period t, but not in period $t+3$: $fc_{ijct} = 1$ and $fc_{ijc,t+3} = 0$, zero otherwise; $startex_{ijc,t+3}$ is a dummy which is one if firms do not export in period t, but start to export in period $t+3$: $prob_{ijct} = 0$ and $prob_{ijc,t+3} = 1$, zero otherwise. Even though the dependent variable in the first stage is the relaxation of financial constraint, not financial constraint itself, we employ the same instruments, the legal rights index and depth of credit information index, because better financial environments also alleviate firms' financial constraint faster. We again expect that $\beta^f_l < 0$, $\beta^f_d < 0$ in the first stage, and $\beta^{p'} > 0$ as firms are more likely to start to export if their financial constraints are relaxed.

Finally, we test the implications of proposition 2 on the growth in firms' intensive margin of growth, using exporters only in the panel data. In the first stage, we still employ the instrument variable method to correct for the endogeneity of firms' financial constraint as in (21), but use the change in export volume $\Delta log(v_{ijc,t+3}) = log(v_{ijc,t+3}) - log(v_{ijct})$ as the dependent variable in the second stage.

$$\begin{aligned} fc_{ijct} &= \alpha^f + \beta^f Z_c + \gamma^f X_{ijct} + d_j + d_t + \epsilon^f_{ijct} \\ \Delta log(v_{ijc,t+3}) &= \alpha^{v'} + \beta^{v'} fc_{ijct} + \gamma^{v'} X_{ijct} + d_j + d_t + \epsilon^{v'}_{ijct}, \end{aligned} \tag{24}$$

According to proposition 2, we expect that $\beta^{v'} > 0$, that export volumes grow faster for financially constrained firms, because constrained firms are still accumulating capital and therefore their export volumes are growing, in contrast to firms that have already reached the optimal capital and export volume level.

In table 1, we summarize the definitions of all variables in (20) to (24). We also report firms's logged sales, employment, and fixed assets, where fixed assets are measures of firms' capital, as in Wang and Wang (2015). These three variables are used to calculate firms' productivity, and are also important characteristics of firms. Then we list the summary statistics of variables in table 2 for the whole sample. Within 5,358 firm-year observations, there are 2,464 exporters and 2,894 non-exporters. Exporters are less financially constrained, older, more productive, and more possible to be FDI firms. Exporters also have larger total sales, more employees, and higher values of fixed assets. The higher values of fixed assets for exporters provide the supporting evidence to our model that firms accumulate capital to relax financial constraints and start exporting. The t tests show that all mean differences in these variables are statistically significant at 1% level.

3.3 Benchmark Results

In the preliminary check, we run OLS and probit regressions to test if financial constraints have impacts on firms' export. Table 3 displays results for firms' export probability and volume, using the whole data. Specifically, we employ linear probability and probit models respectively to perform the first check of financial constraints and firms' export probability. Results in columns 3 and 4 show that financial constraints are negatively related to firms' export probability, controlling for age, productivity, FDI dummy, and industry and year fixed effects. For example, other things equal, the estimation results by the probit model suggests that the export probability for a firm with financial constraints is 17% lower than a firm with no financial constraint. Note that the preliminary checks do not incorporate

the endogenous relaxation of firms' financial constraints. Consequently, even though these results unveil the negative correlations of financial constraints and firms' export status, we cannot derive the causal relationship running from firms' financial constraints to their export choice. Column 5 displays the OLS regressions results on how financial constraints impact firms' intensive margin of export, for exporting firms only in the whole data. Again, firms export less if they are financially constrained.

Table 4 reports the benchmark results by estimating (20), the two-stage regression with firms' financial constraint being the dependent variable in the first stage, and firms' export status being the dependent variable in the second stage. We employ three methods—instrument variable two stage least squares (IV 2SLS), instrument variable general method of moments (IV GMM), and instrument variable probit (IV probit) models, in order to verify whether our estimation results are robust by different methods. In all three methods, following Angrist (2001), we treat the dependent variable in the first stage, financial constraints of firms, as a continuous variable, because regression results are not fundamentally different in comparison with methods that treat financial constraints as a discrete variable, but are technically more difficult. The first two linear probability models, IV 2SLS and IV GMM, are asymptotically efficient under different assumptions. Specifically, we can obtain the efficient estimator by IV 2SLS if the error terms are homoscedastic, or by IV GMM if the error terms are heteroscedastic. In contrast to the first two methods, the third method IV probit model estimates a non-linear equation in the second stage.

The left panel of table 4 presents the estimation result of the first stage in (20), which is identical to all three methods. As predicted by the model, two instruments, the legal rights index and the depth of credit information index, have negative impacts on firms' financial constraints, because firms are less constrained in better financial environments. Moreover, older firms are less constrained after controlling for productivity. Our instruments pass the Stock-Yogo (2005) weak instrument test at the level of 10 %, better than the rule of thumb

15%. We report the Kleibergen and Paap (2006) statistic because the residuals may be heteroscedastic. The right panel displays the second stage results for all three methods. In column 3, an average firm with financial constraints is 61.5% less likely to export than an otherwise identical firm that has no financial constraints by IV 2SLS. The estimation result by IV GMM in column 4 shows that a firm with financial constraints is 66.5% less likely to export. In summary, the negative impacts of financial constraints on export status are robust across different estimation methods. As for the estimation results for control variables, first of all, older firms are more likely to export after controlling for the impacts of firm age on financial constraints. Such estimation effects may indicate the existence of learning-by-exporting. Second, the foreign ownership also facilitates firms' exportation after controlling for the impacts of foreign ownership by relaxing firms' financial constraints.

Our estimation results are qualitatively and quantitatively consistent with results for other countries in the literature. Minetti and Zhu (2011) find that the export probability of firms is approximately 40% lower for credit rationed firms in Italy. The export differences between financially constrained and non-constrained firms are approximately 60% in our sample for 26 developing countries. Manova (2013) suggests that firms with credit constraints in less financially developed countries are disproportionably less likely to export. The estimation difference between Minetti and Zhu (2011) and this paper exactly reflects the cross-country comparison.

We estimate (21) to examine the impacts of financial constraints on the intensive margin of firms' exports, in the whole data with exporting firms only. Estimation results are reported in table 5. We employ three estimation methods, IV 2SLS, IV GMM, and IV treatment effect to estimate (21). The first two methods, IV 2SLS and IV GMM, guarantee that we obtain the asymptotically consistent estimates under homoscedastic or heteroscedastic assumptions. Using the third method IV treatment effect, we view being financially constrained as a binary treatment to firms, and this treatment is endogenous. Therefore, we employ the

IV treatment effect model as in Wooldridge (2010, chapter 21.4.1). The left panel of table 5 presents the first-stage results identical to three estimation methods. Again we use the legal rights index and the depth of credit information index of countries as the instruments. The first stage estimations pass the weak instrument test at 15%, with the Keibergen-Paap statistic being 8.58, slightly higher than 8.68, the 10% critical value. One instrument, the depth of credit information index, has negative impacts on firms' financial constraint. But the other instrument, the legal rights index, is not statistically significant. And firm age has no statistically significant impact on firms' financial constraint. We note that firm age may no longer have impacts on financial constraints if firms reach their optimal capital level and consequently their constraints are already relaxed. Within exporters, a large portion of firms may not be financially constrained and therefore firm age has no impacts on financial constraint status. The right panel of table 5 reports the second stage results. Taking the IV treatment effect results as an example, the point estimate of financial constraint's impact is -2.396 with a 95% interval between -3.438 and -1.354. As in Minetti and Zhu (2011), it suggests that all others equal, financial constraints reduce export volumes for exporters at least by more than 74.2%.[14] Consistent with findings in Gorodnichenko and Schnitzer (2013), IV estimates are larger than OLS estimates (table 3).

We then estimate the impacts of financial constraints on firms' export dynamics in the panel sub-sample, because we can observe firms' export and financial constraint status change only for firms with multiple observations across years. Table 6 presents the estimation results for (22), (23) and (24), which test the hypotheses in proposition 2 that firms are more likely to start to export when they are financially constrained and their export volumes grow faster. We use the IV probit model (clustered at the firm level) and the panel IV model to estimate (22) and (23), and the IV model (clustered at the firm level) and the panel IV model to estimate (24). The panel IV model uses the random effects model as in Berman and

[14] As export volume is in logrithm, the coefficient of -1.354 implies that export volume by firms with constraints is 25.8% of firms with no constraints.

Hericourt (2010), because each firm only contains 2 to 3 observations and the fixed effects model is ill-advised in this case. Columns 3 and 4, estimation results of (22), demonstrate that an average firm may export even though it was previously financially constrained. We need to carefully explain the estimations results. The higher probabilities of export in the next period imply that firms can start to export even though previously financially constrained, but do not imply that firms with financial constraints have advantages in starting exportation. Actually, because firms are financially constrained, when they start to export, the do not reach the optimal level immediately. Therefore, eliminating financial barriers for firms would benefit them by allowing them to start exporting even earlier and quickly reach the optimal export volume. Columns 5 and 6 are estimation results of (23), which shows that firms are more likely to start exporting with the relaxation of financial constraints. The positive coefficients of constraint relaxation measure the slope between changes in financial constraints and changes in export status. Columns 3 and 4, and 5 and 6 jointly imply that in the incomplete financial market, firms accumulate capital to cover fixed costs of exporting and relax their financial constraints; exogenous variations in financial environment may impact the dynamic alleviation of financial constraints and further firms' export status change. Columns 7 and 8 show that the growth rate of export volume is marginally higher for financially constrained exporters.

3.4 Robustness Checks

Industry Reliance on External Finance

The model uses the exogenous variations in financial environment to solve the endogeneity of firms' financial constraints. This identification framework contains an assumption that firms depend on the external finance by a financial intermediatory, not other institutions, and all firms can obtain the amount of financing purely determined by the optimal contract. However, in reality, firms in different industries may have different degrees of reliance on

external finance, as pointed out by Rajan and Zingales (1998). Moreover, firms may acquire external financing through other channels such as trade credit of sellers/buyers. We use two measures of external finance reliance from Kroszner et al. (2007): external finance dependence and asset tangibility, and one measure from Fisman and Love (2003): trade credit. Measures in Kroszner et al. (2007) are based on Rajan and Zingales (1998), but the time spans of industries are extended. External finance dependence measures the median share of capital expenditure not financed by firms' cash flow within an industry, which is determined by the nature of such an industry. This measure describes the degree to which firms' financing depends on external sources. Similarly, asset tangibility is also the intrinsic characteristic of an industry and is measured as the median ratio of fixed assets to total assets. Kroszner et al. (2007) use U.S. industry data to measure external finance dependence and asset tangibility. Because the U.S. is the most developed financial market, closest to the financial frictionless scenario, estimates using the U.S. industry data can be used as the approximate measures of industry finance characteristics. In Fisman and Love (2003), trade credit is defined as the median ratio of accounts payable to total assets for the U.S. industries. Similarly, even though the measure is based on U.S. firm-level data, it is the best approximation of industry characteristics in the frictionless market. Trade credit measures the ratio of firms' borrowing from upstream suppliers and/or downstream consumers, which serves as an additional channel of external financing besides financial intermediaries.

We check the robustness of our benchmark results across industries with different levels of dependence on external finance, asset tangibility, and trade credit. Table 7 reports the robustness check results. We repeat the benchmark regressions of (20) and (21) within sub-samples divided by industry external finance (asset tangibility, trade credit) above/below median. The results in columns 2 to 4 show that robust to industry intrinsic dependence on financial intermediaries, firms with financial constraints are less likely to export. Results in columns 5 to 7 for exporters show that financial constraints exhibit negative impacts on

firms' export volumes across industries with different degrees of external finance dependence, asset tangibility, and trade credit reliance.

Firm-Level Variations in Legal Enforcement

In the benchmark results, we employ the country-level measure of legal system efficiency to solve the endogeneity problem of firms' financial constraints. The country-level measure is identical to all firms in the same country and may not reflect district heterogeneity in the legal system or firm-specific experiences with courts. We employ a firm-specific measure of evaluations on courts to add the individual variations. There is a survey question in the data that asks firms if courts are an obstacle to current operations, and firms answer either no, minor, moderate, major, or very severe obstacle with corresponding scales 0, 1, 2, 3, or 4 respectively.

Beck et al. (2005) justifies why such a self-reporting measure of firms' evaluation with courts is unbiased, with little possibility that unsuccessful firms consciously attribute their poor performance to institutional obstacles. First, the survey questions are collected by a third party, and the survey is not used to evaluate firm performance, and will not affect firms' operational and financing decisions. Second, the questionnaire first asks firms questions about business environment, and then a few detailed questions about their performance. The sequencing of questions minimizes the possibility that firm managers find financial and legal environments as reasons for their failures. Therefore we use firms' answers on their experiences with courts as a measure of firm-level variations in legal enforcement.

We introduce individual variations in two ways. Specifically, we first assume that the legal system quality variations are products of the country-level variations and the firm-specific experiences:

$$legal_{ict} = legal_c + legal_c * court_{ict},$$

where $court_{ict}$ is firms' self-reported evaluations on courts. Alternatively, we assume that the individual variations are additive to the country-level variations of legal system quality:

$$legal_{ict} = legal_c + court_{ict}.$$

Then we use $legal_{ict}$, instead of $legal_c$ to re-estimate (20) and (21).

Table 8 reports the robustness checks. In the not-reported first-stage estimations, the coefficients for the country-level variations are still negative in two types of shocks, as high values of legal rights index indicate better legal environments and reduce firms' financial constraints. The coefficients for the individual variations in court experience, both interacting with and additive to the country-level legal rights index, are statistically significant and positive, which implies that the worse court system increases the possibility that firms are financially constrained. Results in columns 2 and 3 confirm that the fitted financial constraints have negative impacts on firms' export probability, which is consistent with the benchmark results. For example, in column 2, after considering for the firm-level heterogeneity in their evaluations on courts, a firm with financial constraints is 55.9% less likely to export than an otherwise identical firm with no financial constraints. Results in columns 4 and 5 show the robustness of benchmark results about the impacts of financial constraints on export volume.

4 Conclusion

In order to examine how financial constraints dynamically impact firms' exports, this paper develops a model in which firms are financially constrained because of imperfect enforceability. In the optimal contract, the financial intermediary only lends firms the amount of capital that guarantees no defaulting of firms, and the capital is below the optimal level as in the financial frictionless market. Firms relax their financial constraints by using re-

tained earnings to accumulate capital until the optimal level. As capital grows and firm age increases, firms start exporting when they are able to cover export fixed costs. The model provides an identification framework to examine the impacts of financial constraints on firms' export dynamics, after controlling for the endogeneity of financial constraints. We use firm-level data from 26 Eastern European and Central Asian countries between 2001 and 2013 to empirically confirm that firms with less severe constraints export more. We also find that the dynamics of financial constraint relaxation helps to explain firms' export dynamics. Benchmark results are robust to the industry variations in external finance reliance, and to the firm-level variations in legal enforcement.

These findings provide suggestions to policy makers in developing countries. First, besides tariff reductions and export subsidies, this paper implies that policies that improve the financial environment can stimulate firms' exports. Moreover, this paper suggests that simply providing financing to firms but not improving the financial environment may not induce firms to export more, because entrepreneurs may default with financing greater than the optimal contract lending. Therefore, it is important to improve the legal and financial systems to reduce firms' default possibilities, and a better financial environment in turn guarantees that firms have more access to external finance and therefore will quickly grow to their optimal capital level. Second, especially for young firms that are restricted by financing, if the government can help them to obtain necessary external financing to grow and guarantee that these firms do not default, these firms can accelerate capital accumulation process and increase exports.

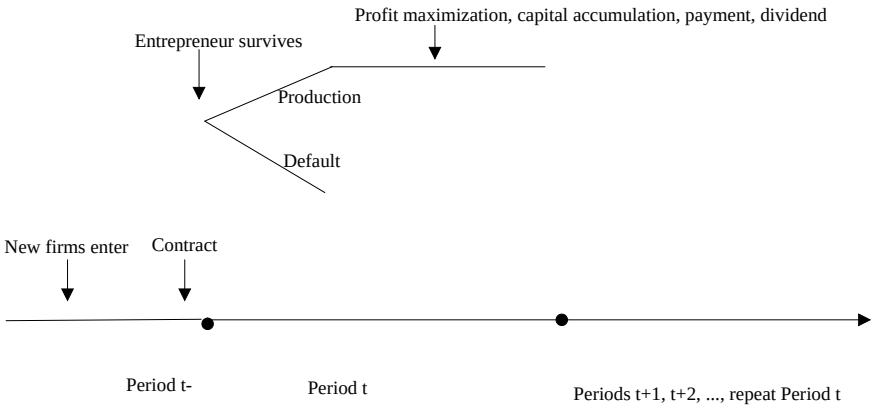

Figure 1: Time Line

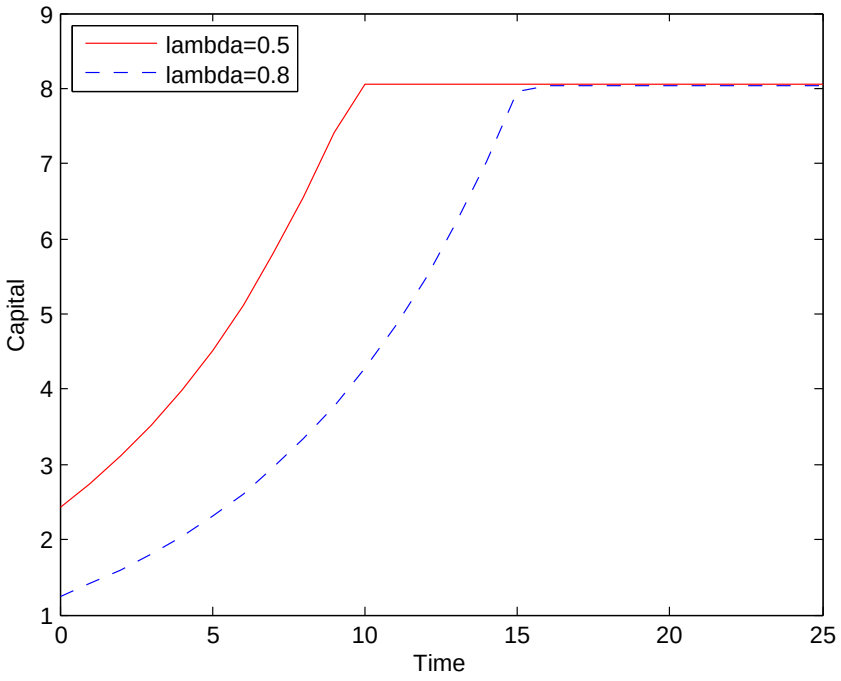

Figure 2: A Firm with Financial Constraint: Capital

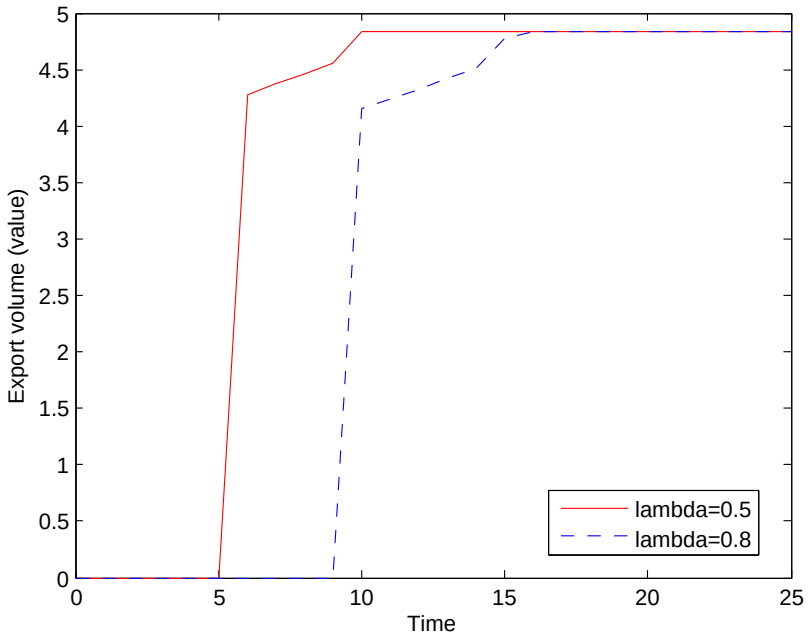

Figure 3: A Firm with Financial Constraint: Export

Table 1: Definitions of Variables in Estimations

Variable	Notation	Definition
Variables in Regressions		
Export Probability	$prob$	One if the firm exports, zero if not.
Log (Export Volume)	$log(v)$	Log(export volume).
Financial Constraint	fc	One if the firm answers that it applied for loans but was rejected, or it did not apply for loans at all because the cost of loans was prohibitive; zero otherwise.
Firm Age	a	Data year-firm birth year.
Productivity	$prod$	Log(total factor productivity of the firm)-log(industry mean in that year).
FDI Dummy	fdi	One if the share of foreign capital is greater than or equal to 10%; zero otherwise.
Legal Rights Index	$legal$	The degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders, ranging from zero to twelve.
Depth of Credit Information Index	$depth$	A measure of rules affecting the scope, accessibility, and quality of credit information, ranging from zero to eight.
Additional Variables		
Log (Total Sales)		Log(total sales).
Log (Employment)		Log(number of employees).
Log (Fixed Assets)		Log(values of machinery, equipment, land, and buildings).

Data resource: Business Environment and Enterprise Performance Survey (BEEPS), jointly collected by the European Central Bank and Enterprise Surveys, the World Bank, and the World Development Indicator, the World Bank. Export volume, total sales, and fixed assets are in 2005 dollars.

Table 2: Summary Statistics

Variable	Exporters		Non-exporters		Mean Diff. Test	
	Mean	Std. Dev.	Mean	Std. Dev.	Diff.	t stat.
Firm Characteristics						
Fin. Constraint	0.244	0.430	0.414	0.493	-0.170^{***}	-13.376
Log(Ex. Volume)	13.637	2.333				
Firm Age	20.355	20.560	14.424	14.112	5.931^{***}	12.451
Productivity	0.189	1.210	-0.056	1.177	0.245^{***}	7.501
FDI Dummy	0.163	0.370	0.054	0.226	0.109^{***}	13.258
Log (Sale)	14.910	2.008	13.058	2.061	1.851^{***}	33.167
Log (Employment)	4.303	1.427	3.338	1.277	0.965^{***}	26.112
Log (Fixed Assets)	10.193	6.382	8.146	5.871	2.047^{***}	12.221
Country Characteristics						
Legal Rights	5.978	1.906	5.802	2.196		
Depth of Credit Info.	3.722	1.942	3.165	2.172		
Observations	2,464		2,894			

All variables are defined in table 1.
*** denotes significance at 1%.

Table 3: Preliminary Results: The Impacts of Financial Constraints on Exports

	Sign	Export Probability		Export Volume
		OLS	Probit	OLS
Fin. Constraint	-	-0.166^{***}	-0.170^{***}	-0.666^{***}
		(0.015)	(0.014)	(0.093)
Firm Age		0.004^{***}	0.005^{***}	0.018^{***}
		(0.001)	(0.001)	(0.002)
Productivity		0.031^{***}	0.030^{***}	0.820^{***}
		(0.006)	(0.005)	(0.038)
FDI Dummy		0.268^{***}	0.278^{***}	0.787^{***}
		(0.020)	(0.021)	(0.108)
R-squared		0.099		0.304
Wald Chi-squared			689.19	
Observations		5,358	5,358	2,464

This table reports the preliminary results regarding the impacts of financial constraints on firms' exports. Columns 3 and 4 display that firms' financial constraints negatively affect their probabilities of exportation in the whole data, using OLS and probit models. Column 5 displays that firms' financial constraints have negative impacts on their export volume for exporters in the whole data, using OLS.
All variables are defined in table 1. Industry and year dummies are included.
***, ** and * denote significance at 1%, 5% and 10% respectively.

Table 4: The Impacts of Financial Constraints on Export Probability

	Sign	First Stage		Sign	IV 2SLS	IV GMM	IV Probit
Legal Rights	-	-0.012^{***}	Fin. Constraint	-	-0.615^{**}	-0.665^{***}	-1.877^{***}
		(0.003)			(0.141)	(0.146)	(0.447)
Depth of Credit Info.	-	-0.032^{***}					
		(0.005)					
Firm Age	-	-0.002^{**}	Firm Age		0.004^{***}	0.004^{***}	0.010^{***}
		(0.0004)			(0.001)	(0.001)	(0.001)
Productivity		-0.046^{***}	Productivity		0.011	0.006	0.027
		(0.005)			(0.009)	(0.009)	(0.027)
FDI Dummy		-0.036^{*}	FDI Dummy		0.252^{***}	0.259^{***}	0.743^{***}
		(0.019)			(0.022)	(0.023)	(0.070)
Kleibergen-Paap F		53.23	R-squared		0.138	0.142	
			Wald chi-squared				616.19
			Observations		5,358	5,358	5,358

This table reports the impacts of financial constraints on export probability by the instrument linear probability models (2SLS, GMM) and the instrument probit model, using the whole data. The first stage results show that exogenous variations in financial environments, instrumented by the legal rights index and the depth of credit information index, impact firms' financial constraints. The second stage results by three models show that firms' financial constraints negatively affect their export probabilities.
All variables are defined in table 1. Industry and year dummies are included.
Kleibergen-Paap F statistic passes the Stock-Yogo weak instrument tests at 10% in the first stage.
The IV probit model reports the marginal effects at the mean level.
***, ** and * denote significance at 1%, 5% and 10% respectively.

Table 5: The Impacts of Financial Constraints on Export Volume

	Sign	First Stage		Sign	IV 2SLS	IV GMM	IV Treatment
Legal Rights	-	-0.001	Fin. Constraint	-	-8.751^{**}	-8.301^{***}	-2.396^{***}
		(0.004)			(3.411)	(3.255)	(0.532)
Depth of Credit Info.	-	-0.019^{***}					
		(0.007)					
Firm Age	-	-0.001	Firm Age		0.017^{***}	0.016^{***}	0.020^{***}
		(0.001)			(0.004)	(0.004)	(0.002)
Productivity		-0.025^{***}	Productivity		0.604^{***}	0.615^{***}	0.795^{***}
		(0.007)			(0.117)	(0.112)	(0.034)
FDI Dummy		0.010	FDI Dummy		0.922^{***}	0.920^{***}	0.945^{***}
		(0.023)			(0.214)	(0.205)	(0.095)
Kleibergen-Paap F		8.58	R-squared		0.274	0.282	
			Wald chi-squared				1093.67
			Observations		2,464	2,464	2,464

This table reports the impacts of financial constraints on export volume by the instrument models (2SLS, GMM, treatment effect), using firms with positive export volumes in the whole sample. The first stage results show that exogenous variations in financial environments impact firms' financial constraints. The second stage results from the three models show that firms' financial constraints negatively affect their export volumes.
All variables are defined in table 1. Industry and year dummies are included.
Kleibergen-Paap F statistic passes the Stock-Yogo weak instrument tests at 15% in the first stage.
***, ** and * denote significance at 1%, 5% and 10% respectively.

Table 6: The Impacts of Financial Constraints on Export Dynamics

	Sign	Future Export Probability		Start Exporting		Change in Export Volume	
		IV Probit	Panel IV	IV Probit	Panel IV	IV	Panel IV
Fin. Constraint	+	0.713***	0.872*			1.330*	1.316*
		(0.141)	(0.497)			(0.763)	(0.772)
Constraint Relax.	+			6.344***	1.698***		
				(0.109)	(0.651)		
Firm Age		0.002**	0.004***	−0.001	−0.001	−0.002**	−0.002***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Productivity		0.051***	0.076**	0.067***	0.015	−0.048**	−0.050**
		(0.014)	(0.030)	(0.021)	(0.001)	(0.020)	(0.020)
FDI Dummy		0.186***	0.308***	0.040	−0.014	−0.036	−0.033
		(0.049)	(0.078)	(0.074)	(0.023)	(0.049)	(0.049)
R-squared			0.093		0.056	0.027	0.027
Wald Chi-squared		177.18		3829.65			
Observations		1,342	1,342	1,342	1,342	942	942

This table examines the impacts of financial constraints on firms' export dynamics in the panel sub-sample. Columns 3 and 4 show that firms may start to export even though they were previously constrained. Columns 5 and 6 present that relaxing financial constraints increases the probability of starting export. Columns 7 and 8 imply that the growth rate of export volume is higher for financially constrained exporters.
Start exporting is a dummy that equals one if a firm does not export in this period but exports in next period, zero otherwise. Constraint relaxation is a dummy that equals one if a firm is financially constrained in this period but not in next period, zero otherwise. All other variables are defined in table 1. Industry and year dummies are included.
The IV probit model is clustered at the firm level and reports the marginal effects.
The IV model is clustered at the firm level.
All other variables are defined in table 1. Industry and year dummies are included.
***, ** and * denote significance at 1%, 5% and 10% respectively.

Table 7: Robustness Check: Industry Reliance on External Finance

	Export Probability IV GMM			Export Volume IV Treatment		
	Coeff.	Std. Err.	Obs.	Coeff.	Std. Err.	Obs.
External Finance Dependence						
(1) High External Dependence	−1.085***	(0.372)	2,021	−3.069***	(0.573)	1,121
(2) Low External Dependence	−0.887***	(0.217)	3,195	−3.792***	(0.284)	1,342
Asset Tangibility						
(1) High Tangibility	−0.539***	(0.171)	3,052	−3.729***	(0.269)	1,339
(2) Low Tangibility	−0.902***	(0.278)	2,306	−3.368***	(0.577)	1,124
Trade Credit						
(1) High Trade Credit	−0.488***	(0.148)	2,746	−3.842***	(0.263)	1,265
(2) Low Trade Credit	−0.906**	(0.245)	2,611	−3.057***	(0.658)	1,198

This table displays the robustness checks of the financial constraints' impacts on firms' exports. Firms are split based on the exogenous variations in industry reliance on external finance, asset tangibility, and reliance on trade credit. External finance dependence measures the median share of capital expenditure not financed by firms' cash flow within an industry. Asset tangibility is measured as the median ratio of fixed assets to total assets within an industry. These two measures are from Kroszner et al. (2007). Trade credit is the median ratio of accounts payable to total assets for each industry from Fisman and Love (2003). The cutoffs for high and low values are the median values of each measure. Columns 2 to 4 report robustness checks in the whole data, and these results show that financial constraints have negative impacts on firms' probability of exportations. Columns 5 to 7 report robustness checks using exporters only from the whole data, and these results show that financial constraints have negative impacts on firms' export volume.
All other variables are defined in table 1. Industry and year dummies are included.
***, ** and * denote significance at 1%, 5% and 10% respectively.

Table 8: Robustness Check: Individual Variations in Financial Constraints

	Export Probability Shock Type 1 IV GMM	Export Probability Shock Type 2 IV GMM	Export Volume Shock Type 1 IV GMM	Export Volume Shock Type 2 IV GMM
Fin. Constraint	-0.559^{***}	-0.554^{***}	-5.160^{***}	-6.715^{***}
	(0.145)	(0.146)	(1.886)	(2.511)
Firm Age	0.001^{***}	0.001^{***}	0.017^{***}	0.016^{***}
	(0.0004)	(0.0004)	(0.003)	(0.003)
Productivity	0.011	0.012	0.678^{***}	0.637^{***}
	(0.009)	(0.009)	(0.071)	(0.088)
FDI Dummy	0.251^{***}	0.251^{***}	0.826^{***}	0.836^{***}
	(0.023)	(0.023)	(0.150)	(0.176)
R-squared	0.135	0.135	0.287	0.288
Observations	5,004	5,004	2,359	2,359

This table presents the robustness checks on the impacts of firms' constraints on their exporting, after incorporating firm-level evaluations on the legal system. Columns 2, 3, 4 and 5 show that eliminating financial constraints increases firms' probability of exporting and export volume respectively.
"Shock type 1" refers to firm-level legal system evaluations interacting with the country-level legal rights index, and "shock type 2" refers to firm-level legal system evaluations additive to the country-level legal rights index.
All other variables are defined in table 1. Industry and year dummies are included.
***, ** and * denote significance at 1%, 5% and 10% respectively.

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5 Appendix

The recursive problem

The recursive problem with constraints can be written as

$$V(k,\nu;z) = \pi(k;z) - k' + (1-\delta)k - s + \beta EV(k',\nu';z) + \mu\big[\pi(k;z) - k' + (1-\delta)k - s\big] \\ + \gamma\big[\beta EV(k',\nu';z) - D(k)\big] + \chi\big[s + \beta E\nu' - \nu\big].$$

Taking the first order conditions and envelop conditions yield (15) to (19).

Proof of Lemma 1

(i) We describe two observations from conditions (15) to (19) and then the changes in capital and dividends.

First, the firm value function V is decreasing in the promised repayment to the financial intermediary ν as in (19).

The second observation is about how γ affects χ and μ. Substituting (19) into (17) yields

$$\chi = (1+\gamma)E\chi'. \tag{25}$$

Therefore, when the contract enforcement constraint is binding ($\gamma > 0$), the multiplier for the promised repayment constraint χ decreases until it reaches it's minimum, where $\chi = 1$ and $\gamma = 0$. Furthermore, by (15), the firm budget constraint multiplier $\mu > 0$ when $\chi > 1$. In contrast, when the contract enforcement constraint slacks $\gamma = 0$, we have $\chi = 1$ and $\mu = 0$.

Now we can show the change in capital k and dividend d. If both firm budget and contract enforcement constraints (10) and (12) are slack ($\mu = \gamma = 0$), (16) and (18) become:

$$\begin{aligned} \beta EV_{k'}(k',\nu';z) &= 1, \\ V_k(k,\nu;z) &= \pi_k(k;z) + 1 - \delta, \end{aligned} \tag{26}$$

which yield

$$\pi_k(k^*;z) = 1/\beta - 1 + \delta. \tag{27}$$

Furthermore, when the budget constraint multiplier $\mu = 0$, by (10), dividend $d > 0$.

We solve the first-best problem to show that $k^* = k^{fb}$. The first-best problem can be written as

$$V^{fb}(k,\nu;z) = \pi(k;z) - k' + (1-\delta)k - s + \beta EV^{fb}(k',\nu';z) \\ + \mu\big[\pi(k;z) - k' + (1-\delta)k - s\big] + \chi\big[s + \beta E\nu' - \nu\big].$$

The first order conditions for s, k' and ν' and the envelop conditions for k and ν are

$$\begin{aligned}
\chi &= 1+\mu \\
\beta E V_{k'}^{fb}(k',\nu';z) &= 1+\mu \\
E V_{\nu'}^{fb}(k',\nu';z)+\chi &= 0 \\
V_k^{fb}(k,\nu;z) &= (1+\mu)\big[\pi_k(k;z)+1-\delta\big] \\
V_\nu^{fb}(k,\nu;z) &= -\chi.
\end{aligned}$$

These conditions imply that $\pi_k(k^{fb};z) = 1/\beta - 1 + \delta$. With (27), we have $k^* = k^{fb}$.

(ii) When both firm budget and contract enforcement constraints (10) and (12) are binding ($\mu > 0$, $\gamma > 0$), we re-write (16) one period lagged as

$$(1+\gamma_{-1})\beta V_k(k,\nu;z) = 1+\mu_{-1}, \tag{28}$$

where γ_{-1}, μ_{-1} are the Lagrangian multipliers in the lagged period. Substituting (18) into (28) and using (2) yield

$$(1+\mu)\big[\pi_k(k;z)+1-\delta\big] - \gamma\lambda = \frac{1}{\beta}\frac{1+\mu_{-1}}{1+\gamma_{-1}}. \tag{29}$$

In (29), in order to find the relationship among μ, μ_{-1} and γ, we need to re-write (15) and (25) one period lagged

$$\chi_{-1} = 1+\mu_{-1}, \tag{30}$$

$$\chi_{-1} = (1+\gamma_{-1})\chi. \tag{31}$$

Substituting (15), (30) and (31) into (29) yields

$$\begin{aligned}
\chi\big[\pi_k(k;z)+1-\delta\big] - \gamma\lambda &= \frac{1}{\beta}\frac{\chi_{-1}}{1+\gamma_{-1}} \\
\pi_k(k;z)+1-\delta-\frac{\gamma\lambda}{\chi} &= \frac{1}{\beta} \\
\pi_k(k;z) &= \frac{1}{\beta}-1+\delta+\frac{\gamma\lambda}{\chi}.
\end{aligned} \tag{32}$$

Therefore, the return rate of capital is higher when the contract enforcement constrain is binding $\gamma > 0$ and capital k grows.

Proof of Lemma 2

A larger λ, or a worse financial environment, gives the contract enforcement constraint (12) a higher probability of binding when the firm accumulates capital. Following Albuquerque and Hopenhayn (2004, section 4.6.2 regarding enforcement), the contract enforcement constraint will then experience slower elimination and therefore the firm has

a more stringent constraint. From lemma 1, when the firm is financially constrained, $\pi_k(k;z) = \frac{1}{\beta} - 1 + \delta + \frac{\gamma\lambda}{\chi}$. Therefore, other things equal, a worse financial environment makes the firm's marginal rate of return to capital higher, and k smaller.

When the firm is no longer financially constrained, from lemma 1, capital reaches its optimal level k^*. Therefore, the financial environment has no impact on the firm.

Proof of Lemma 3

(i) The profit maximization problem (3) assumes that capital k is given by the optimal contract problem (9). Equivalently, we assume the marginal rate of return to capital, or the shadow price of capital, is given by the optimal contract problem. We then solve a firm's profit maximization problem (3) in two steps. First, we find its marginal cost. Assume the input bundle is $k^\alpha l^{1-\alpha}$, then 1 unit of output y can be produced by $1/z$ unit of input bundle. Lemma 1 shows that the internal rate of return for capital is

$$r(\gamma) = \begin{cases} 1/\beta - 1 + \delta + \gamma\lambda/\chi, & \gamma > 0 \\ 1/\beta - 1 + \delta, & \gamma = 0 \end{cases}$$

then the marginal cost of output y is

$$mc(\gamma, z) = \alpha^{-\alpha}(1-\alpha)^{\alpha-1}\frac{r(\gamma)^\alpha w^{1-\alpha}}{z}, \tag{33}$$

where $w = 1$ from the homogenous good sector. Thus the firm's marginal cost reaches its minimum when the firm is not financially constrained: $\gamma = 0$.

(ii) Second, we find out the optimal prices and quantities for domestic and foreign markets. It is well known that the optimal pricing strategy for firms experiencing the monopolistic competition is constant markup pricing. Then the optimal prices for domestic and foreign markets are

$$p^d = \frac{\sigma}{\sigma-1}mc(\gamma,z),\ p^x = \frac{\sigma}{\sigma-1}\tau mc(\gamma,z). \tag{34}$$

Then the export profit is

$$\pi^x = \big(p^x - \tau mc(\gamma,z)\big)q^x - f^x, \tag{35}$$

where $q^x = \big(p^x\big)^{-\sigma}\hat{R}/\hat{P}^{1-\sigma}$.

As a firm's marginal costs decrease with lower γ, the firm achieves its lowest marginal cost when not financially constrained: $\gamma = 0$. Consequently, the lower bound of z above which a firm eventually exports, $\underline{z}^x$, can be found when a firm's export profit is zero and it is not financially constrained:

$$p^x q^x - \tau mc(0, \underline{z}^x)q^x = f^x,$$

which yields

$$\underline{z}^x = \left(f^x/c^x\right)^{\frac{1}{\sigma-1}} r(0)^{\alpha} w^{1-\alpha} \hat{R}^{\frac{1}{1-\sigma}} / \hat{P},$$

where $c^x = \frac{1}{\sigma-1}(\frac{\sigma}{\sigma-1})^{-\sigma}\tau^{1-\sigma}[\alpha^{-\alpha}(1-\alpha)^{\alpha-1}]^{1-\sigma}$. The cutoff productivity $\underline{z}^x$ is consistent with that in the scenario of perfect commitment, because a firm with productivity $\underline{z}^x$ exports when it is not financially constrained.

(iii) Finally, we look at a firm's export volume after deriving the situation in which a firm with $z \geq \underline{z}^x$ begins to export. A firm starts to export if $\pi^x \geq 0$. When it accumulates enough capital, its internal rate of capital decreases, and thus its marginal cost is low enough, as seen in lemma 1. Specifically, a firm with $z \geq \underline{z}^x$ starts to export if

$$\frac{r(\gamma)^{\alpha} w^{1-\alpha}}{z} \leq (\frac{f^x}{c^x})^{\frac{1}{1-\sigma}} \hat{P}\hat{R}^{\frac{1}{\sigma-1}},$$

which is directly derived by subsituting (33) and (34) into (35). When the firm accumulates more capital, its marginal cost decreases. Therefore it is more likely to export.

(iv) The export volume for a firm is

$$R^x = p^x q^x = (\frac{\sigma}{\sigma-1})^{1-\sigma}\tau^{1-\sigma} mc(\gamma, z)^{1-\sigma} \hat{P}^{\sigma-1}\hat{R}.$$

Therefore, as the firm's export volume increases it accumulates more capital and its marginal cost decreases. The firm reaches its maximum export volume when it is not constrained: $\gamma = 0$.

The assumption of I_0

We derive the assumption about the initial setup cost I_0, which suggests the optimal contract problem (9) is not trivial, or in other words, the contract enforcement constraint (7) is binding in the initial period. Intuitively, if the initial set-up cost of the firm is large enough, and the financial intermediary lends the firm its optimal capital level, the firm would deviate in the initial period because defaulting with the capital is better than the alternative of producing and repaying the financial intermediatory.

We focus on a firm with the highest productivity $\bar{z}$, which sets the largest value needed for I_0 to satisfy.

Define the optimal capital for the firm with productivity $\bar{z}$ as $k^*(\bar{z})$. Assume that the financial intermediary were to lend a firm its optimal capital level $k^*(\bar{z})$. The firm then has a positive dividend from the initial period. To simplify the solution, we choose a constant dividend schedule: $d_t = d_{t+1} = \cdots = d$. We also choose a constant repayment schedule: $s_t = s_{t+1} = \cdots = s$. With the financial intermediary's break-even constraint (8), we have $s = (1-\beta)I_0$. The firm's value becomes

$$V = d + \beta V' \;\Rightarrow\; V = \frac{1}{1-\beta} d. \tag{36}$$

We need to derive the dividend d. We first solve the firm's profit maximization problem:

$$\pi(\bar{z}) = c\tilde{R}\bar{z}^{\sigma-1} - f^x,$$

where $c = \sigma^{-\sigma}(\sigma-1)^{\sigma-1}\alpha^{\alpha(\sigma-1)}(1-\alpha)^{(1-\alpha)(\sigma-1)}(1/\beta - 1 + \delta)^{1-\sigma}$, $\tilde{R} = P^{\sigma-1}R + (\hat{P}/\tau)^{\sigma-1}\hat{R}$. From the budget constraint (10) and the law of motion for capital (11), the dividend can be written as

$$d = \pi(\bar{z}) - \Big(k^*(\bar{z}) - (1-\delta)k^*(\bar{z})\Big) - s = \pi(\bar{z}) - \delta k^*(\bar{z}) - (1-\beta)I_0. \tag{37}$$

Finally, if the optimal capital k^* breaks the contract enforcement constraint (12), we have

$$\begin{aligned} D\big(k^*(\bar{z})\big) &> \beta EV' \\ \lambda k^*(\bar{z}) &> \frac{\beta}{1-\beta} d \\ I_0 &> \frac{1}{1-\beta}\pi(\bar{z}) - \Big(\frac{\delta}{1-\beta} + \frac{\lambda}{\beta}\Big)k^*(\bar{z}), \end{aligned}$$

where the second inequality is from (36) and the third inequality is from (37).

Calibration

In the numerical example, the first group of parameters is calibrated to our panel data set. In order to find the discount rate $\beta = \tilde{\beta} * (1-\xi)$ across, we need to find the discount rate $\tilde{\beta}$ across and the exit rate ξ across firms. In the data, the average real interest rate is 0.06, which implies that $\tilde{\beta} = 1 - 0.06 = 0.94$. The exit rate across firms cannot be directly observed in data but can be backed out by new firms' share, because the model assumes the entry rate across new firms equals old firms' exit rate. New firms (firm age=0) accounts for 6% of all firms. Then the discount rate across firms is $\beta = 0.94 * (1 - 0.06) = 0.88$.

In order to determine z_H and z_L, we first construct the logged total factor productivity in the data and estimate it as an AR(1) process. We estimate an AR(1) model for the logged productivity and obtain $\tilde{\rho}$ as the coefficient and $\tilde{\sigma}_\epsilon^2$ as the variance of residual. We discretize AR(1) process as in Tauchen and Hussey (1991): $z_H = exp\big(\sqrt{\tilde{\sigma}_\epsilon^2/(1-\tilde{\rho}^2)}\big)$, $z_L = exp\big(-\sqrt{\tilde{\sigma}_\epsilon^2/(1-\tilde{\rho}^2)}\big)$, and $\rho = (1+\tilde{\rho})/2$. We have productivity status parameters $z_H = 1.37$, $z_L = 0.73$ and transition matrix parameter $\rho = 0.96$. We set iceberg cost $\tau = 1.14$ to match the ratio of exports over domestic sales 0.88 in the data.

The second group of parameters is set based on model assumptions. We set wage $w = 1$, because one unit of labor produces one unit of numeraire good. The deviation parameter is set as $\lambda = 0.5$ in the benchmark.

The third group of parameters is based on literature. We set elasticity of substitution as $\sigma = 2$, consistent with Ruhl (2004). Capital share is $\alpha = 0.33$, consistent with Ai, Kiku and Li (2013) and other papers. The depreciation rate of capital is $\delta = 0.05$. We set the fixed cost $f_x = 0.47$ such that fixed cost of export (because of border-related trade barriers) is 44% of marginal cost, as in Anderson and van Wincoop (2004).

Table 9: Parameter Calibration

Variable	Description	Value
$\tilde{\beta}$	Discount rate	0.94
ξ	Exit rate	0.06
β	Discount rate of firms	0.88
z_H	Productivity: High status	1.37
z_L	Productivity: Low status	0.73
ρ	Transition matrix parameter	0.96
τ	Iceberg cost	1.14
w	Wage	1
λ	Deviation parameter	0.5
α	Capital share	0.33
σ	Elasticity of substitution	2
δ	Depreciation rate of capital	0.05
f_x	fixed cost of export	0.47

Data Cleaning Procedures

Environment and Enterprise Performance Survey (BEEPS) provides six cross-sectional data sets (survey years 1999, 2002, 2004, 2005, 2009, 2012-2014) and one panel data set (survey years 2002-2009). The survey questions regarding financial constraints are only available for cross-sectional data sets 2009, 2012-2014 and the panel data set. Therefore, in order to incorporate as many observations as possible, the whole data set used in this paper contains two cross-sectional data sets from 2009 and 2012-2014, and firms that have been surveyed in 2002 and 2005 in the panel data set. As data year = survey year − 1, the corresponding data years of the whole sample is between 2001 and 2013. We keep firms in the manufacturing industries only. Firms need to have non-missing values for annual sales, numbers of employees, indicators of export, and answers to financial constraint questions.

The sub-sample of firms with at least two observations is based on the panel data between survey years 2002 and 2009. Because surveys examine firms' performance one year before the survey year, the corresponding data years are 2001 to 2008. Each firm has been surveyed in every three years. BEEPS creates panel firm identification numbers to set up the panel data set. We apply the same rules as in the whole sample to keep firm-year observations. Because only a portion of firms have been surveyed multiple times, the panel data set is a sub-sample of the whole data set.

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