Financial Development, Endogenous Dependence on External Financing, and Trade*

ByeongHwa Choi†

February 9, 2018

Abstract

Influential papers on how credit constraints affect growth and international trade have shown a tendency to assume that asset tangibility and the share of external borrowing are exogenous industry characteristics that are time- and country-invariant. In the finance literature, however, the share of external borrowing is viewed as endogenous and dependent on the amount of collateral a firm can provide (and thus, implicitly, on its asset tangibility). Drawing from the finance literature, I hypothesize that there are supply-side factors that exert substantial influences on the share of external financing. I test this new perspective with country- and industry-specific measures of asset tangibility and external borrowing. I find that (i) the share of external borrowing increases in asset tangibility and (ii) the sectoral rankings of asset tangibility and the share of external borrowing vary significantly across countries. Further, I develop a theoretical model by incorporating financial frictions into an otherwise standard trade model to investigate the impact of financial development and asset tangibility on the demand and supply of external finance and exports. The model yields theoretical predictions that are consistent with, and provide intuition for, the above results. Both the model and my empirical results demonstrate that industries with more tangible assets export more from countries with high levels of financial development.

JEL classification: F10, F14, G20, O14, O16
Keywords: Financial development, External finance, Asset tangibility, International trade

---

*I want to thank Tibor Besedeš, Mostafa Beshkar, Kerem Cosar, Gene Grossman, Michael Kaganovich, Andrei Levchenko, Volodymyr Lugovskyy, Kalina Manova, Marc-Andreas Muendler, and seminar and conference participants at the 2016 Western Economic Association International Annual Conference, Yonsei University, the 2017 Empirical Investigations in Trade and Investment Conference, and the 2017 Asia Pacific Trade Seminars for very helpful comments and suggestions. This work was supported by the Ministry of Science and Technology of Taiwan (MOST 106-2410-H-002-001).

†Department of Economics, National Taiwan University, No. 1, Sec. 4, Roosevelt Road, Taipei, 10617 Taiwan (R.O.C.); E-mail: bhchoi@ntu.edu.tw.

Financial Development, Endogenous Dependence on External Financing, and Trade

1 Introduction

There has been a considerable focus on financial development in the recent literature on growth and international trade. This literature demonstrates that financial development increases economic growth (Beck et al., 2000; King and Levine, 1993a,b; Levine, 2005; Levine et al., 2000; Rajan and Zingales, 1998) and firms' ability to export (Berman and Héricourt, 2010; Chaney, 2013; Greenaway et al., 2007; Manova, 2013; Muûls, 2008). Researchers have examined this effect in depth by relating cross-country differences in industry performance to an interaction between country-level financial development and industry characteristics. Within a country, financial development has been found to be more important for financially vulnerable sectors—that is, those most in need of external finance and those with few tangible assets (e.g., Amiti and Weinstein, 2011; Beck, 2002, 2003; Braun, 2003; Chor, 2010; Claessens and Laeven, 2003; Hur et al., 2006; Manova, 2013; Rajan and Zingales, 1998; Svaleryd and Vlachos, 2005).[1]

The key idea in this literature is that the amount of external finance that firms demand to operate and their observed asset structure reflect an exogenous component, which is technologically determined by the nature of production. The dominant approach in such research is to assume that these industry characteristics are country- and time-invariant and that the share of external borrowing (relative to capital expenditure) and asset tangibility (the ratio of tangible assets to total assets) are independent of each other. These measures are typically calculated for the United States for the period 1986–1995 and applied to other countries and time periods.[2]

Both of these assumptions are at odds with the literature on international trade and finance; therefore, I explore what happens if they are relaxed. Specifically, following the

[1] Throughout this paper, the term "sector" is employed as a synonym for "industry". External finance refers to sources of funds outside of a firm, including both domestic and foreign finance. Collateral value of assets is measured as the ratio of net property, plant and equipment over total assets. Since information on the value and type of collateral offered by a borrower is difficult to obtain and tangible assets are easy to collateralize for debt, I use asset tangibility as a proxy for collateral.

[2] For a more detailed discussion of why these assumptions are reasonable, see Braun (2003) and Manova (2013).

empirical trade literature, I allow for variation in industry-level asset tangibility across countries, motivated by the Leontief paradox, which shows that the same industries often have different factor intensities across countries[3], and thus are likely to have different shares of tangible assets. Furthermore, I allow for endogeneity of external borrowing on asset tangibility, following the established finance literature, which shows that lending institutions link loan amounts to available collateral.[4]

First, I demonstrate that some basic data patterns are inconsistent with the aforementioned assumptions. To this end, using Compustat Global data for 10 countries (with relatively high private credit-to-GDP ratios) between 1987 and 2006, I construct industry-level measures of asset tangibility and external borrowing individually *for each country*. I show that (i) their industry rankings vary across countries and (ii) external borrowing is positively correlated with asset tangibility. These results confirm my prior conjectures and provide the motivation for my model.

Next, I develop a theoretical model showing that the share of outside capital available to a firm increases in the degree of asset tangibility and level of financial development. The model also reveals that financial development, by reducing the costs of external finance, helps disproportionately more exports from industries with high asset tangibility. This is because firms with substantial tangible assets can raise much more external finance to cover trade costs and benefit more from cheaper external finance. This finding contradicts previous studies assuming exogenous variation in the degree to which firms depend on external finance and suggests that the role of collateral in obtaining a given loan amount should decline as the country's financial system develops.

I test the empirical implications of the model by employing Manova's (2013) specification as a benchmark. Owing to the positive relationship between external finance share and asset

[3] This line of research includes work by Dollar et al. (1988) and Wood (1995). Acemoglu and Zilibotti (2001), Bernard and Jones (1996), and Schott (2004) suggest that the optimal technology choice depends on many factors that vary across countries.

[4] A higher availability of collateral increases the supply of external finance since collateral can mitigate the informational asymmetries between borrower and lender and provide the lender the security of repayment of the loan. See, for example, Almeida and Campello (2007), Bradley et al. (1984), Braun and Larrain (2005), Claessens and Laeven (2003), Gompers (1995), Hart and Moore (1994), and Moore and Kiyotaki (1997).

tangibility, I exclude the former and include only the latter as an industry-level measure of financial constraints. To determine if, indeed, the effect of financial development on exports is more prominent in sectors with more tangible assets, I include an interaction term between the development of a country's financial sector and asset tangibility. The results support my theoretical prediction: the coefficient on the interaction term is positive and statistically significant. In other words, higher tangibility of assets reinforces the positive effects and alleviates the negative effects on exports. This result is at odds with Manova (2013), who finds the opposite sign in the specification using technological industry characteristics in the United States. This discrepancy reflects cross-country differences in relevant industry characteristics.

Further, to test the potential endogeneity of asset tangibility, I employ two-stage regressions and set the U.S. measure of asset tangibility calculated by Braun (2003) as an instrument variable for asset tangibility. The analysis shows that asset tangibility can be taken as exogenous, and the main findings remain unchanged.[5]

This paper is relevant to several literature streams. First, it contributes to the literature on credit constraints and patterns of trade. In particular, it delves into the impact of the interplay between financial development and asset tangibility. Hur et al. (2006) and Manova (2013) find that financial development is associated with more exports in industries with more intangible assets. While both Hur et al. (2006) and the present paper find a positive correlation between the proxy for asset tangibility and the external finance share, the present paper provides a different conclusion—namely, that financial development leads to more exports in industries characterized by a higher share of tangible assets. To my knowledge, Yousefi (2011) is the only one to show that financial development and asset tangibility are complementary in exports. Using exports data collected for 15 countries hit by severe financial crises during the period 1975–2005, the author finds that industries with high tangible assets grow faster in the export market as private credit becomes increasingly

[5] Berger and Udell (1990) and John et al. (2003) assume that collateral is exogenous. Nguyen and Qian (2012) find that financial development has no robust association with collateral value.

available.[6] However, he employs a U.S.-based measure of asset tangibility calculated by Braun (2003), which may be less applicable to less financially developed countries.[7]

This paper also relates to the large body of literature on the heterogeneity in factor intensity for a given industry across countries, especially since asset tangibility is correlated with the capital intensity of a given industry. Capital intensity describes the amount of plant, property equipment, inventory, and other tangible or physical assets used to generate revenue. In fact, several papers employ the firm's share of fixed capital (i.e., property, plant, and equipment) in total assets as a measure of capital intensity (e.g., Dopuch and Pincus, 1988; Lubatkin and Chatterjee, 1994). In the present paper, I use the same definition to measure asset tangibility. In this sense, the results of this paper provide an interesting parallel to the results of studies adopting the standard Heckscher-Ohlin model, which indicate that countries will export products produced using abundant and cheap factors of production. This paper demonstrates that countries will export more products from industries that have more tangible assets, and thus use cheaper external funds.

The remainder of the paper is organized as follows. In the next section, I discuss the adequacy of new measures of the share of external borrowing and asset tangibility, and describe the data used to measure them. Section 3 outlines the theoretical model of firms that decide on borrowing and exporting in the presence of financial constraints. Section 4 describes the data and introduces the empirical framework. Section 5 presents the results of the empirical analysis and the robustness tests. Section 6 concludes with a brief summary of the results.

2 Empirical Patterns

Before presenting a model and using the data to formally test its predictions, I discuss the key empirical patterns in the data that serve as the motivation for the theoretical model

[6] The sample of countries includes Spain, Norway, Finland, Sweden, Japan, Indonesia, Korea, Malaysia, Philippines, Thailand, Argentina, Chile, Colombia, Mexico, and Turkey.

[7] While it is not directly related to trade, Fernandes (2011) supports the complementarity of financial development and asset tangibility, showing that firms with high levels of tangible assets are better able to raise finance in countries that provide strong creditor protection.

and empirical analysis.

2.1 Measures of External Finance Share and Asset Tangibility

I obtain the data for firm characteristics from the annual databases of Compustat North America (for U.S. firms) and Global (for firms outside the United States). I follow the level of industry aggregation used in Braun (2003), Manova (2013), and Rajan and Zingales (1998), which is based on the International Standard Industrial Classification Revision 2 (ISIC Rev.2).[8]

To measure the share of sectoral external funds, I adhere as closely as possible to Rajan and Zingales's (1998) definition: the share of capital expenditures (Compustat item *capx*) of firms not financed by cash flow from operations for a median publicly-listed company.[9] Cash flow from operations is defined as the sum of funds from operations plus decreases in inventories (Compustat item *invch*), decreases in accounts receivable (Compustat item *recch*), and increases in accounts payable (Compustat item *apalch*).[10] Both capital expenditure and cash flow are summed up over the relevant years to smooth any temporal fluctuations. To avoid excessively weighting large companies, each industry's external finance share is calculated as the median external finance share of all active companies in the industry in each country contained in the Compustat database.[11]

Following Braun (2003), I proxy firms' ability to raise external finance with the endowment of hard assets that companies can pledge as collateral. It is gauged by asset tangibility, defined as the ratio of net property, plant, and equipment (Compustat item *ppent*) over total

[8] I would like to thank Luc Laeven for providing the industry concordance table.

[9] Capital expenditures are cash outflow or funds used for additions to the company's property, plant, and equipment (e.g., expenditures for capital leases, increase in funds for construction, reclassification of inventory to property, plant, and equipment, and increase in leaseback transactions).

[10] See Appendix for details of the construction of the measure.

[11] In Rajan and Zingales (1998):

> "We sum the firm's use of external finance over the 1980's and then divide by the sum of capital expenditure over the 1980's to get the firm's dependence on external finance in the 1980's. This smooths temporal fluctuations and reduces the effects of outliers. To summarize ratios across firms, however, we use the industry median."

assets (Compustat item *at*) (i.e., the proportion of total assets that has collateral value).[12] Again, I take the sum of the numerator and denominator over the relevant years to smooth out the data from any single year. I compute firm-specific numbers, and then report the median value within each industry in a country.[13]

The present sample contains 10 countries and 25 manufacturing industries. The availability of firm-level financial data in the Compustat database determines the choice of countries and industries in the sample. Rajan and Zingales (1998) specify that there should be more than one observation per industry. In this study, I use stringent criteria for the number of firms in each industry to avoid a situation where only a few observations determine the characteristics of an industry. Consequently, there are few countries in which an appropriate number of firms are active in each sector. I focus on 9 countries (besides the United States) that have more than 15 sectors in common with the United States, with 5 or more firms in each industry.[14] Those countries are China, France, Hong Kong, India, Japan, South Korea, Malaysia, Singapore, and Thailand, which have relatively high private credit-to-GDP ratios (see Figure A.1).

The number of industries varies across countries from 16 sectors in France, Singapore, and Thailand to 25 sectors in the United States. These differences are largely due to the fact that in most of these countries, import and export compositions are very dissimilar. The number of industries and the number of firms per industry available for each country are listed in Table A.3 in the Appendix. In Table A.4, I describe the distribution of the share of external finance and asset tangibility measures for each ISIC industry across the available countries.

[12] This proxy has been commonly used in the finance literature (e.g., Campello and Giambona, 2013; Frank and Goyal, 2003; Johnson, 1997). Myers and Majluf (1984) argue that it reflects the ability to use the assets as collateral, and can be associated with a higher debt capacity.

[13] Rajan and Zingales (1998) do not measure asset tangibility. Braun (2003) does so while adopting the measure of external finance dependence provided by Rajan and Zingales (1998). Several empirical studies in this literature, including Manova (2013), use the values of external finance dependence and asset tangibility as provided by Rajan and Zingales (1998) and Braun (2003).
See Tables A.1 and A.2 for external finance share and asset tangibility figures of the U.S. industries for the time periods 1987–1996, 1997–2006, and 1987–2006.

[14] Tong and Wei (2011) calculate the sector-level median from firm ratios of dependence on external financing for each SIC 3-digit sector that contains 5 or more firms.

Table 1: Correlations with the U.S. index for 1987–2006

	External finance share			Asset tangibility	
	Pearson corr. of value	Spearman's rank corr.		Pearson corr. of value	Spearman's rank corr.
Japan	-0.10	0.20	Malaysia	0.41*	0.45**
France	-0.08	-0.05	Singapore	0.45*	0.41
Hong Kong	0.04	0.04	Thailand	0.50**	0.51**
Korea, Rep.	0.08	0.00	France	0.64***	0.80***
China	0.21	0.29	Japan	0.67***	0.65***
Malaysia	0.27	0.31	India	0.68***	0.71***
Singapore	0.34	0.33	Hong Kong	0.71***	0.76***
India	0.42**	0.18	Korea, Rep.	0.77***	0.83***
Thailand	0.43	0.50**	China	0.82***	0.85***

Notes: This table shows Pearson correlation and Spearman's rank correlation coefficients of external finance share and asset tangibility with the corresponding U.S. measure for countries that have more than 15 industries in common with the U.S. with five or more firms in each industry. Countries are ordered from lowest to highest, based on the Pearson correlation of each measure. Correlation is * significant at 10%; ** significant at 5%; *** significant at 1%.

2.2 Comparison of Rankings across Countries

In the following subsections, I empirically test the conventional assumptions using two indices of external finance share and asset tangibility. In particular, this analysis aims to show that the sectoral rankings of the share of external finance and asset tangibility are not stable across countries, but relatively stable across years.

The argument that the sectors' external finance dependence and asset tangibility differ due to inherent technological factors motivates the assumption in the aforementioned literature that the measures for the U.S. industries should be representative of the corresponding industries in other countries. In other words, the ranking of the sectors according to their outside capital share or asset tangibility should not change considerably if non-U.S. data are used instead.

Table 1 shows how the rankings according to the share of external finance and asset tangibility of the U.S. industries are correlated with those of other countries' industries. I use two types of correlation coefficients: Pearson correlation and Spearman's rank correlation. Since I use the direct measurements, rather than rankings, in the regressions, applying Pearson correlation is more adequate. The Spearman's rank correlation coefficient is provided for completeness and also to test whether the claim of the earlier studies that sectoral rankings are similar across countries is valid.[15] As the table illustrates, the overall ranking of the sectors according to their level of external capital share appears to be unstable across countries. The lack of a significant correlation suggests that the factors affecting the external finance share of industries may not be entirely the same across countries. One explanation is that different countries accept different types of assets as eligible collateral. For example, in developing countries, many assets are not capable of fully securing lender's interests due to the absence of the legal system to recognize them. Thus, the set of assets that can be used as collateral in many developing countries tends to be restricted. The absence of a significant correlation may also be attributable to the relatively small variability in the external finance share of the U.S. industries.

On the contrary, the asset tangibility measure computed using Compustat Global data is relatively highly correlated with the corresponding measure computed on the U.S. data. It implies that this measure is largely exogenous. This justifies my approach of using asset tangibility in the regression analysis. Although the correlations are positive and significant, they are far from unity and insufficient to suggest that applying the U.S. industry-level measure to all other countries will reproduce the results using the country- and industry-specific measure.

In addition, I find cross-country heterogeneity within individual industries.[16] For example, in the printing and publishing industry (ISIC 342), one of the most diverse across countries in terms of asset tangibility, the value of asset tangibility ranges between 0.02 and 0.5, and it is the lowest for France and the highest for Malaysia. This implies that in the labor-intensive manufacturing sector, firms in developing countries tend to have a higher pro-

[15] Spearman's rank correlation is useful for non-normally distributed data and/or small sample size.

[16] I used the coefficient of variation, the standard deviation divided by the mean, as a measure of dispersion. See Table A.4 for summary statistics.

Table 2: Correlations of time periods 1987–1996 and 1997–2006

	External finance share			Asset tangibility	
	Pearson corr. of value	Spearman's rank corr.		Pearson corr. of value	Spearman's rank corr.
France	-0.13	-0.05	Hong Kong	-0.14	-0.07
Japan	0.16	0.04	France	0.59	0.33
India	0.52**	0.66***	Korea, Rep.	0.72***	0.77***
United States	0.55***	0.48**	China	0.75***	0.68***
Korea, Rep.	0.57*	0.56*	Malaysia	0.81***	0.81***
Hong Kong	0.58	0.68*	India	0.84***	0.81***
Malaysia	0.86***	0.84***	Japan	0.89***	0.85***
Thailand	0.96**	0.80	United States	0.93***	0.92***
China			Thailand	0.97**	0.40

Notes: Countries are ordered from lowest to highest, based on the Pearson correlation of each measure. Correlation is * significant at 10%; ** significant at 5%; *** significant at 1%.

portion of fixed assets than firms in developed countries, which is consistent with Demirgüç-Kunt and Maksimovic (1999). I observe similar patterns in other unskilled, labor-intensive industries with the largest variation, including footwear (ISIC 324) and other manufactured products (ISIC 390). From this, we can expect the share of external funds to differ across countries. I indeed observe that the share of external finance in the printing and publishing industry (ISIC 342) ranges from -1.38 to 0.53, and it is the lowest for the United States, where asset tangibility is the second lowest; it is the highest for India, where asset tangibility is the fourth highest. In summary, the observed heterogeneity across countries within industries prompts the use of country- and industry-specific measures.

2.3 Comparison of Rankings over Time

Another important question to be addressed is whether the sectors' ranking changes over time. In Table 2, the correlations between time periods 1987–1996 and 1997–2006 in terms of asset tangibility indicate that the rankings of industries are relatively stable over time for the sample of countries. This is one reason why I use the asset tangibility measure calculated for 1987–2006 in the analysis. The other reason is that there are only 4 countries (China, India, Japan, and the U.S.) that have more than 15 sectors, with 5 or more firms in each sector in 1987–1996.

3 Model

This section develops a model focusing on the relationship between firms' financial constraints and asset tangibility and their external borrowing and exports, and formulates some empirical predictions. The basic setup is the same as that in Chaney (2013) and Muûls (2008) which incorporate credit constraints of firms in a Melitz's (2003) framework. The present model offers a micro-foundation for the lending and borrowing decisions that have often been overly simplified in the relevant literature. I introduce collateral into the framework of Galor and Zeira (1993) whose model incorporates the enforcement cost incurred by lenders in interest rate determination and allow for endogenous changes in the interest rate. As a result, in my model, individual borrower's interest rate decreases in the amount of collateral and the level of financial development, and increases in the amount of external finance. This approach allows one to understand the mechanism behind the differential effects of financial development according to asset tangibility. This model is perfectly tractable and moreover can be easily extended to a model where firms can succeed or fail with firm-specific probabilities, such that firms with a high success probability pay a lower interest rate.

As in Chaney (2013) and Muûls (2008), suppose that there are two countries, home and foreign. Production requires only one input, labor, and population size (or total demand for a variety in a given country) is L for home country, L^* for the foreign country. There are two sectors. One sector produces a homogeneous good which is used as the numeraire, i.e., its price normalized to unity. When both countries produce the homogeneous good, wages will be fixed by this sector's production at w and w^*, respectively. The unit labor requirement for producing the homogeneous good is $1/w$ at home and $1/w^*$ abroad. The other sector produces a continuum of differentiated goods and each firm is a monopolist for the variety it produces.

3.1 Demand

Consumers are endowed with one unit of labor. Consider a constant elasticity of substitution (CES) utility function given as

$$U = q_0^{1-\mu}\left(\int_{\omega\in\Omega} q(\omega)^{\frac{\sigma-1}{\sigma}} d\omega\right)^{\frac{\sigma}{\sigma-1}\mu}, \qquad \sigma > 1 \tag{1}$$

where σ is the elasticity of substitution between two varieties of the differentiated good. The utility level is determined by the consumption of q_0 units of the numeraire good and $q(\omega)$ units of each variety ω of the differentiated good, for all variety ω in the set Ω.

As in Melitz (2003), consumer behavior can be modeled by considering the set of varieties consumed as an aggregate good, U. If all varieties in the set Ω are available domestically at price $p(\omega)$, the price index for differentiated goods is defined as

$$P = \left(\int_{\omega\in\Omega} p(\omega)^{1-\sigma} d\omega\right)^{\frac{1}{1-\sigma}}. \tag{2}$$

This implies that the representative consumer has an isoelastic demand function for each differentiated variety:

$$q(\omega) = \mu w L\left(\frac{p(\omega)^{-\sigma}}{P^{1-\sigma}}\right). \tag{3}$$

Everything else being equal, a 1% rise in $p(\omega)$ reduces demand $q(\omega)$ by σ%. The amount spent on each variety ω (or the revenue per variety) is

$$R(\omega) = \mu w L\left(\frac{p(\omega)}{P}\right)^{1-\sigma} \tag{4}$$

where $\mu w L$ is the total amount spent on differentiated goods.

3.2 Production

Both countries have the same technology and the constant marginal product of labor. In each country, there is a continuum of firms. As in Chaney (2013) and Muûls (2008), each firm starting production for the domestic market pays a fixed entry cost f_e in terms of domestic labor, or wf_e in terms of the numeraire. This is a tangible asset that can be used as collateral. After paying f_e, the firm draws a unit labor productivity $x \geq 0$ which determines its production cost. The cost of producing $q_d(x)$ units of good for the home market is:

$$c_d(q_d(x)) = q_d(x)\frac{w}{x} + wf_e. \tag{5}$$

After entry into the domestic market, firms must decide whether or not to enter the export market. The sunk cost makes sure that firms who enter exporting markets plan to recoup their sunk costs. Firms enter the market if their ex-ante expected value of future profits from exports at least equals the entry cost. If the firm decides to enter the export market, it must pay a fixed entry cost f_{ex} in terms of foreign labor, or $w^* f_{ex}$ in terms of the numeraire. There is a variable cost in the form of an "iceberg" transportation cost τ. If one unit of any variety of the differentiated good is shipped, only fraction $1/\tau$ arrives in the foreign country. The cost of producing $q_f(x)$ units of good for the foreign market is:

$$c_f(q_f(x)) = q_f(x)\frac{\tau w}{x} + w^* f_{ex} + r(q_f(x))E(q_f(x)). \tag{6}$$

The last term represents the net costs of external financing. Each price is expressed in terms of units of labor, used as the numeraire.

Firms should pay a fixed cost and a fraction of variable cost before any profits are made abroad. The costs can be financed in three ways. A firm can use the profits generated from domestic sales, $\pi_d(x)$. Further, it is endowed with a random exogenous liquidity shock, A, which has a value of wA. Finally, a firm can borrow external funds, $E(q_f(x))$, with a financial cost at a rate $r(q_f(x))$. If available, a firm will prefer to use internal funds rather than external borrowing because the latter is more costly than internal finance. For simplicity, this paper assumes that external borrowing exists only in financing the production for export market. In order to borrow, a firm must pledge tangible assets as collateral which are assumed to be proportional to the fixed domestic entry cost. The proportionality t_s is supposed to be different across countries and sectors. Therefore, similar to Manova (2013), $t_s w f_e$ is pledgeable as collateral. Similar to Galor and Zeira (1993), an investor (or a lender) exerts enforcement effort at a cost $e(E(q_f(x)), t_s w f_e)$, that is sufficient to deter the borrower from defaulting. As shown below, this cost increases in the size of the borrower's loan, $E(q_f(x))$, and decreases in the amount of collateral it can provide, $t_s w f_e$. A firm that borrows an amount of $E(q_f(x))$ is charged interest rate, $r(q_f(x))$, which covers the lender's interest rate, r_0, and lender's enforcement cost, $e(E(q_f(x)), t_s w f_e)$. This cost creates a credit market imperfection, where firms can borrow only at an interest rate higher than r_0. As all investors break even assuming perfect competition in international credit markets,

$$r_0 E(q_f(x)) + e(E(q_f(x)), t_s w f_e) = r(q_f(x)) E(q_f(x)). \tag{7}$$

Lenders choose $e(E(q_f(x)), t_s w f_e)$ to be high enough to make defaulting adequately costly:

$$E(q_f(x))(1 + r(q_f(x))) = \nu e(E(q_f(x)), t_s w f_e) + t_s w f_e \tag{8}$$

where $\nu > 1$. The first term in the right hand side of (8) is the borrower's punishment in case of a default, which is proportional to the enforcement spending. Parameter ν increases as financial institutions become stronger such that evasion of enforcement becomes costlier for a given level of enforcement spending. By the same token, a higher ν implies a lower enforcement cost, other things equal, i.e., enforcement becomes more efficient. Equation (8) is thus the borrower's *incentive compatibility constraint*, similar to that introduced by Galor and Zeira (1993). Combining (7) and (8) yields

$$e(E(q_f(x)), t_s w f_e) = \frac{r_0 E(q_f(x)) + (E(q_f(x)) - t_s w f_e)}{\nu - 1}. \tag{9}$$

Substituting (9) into (7), I obtain the interest rate on borrowing as a function of the borrower's collateral (equivalently, of its output/productivity) and the country's level of financial development characterized by parameter ν:

$$r(q_f(x)) = \frac{\nu r_0 + 1}{\nu - 1} - \frac{t_s w f_e}{E(q_f(x))(\nu - 1)}. \tag{10}$$

It is clear that the interest rate decreases in the amount of collateral and the level of financial development, and increases in the demand for external finance.

A firm's profits in domestic and foreign markets are respectively expressed as

$$\pi_d(x) = p_d(x) q_d(x) - \frac{q_d(x) w}{x} - w f_e \tag{11}$$

subject to

$$q_d(x) = \mu w L \left(\frac{p_d(x)^{-\sigma}}{P^{1-\sigma}} \right) \tag{12}$$

and

$$\pi_f(x) = p_f(x) q_f(x) + wA + \pi_d(x) - \frac{q_f(x) \tau w}{x} - w^* f_{ex} - r(q_f(x)) E(q_f(x)) \tag{13}$$

subject to

$$q_f(x) = \mu w^* L^* \left(\frac{p_f(x)^{-\sigma}}{P^{*1-\sigma}} \right) \tag{14}$$

$$\begin{aligned} NR(x) &= p_f(x) q_f(x) + wA + \pi_d(x) + E(q_f(x)) - \frac{q_f(x) \tau w}{x} - w^* f_{ex} \\ &\geq (1 + r(q_f(x))) E(q_f(x)) \end{aligned} \tag{15}$$

as well as the participation constraint of a creditor, as in (7). Equations (12) and (14) are the demand functions for individual varieties. Equation (15) reflects the maximum net revenue that the firm can offer to an investor, $NR(x)$.

Due to monopolistic competition and CES demand structure, firms set the optimal price as a constant markup over marginal costs. Therefore, we obtain (see Appendix for details)

$$\begin{aligned} p_f(x) &= \frac{\sigma}{\sigma-1}\left[\frac{\tau w}{x} + \left(\frac{\partial r(q_f(x))}{\partial q_f(x)} E(q_f(x)) + r(q_f(x))\frac{dE(q_f(x))}{dq_f(x)}\right)\right] \\ &= \frac{\sigma}{\sigma-1}\left[\frac{\tau w}{x} + \frac{\nu r_0+1}{\nu-1}\frac{dE(q_f(x))}{dq_f(x)}\right]. \end{aligned} \tag{16}$$

Assume that internal and external funds cover the fixed entry cost and the share $\delta \in (0,1]$ of variable cost and financial cost before export revenue is realized:

$$wA + \pi_d(x) + E(q_f(x)) \geq w^* f_{ex} + \delta\left[q_f(x)\frac{\tau w}{x} + r(q_f(x))E(q_f(x))\right]. \tag{17}$$

Note that when the economy is financially developed and domestic profits are high, the firm in that economy is financially less constrained. The firm's demand for external loan is thus given by

$$E(q_f(x)) = \frac{1}{1-\delta r(q_f(x))}[w^* f_{ex} + \delta q_f(x)\frac{\tau w}{x} - wA - \pi_d(x)] \tag{18}$$

at optimum. Combining (10) and (18) will in turn determine the optimal amount of external finance:

$$E(q_f(x)) = \frac{(\nu-1)[w^* f_{ex} + \delta q_f(x)\frac{\tau w}{x} - wA - \pi_d(x)] - \delta t_s w f_e}{(\nu-1) - \delta(\nu r_0 + 1)}. \tag{19}$$

Notice that the amount of external finance increases in the sector's exogenous need for external finance, which is parameterized by δ. For simplicity, I define the share of external finance as the ratio of the volume of external finance, $E(q_f(x))$, to the value of fixed assets, wf_e, which is a base for defining collateralized assets: $s(q_f(x)) = E(q_f(x))/wf_e$.[17] Using

[17] Capital expenditure, which is supposed to be the denominator in the calculation of the external finance share, includes investments in fixed assets.

(19), we can rewrite (16) as

$$p_f(x) = \frac{\sigma}{\sigma - 1}\frac{\tau w}{x}\frac{\nu - 1}{\nu - 1 - \delta(\nu r_0 + 1)}. \tag{20}$$

Note that it is higher than in case without financial constraints, which is consistent with the result of Fan et al. (2015) in the absence of quality choice. More differentiated goods provide the firm with a larger market power (lower price elasticity of demand) and thereby allow to set higher prices.

Proposition 1. *Financial development increases the share of external finance* $\left(\frac{\partial s(q_f(x))}{\partial \nu} > 0\right)$ *if* $t_s w f_e > \frac{r_0+1}{1-\delta r_0}[w^* f_{ex} - wA - \pi_d(x)]$*, i.e., collateral is sufficiently large. This effect is stronger in industries with more tangible assets* $\left(\frac{\partial^2 s(q_f(x))}{\partial \nu \partial t_s} > 0\right)$.

Proof. *See Appendix.* □

Financial development reduces the cost of external finance and eases firm access to external finance. Firms offer collateral to signal their credit quality and therefore secure a lower interest rate on their loans. The more of collateral the firm has, the more it can borrow and the more favorable the terms of the loans. For firms with too few collateralizable assets whose constraints are too strong (i.e., $t_s w f_e \leq \frac{r_0+1}{1-\delta r_0}[w^* f_{ex} - wA - \pi_d(x)]$), however, financial development will not help much because external financing is fundamentally difficult to obtain without substantial tangible collateral.

Since net revenue $NR(x)$ increases with productivity, equation (15) is binding for firms with productivity below a certain cut-off x_D. Substituting the optimal interest rate from (10) into (15) and setting $NR(x) = (1 + r(q_f(x)))E(q_f(x))$, this threshold is given by the following revenue function:

$$\begin{aligned} R_f(x) &= \frac{\mu w^* L^*}{P^{*1-\sigma}}\left[\frac{\sigma}{\sigma - 1}\frac{\tau w}{x}\frac{\nu - 1}{\nu - 1 - \delta(\nu r_0 + 1)}\right]^{1-\sigma} \\ &= \sigma\left[\frac{\{(\nu r_0 + 1)(1 - \delta) + (\nu - 1)\}\{w^* f_{ex} - wA - \pi_d(x)\} - t_s w f_e}{\nu - 1 - \delta(\nu r_0 + 1)}\right], \end{aligned} \tag{21}$$

where the equality holds at $x = x_D$.

Proposition 2. *(Firm exports) The value of firms' exports increases as financial system develops* $\left(\frac{\partial R_f(x)}{\partial \nu} > 0\right)$ *if* $t_s w f_e > \frac{r_0+1}{1-\delta r_0}[w^* f_{ex} - wA - \pi_d(x)]$, *i.e., collateral is sufficiently large. This effect is stronger in industries with more tangible assets* $\left(\frac{\partial^2 R_f(x)}{\partial \nu \partial t_s} > 0\right)$.

Proof. *See Appendix.* □

Firms need external funds to overcome both fixed and variable costs of exporting. By reducing the marginal costs of external finance, the improvement in the financial system allows firms easier access to external funds which is conducive of better export performance. Those with substantial tangible assets can raise much more external finance and benefit more from cheaper external financing. For the aforementioned reason, firms with too little collateral will not benefit from financial development.

Following Melitz and Ottaviano (2008), I assume that productivity draws $x = 1/c$ follow a Pareto distribution with lower productivity bound $x_M = 1/c_M$ and shape parameter $k \geq 1$. This implies a distribution of cost draws c given by

$$G(c) = \left(\frac{c}{c_M}\right)^k, \quad c \in [0, c_M]. \tag{22}$$

The shape parameter k indexes the dispersion of cost draws. When $k = 1$, the cost distribution is uniform on $[0, c_M]$. As k increases, the relative number of high-cost (low-productivity) firms increases.

Given this parameterization, the equilibrium free entry condition determines the productivity cut-off x_D:

$$\int_{x_D}^{\infty} (p_f(x)q_f(x) + wA + \pi_d(x) - q_f(x)\frac{\tau w}{x} - r(q_f(x))E(q_f(x)))dG(x) = w^* f_{ex}. \tag{23}$$

This productivity cut-off x_D satisfies

$$\left(\frac{x_M}{x_D}\right)^k \left(\frac{k}{1-\sigma+k} M \left(\frac{1}{x_D}\right)^{1-\sigma} + N\right) = w^* f_{ex} \tag{24}$$

where $M \equiv \frac{\mu w^* L^*}{P^{*1-\sigma}} \left[\frac{\sigma}{\sigma-1}\tau w \frac{\nu-1}{\nu-1-\delta(\nu r_0+1)}\right]^{1-\sigma} \frac{1}{\sigma} + \frac{\mu w L}{P^{1-\sigma}} \left(\frac{\sigma}{\sigma-1}w\right)^{1-\sigma} \frac{1}{\sigma}\left(1+\frac{\nu r_0+1}{\nu-1-\delta(\nu r_0+1)}\right)$ and $N \equiv wA\left(1+\frac{\nu r_0+1}{\nu-1-\delta(\nu r_0+1)}\right) - wf_e\left(1+\frac{\nu r_0+1}{\nu-1-\delta(\nu r_0+1)}\right) - \frac{\nu r_0+1}{\nu-1-\delta(\nu r_0+1)} w^* f_{ex} + \frac{t_s w f_e}{\nu-1-\delta(\nu r_0+1)}$.

Aggregating across firms, total exports in a sector are

$$Q_f(x) = \int_{x_D}^{\infty} \mu w^* L^* \left(\frac{p_f(x)}{P^*}\right)^{1-\sigma} dG(x). \tag{25}$$

Proposition 3. *(Aggregate exports) Financially developed countries have a comparative advantage in industries with more tangible assets* $\left(\frac{\partial^2 Q_f(x)}{\partial \nu \partial t_s} > 0\right)$ *if* $1 + \frac{(\sigma-1)\delta(1+r_0)}{1-\delta r_0} < \nu$.

Proof. *See Appendix.* □

Financial development would increase the cut-off productivity for exporting by increasing the overall productivity of capital, but less in industries with more tangible assets $\left(\frac{\partial^2 x_D}{\partial t_s \partial \nu} < 0\right)$, while increasing the value of firm exports, as shown in Proposition 2. As a result, it increases the aggregate value of exports relatively more in industries with high asset tangibility. The condition $1 + \frac{(\sigma-1)\delta(1+r_0)}{1-\delta r_0} < \nu$ implies that financial development helps to reduce the credit constraints if a country is at a sufficiently high level of financial development, which is consistent with the argument in Berman and Berthou (2009) and Fisman and Love (2004). Berman and Berthou (2009) argue that credit constraints are not observed at very low levels of financial development, since credit market cannot operate. This condition also suggests that the intrinsic dependence on external financing should not be too high $\left(\delta < \frac{\nu-1}{(\sigma-1)(1+r_0)+r_0(\nu-1)}\right)$. A high demand for external funds due to high initial start up costs can make firms more vulnerable to external shocks and raise concerns about achieving the needed return on investment. Therefore, the development of formal financial sectors will not significantly help ease financial constraints for firms that have to rely much on external finance.

4 Data and Empirical Strategy

4.1 Data

As the dependent variable, I use the bilateral total exports (in $1,000s) obtained from UN Comtrade, which provides detailed and disaggregated export data for over 140 countries. I collect the three-digit ISIC Rev.2 data for exports for a sample of countries during the period 1987–2006. To account for the skewed distribution of exports, the dependent variable is the natural log of the value of exports.

A country- and industry-specific measure of asset tangibility is constructed on the basis of data for all publicly traded firms in 25 manufacturing sectors and 10 countries between 1987 and 2006. It is calculated as the median, across firms in a given industry, of the share of fixed assets (property, plant, and equipment) in total assets. Higher tangibility implies higher value of collateral for lenders.

I include several control variables, such as domestic financial sector development, real GDP of both exporting and importing countries, and the distance between the trading countries, to capture country differences. Following Chinn and Ito (2006) and Girma and Shortland (2004), I use traditional measures of the level of financial development: the ratios of private credit by deposit banks and other financial institutions to GDP and stock market capitalization to GDP.[18] These data are taken from the 2013 version of the World Bank's Financial Structure Database. In the robustness regressions, I use time-invariant measures of financial contractibility—that is, contract repudiation, accounting standards, and expropriation risk from La Porta et al. (1998). These indices reflect the strength of the legal system and contractual environment in a country. I also use the financial institutions index that illustrates how deep, accessible, and efficient financial institutions are, developed by Sviry-

[18] Private credit is defined as financial sources provided to the private sector, such as loans, purchases of non-equity securities, and trade credits, as well as other accounts receivable that establish a claim for repayment. Although this variable, which only captures quantities, is an imperfect measure of financial development, it remains the best indicator of financial depth which is available for a large cross-section of countries (e.g., Manova, 2013; Rajan and Zingales, 1998).
Stock market capitalization to GDP is equal to the value of listed shares and serves as a measure of relative stock market size. A bigger stock market, or a higher capitalization, is associated with better mobilization of capital and better diversification of risk and therefore indicates an important aspect of financial development.

dzenka (2016).[19] Other country-specific variables, such as the real GDP (in $1,000s; at 2005 constant prices) of countries and the kilometer distance between the source and destination countries, are sourced from Penn World Table and the Center for Studies, Prospective and International Information (CEPII), respectively.

The sectoral price index in the importing country is proxied by the importer's consumer price index (CPI), which is taken from the International Monetary Fund's (IMF) International Financial Statistics, and its interactions with sector dummies.[20] I draw annual observations of other industry-level data in the ISIC classification (Rev.2), such as the number of domestic establishments and output in the exporting country, from the United Nations Industrial Development Organization's (UNIDO) Industrial Statistics Database.

Table A.5 presents the descriptive statistics for some variables used in this study and the number of trade partners for each country. The sample countries have relatively high private credit-to-GDP ratios (see also Figure A.1). Yet, there is considerable variation in the average private credit-to-GDP ratio over 1987–2006, ranging from a low of 27% in India to a high of 192% in Japan. I observe that the number of trading partners of each country is large.

4.2 Empirical Strategy

The empirical strategy in this paper closely follows Manova (2013). However, there are two major differences in my methodology. First, owing to the positive correlation between external finance share and asset tangibility discussed in detail in the earlier sections, I exclude the former and include only the latter as a sector-level measure of financial constraints. An important advantage of exploiting the variation in asset tangibility, instead of the share of external finance, in the regressions is that it helps establish the causal effect of domestic financial development on the volume of international trade.[21] The variation in the share

[19] Financial institutions include banks, insurance companies, mutual funds, and pension funds.

[20] Using the importer-sector-year fixed effects also allows to estimate the coefficients of interest. The main result continues to hold in this case.

[21] The empirical evidence about the direction of causality in the relationship between finance and trade is mixed. While a number of papers including Amiti and Weinstein (2011), Beck (2002, 2003), Manova

of external finance is insufficient in this respect. As Bernard et al. (2010) and Manova (2008) point out, there may be a concern about reverse causality between external finance dependence and exporting when higher foreign demand for sectors that are intensive in external funds increases the demand for loans in these sectors. The method presented in this paper alleviates this problem and bolsters the argument in favor of a causal effect running from credit constraints to exporting, because tangibility is independent of foreign demand fluctuations. Second, my measure of asset tangibility is both country- and sector-specific, while it is only sector-specific in Manova (2013).

The main regression specification is

$$\begin{aligned}\ln X_{ijst} =& \alpha + \beta_0 FinDev_{it} + \beta_1 Tang_{is} + \beta_2 (FinDev_{it} \times Tang_{is}) \\ &+ \sum_i \lambda_i D_i + \sum_j \lambda_j D_j + \sum_s \lambda_s D_s + \sum_t \lambda_t D_t + \gamma K + \varepsilon_{ijst}\end{aligned} \tag{26}$$

I estimate the regressions using the fixed effects regression model. The dependent variable is the natural logarithm of the bilateral total exports of country i to country j in sector s in year t, paralleling the work of Manova (2013). $Findev_{it}$ measures the level of financial development in country i in year t, while $Tang_{is}$ denotes the degree of asset tangibility of sector s in country i. The parameter β_2 quantifies the effect of financial development if industries with different levels of asset tangibility are affected differently by a change in financial development. If the asset tangibility is measured with error, a classical attenuation bias may arise with the estimate of β_2 being biased toward zero. D_i, D_j, D_s, and D_t are the exporter, importer, sector, and year fixed effects, respectively. These fixed effects reduce the concern of omitted variable bias or model misspecification. However, we still need to include the potential determinants of exports that vary over multiple dimensions and might be correlated with the interaction term. K is a vector of additional control variables, including the (log) number of domestic establishments, (log) output, price index, (log) real GDP, and

(2013), and Svaleryd and Vlachos (2005), provide evidence that the financial development is a positive force behind export growth, recent evidence also suggests that trade patterns affect financial development (Do and Levchenko, 2007).

(log) distance. α is a constant and ε_{ijst} is an error term clustered by exporter-importer pair. The result of most interest for this study, according to the hypothesis, is that the coefficient β_2 is positive.

In order to confirm that the model does not present endogeneity problems, I estimate the empirical model (26) using the method of instrumental variable (see Section 5.1). I employ two-stage regressions by setting the U.S. measure of asset tangibility calculated by Braun (2003) as an instrument variable.

5 Results

This section analyzes whether industry exports are significantly differentially influenced by a change in financial development depending on the tangibility of firms' assets.

First, I analyze the determinants of the share of external finance, such as asset tangibility, productivity (measured by sales-to-asset ratio), firm size (measured by the log of total assets), profitability (measured by return on assets, i.e., earnings before interest and taxes divided by total assets), and growth opportunity (measured by sales growth).[22] These variables, except for firm size and sales growth, are constructed using the same method as Rajan and Zingales (1998), where the numerator and denominator are summed over all years for each firm.[23] In column (1) of Table 3, which does not include the country-level financial development indicator, I find that the share of external borrowing is higher for firms with more tangible assets. This is consistent with a large body of finance literature. The share of external finance is estimated to increase by 1 percentage point for a one percentage point increase in asset tangibility.[24] When including the financial development indicator and its interaction term with asset tangibility (column (2)), the result is similar. The share of external finance is estimated to increase by 1.08 percentage points for every one percentage point increase in

[22] I obtain the data for firm characteristics from the annual databases of Compustat North America (for U.S. firms) and Global (for firms outside the United States.).
There is no formal model linking firm characteristics to the use of external financing.

[23] Firm size and sales growth are averaged over time.

[24] The share of external finance has a mean of -0.13 and a standard deviation of 0.738.

Table 3: Estimated coefficients from OLS models of the share of external finance by country- and industry-specific characteristics

Dependent variable: external finance dependence		
Indicator of Fin devt:		Private credit
Fin devt		-0.520
		(-2.52)**
Fin devt × Tang		1.483
		(2.42)**
Tang	1.001	-0.513
	(1.94)*	(-0.61)
Sales-to-asset ratio	0.283	0.297
	(1.46)	(1.56)
Firm size	-0.108	-0.110
	(-2.15)**	(-2.20)**
Return on assets	-8.641	-8.868
	(-6.19)***	(-6.61)***
Sales growth	1.531	1.498
	(5.63)***	(5.89)***
Controls:		
Exporter, Sector FE	Y	Y
R-squared	0.76	0.78
# observations	3,964	3,848

Notes: The dependent variable is the share of external finance for the period 1987–2006. All regressions include a constant term, exporter and sector fixed effects, and cluster errors by sector. T-statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

asset tangibility.[25]

Figure 1 displays the extent of the marginal effect of asset tangibility, based on the coefficients in column (2) of Table 3, over a varying range of levels of private credit to GDP. Dashed lines exhibit 95% confidence intervals. This shows that as private credit becomes increasingly available, the marginal effect of tangible assets on the share of external funds

[25] The estimated marginal effect is calculated at the means of the variables and significant at the 5% level.

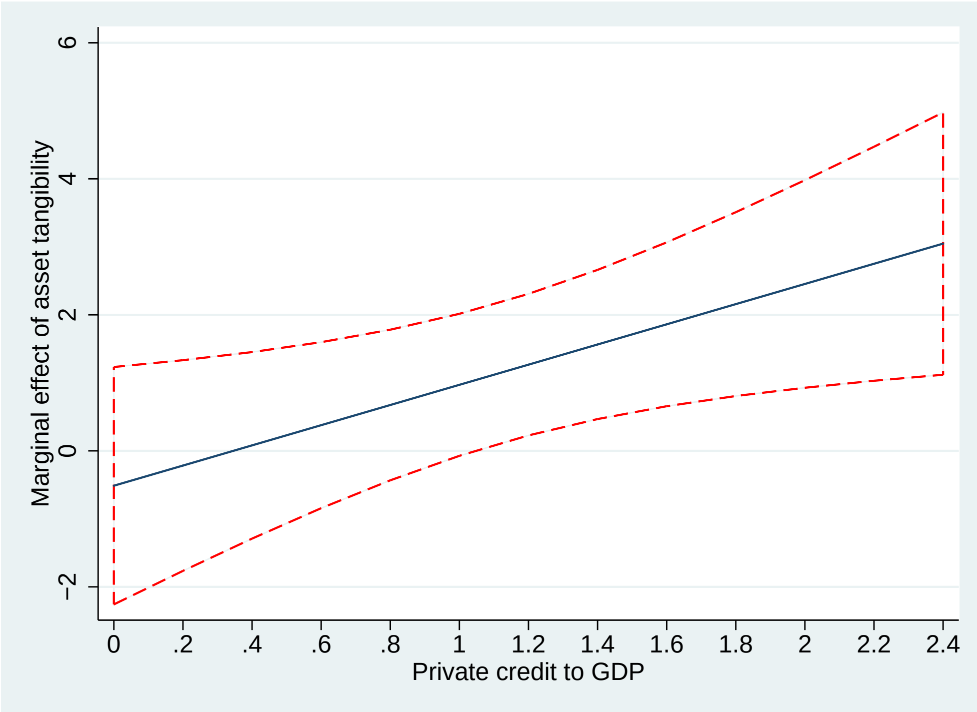

Figure 1: Marginal effect of asset tangibility on the share of external finance over a varying range of private credit to GDP with 95% CIs

increases (rather than decreases) as well. It is interesting to note that the marginal effect is not statistically significant until the ratio of private credit to GDP gets close to or exceeds 1 (which is the case for the private credit-to-GDP ratio for Malaysia in 1993). In this sample, more than 54% of the observations are above this threshold. The increasing importance of tangible assets helps explain the mechanism behind the result in the present paper that industries with high asset tangibility tend to benefit more from financial development.

Another possible mechanism that I propose to explain the high share of outside capital of firms involves the country-specific factor that has the potential to influence the importance of tangible assets as collateral in borrowing. In column (2) of Table 3, the share of external capital is estimated to decrease by 0.017 percentage points for a one percentage point increase in private credit to GDP, but this effect is insignificantly different from zero.

A stronger and more important result is that the interaction between the level of financial development and the degree of asset tangibility is statistically significantly positive at the 5%

level. This suggests that industries with a high proportion of tangible assets borrow more than those with fewer tangible assets when more and cheaper finance becomes available. This also implies that the possible negative effect of financial development can be avoided in the industries with a reasonably high level of asset tangibility.

In Table 3, I also find large explanatory power of firm profitability, which is proxied by return on assets. There is a negative relationship between profitability and the share of external funds. This result is consistent with standard capital structure theories (e.g., Myers and Majluf, 1984), suggesting that the more profitable the firm, the greater the availability of internal capital, and hence firms will opt for internal over external financing.

In summary, the results presented in Table 3 suggest a significant role of asset tangibility and its interaction with financial development in firms' choice of external funding. Note that the measure of external finance share varies systematically across countries in ways that suggest that it is not just noise.

Next, I analyze the effect of finance on manufacturing exports. In order to make a comparison with the results of the present paper, I replicate the empirical specifications in Manova's (2013) Table 1 by simply dropping the interaction term of financial development and external finance dependence. The results for Manova's (2013) full sample are shown in Table A.6, whereas the results for the sub-sample of countries and sectors considered in this paper are in Table A.7. We can see that the main results in Manova (2013) are unchanged when using the U.S. industry measure of asset tangibility.

Table 4 presents the basic estimates of the regression (26). Interestingly, using the country- and industry-specific measure of asset tangibility changes the sign of the coefficient of the interaction between the level of financial development and the degree of asset tangibility. The coefficient of the interaction term is statistically significantly positive at the 1% level.[26] This implies that sectors with a high proportion of tangible assets export disproportionately more than sectors with fewer tangible assets in countries with more developed financial systems. Financial development alone may lead to lower exports, but it

[26] The result does not depend on the inclusion of the interaction term between financial development and the share of external finance (results available upon request).

Table 4: Estimated coefficients from OLS models of trade by financial constraints (using the country- and industry-specific measure of asset tangibility)

Financial development measure: Private credit Dependent variable: (log) bilateral total exports by sector			
	(1)	(2)	(3)
Fin devt	-1.326	-0.281	-1.475
	(-8.26)***	(-1.85)*	(-8.91)***
Tang	0.991	-0.837	0.785
	(3.21)***	(-2.89)***	(2.45)**
Fin devt × Tang	1.696	1.768	1.796
	(5.26)***	(5.98)***	(5.41)***
(Log) # Establish	0.673		0.692
	(21.90)***		(22.27)***
(Log) Output		0.872	
		(36.52)***	
p			0.009
			(2.32)**
LGDPE	0.216	-0.244	0.129
	(1.43)	(-2.03)**	(0.82)
LGDPI	0.599	0.723	0.572
	(4.74)***	(6.63)***	(2.91)***
LDIST	-1.363	-1.341	-1.356
	(-18.11)***	(-25.33)***	(-16.30)***
Controls:			
Exporter, Year FE	Y	Y	Y
Importer, Sector FE	Y	Y	Y
R-squared	0.59	0.64	0.61
# observations	125,741	168,184	107,841
# exporter-importer clusters	1511	1546	1277

Notes: The dependent variable is (log) bilateral exports (in $1,000s) in a 3-digit ISIC sector and year 1987–2006. The measure of financial development is private credit. Asset tangibility (Tang) is defined in the text. (Log) # Establish and (Log) Output are the (log) number of domestic establishments and (log) output in the exporting country by year and sector. The sectoral price index in importing country (p) is proxied by the importer's consumer price index (CPI) and its interactions with sector dummies. LGDPE, LGDPI, and LDIST indicate the (log) real GDP (in $1,000s) of the exporting and importing country and the (log) kilometer distance between them. All regressions include a constant term, exporter, sector, year, and importer fixed effects, and cluster errors by exporter-importer pair. T-statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

can be avoided in industries with a reasonably high level of asset tangibility which mitigates some of the constraints of exporting. In general, export activities increase the need for liquid asset holdings due to a longer and more unpredictable business cycle (Ramirez and Tadesse, 2009). In the case where financial development ultimately reinforces the role of tangibles as a key determinant of liquid asset holdings, financial development may particularly benefit industries with rich tangible assets by facilitating their external finance.

The marginal effect of asset tangibility is consistently positive for all specifications. In column (3), the marginal effect at the means of the covariates is 2.58 (p-value < 0.01). That is, a one-unit increase in asset tangibility would lead to an approximately 258% increase in bilateral exports.

In contrast to the usual cross-country result of a positive relationship between the size of the financial sector and exports, I find that the indicator of financial development tends to have a significant negative effect on bilateral exports.[27] The marginal effects of financial development at the means of the covariates are -0.73, 0.29, and -0.84 (p-value < 0.01) for each column of Table 4, respectively. One possible explanation for the negative effect of financial development on exports may be that the development of the financial sector subtracts resources from the productive sectors. It may also be due to limited variation in financial conditions within countries over time. Recent research has also found evidence of a negative effect of financial development on the aggregate exports of countries and sectors. Beck (2002) finds that financial development has a negative effect on the merchandise trade balance. Cezar (2014) concludes that financial development reduces exports in less financially intensive industries because specialization in financially intensive industries, induced by financial development, leads to disengagement in less financially intensive industries.[28]

[27] This result is consistent with the negative sign of the financial development variable on exports in some of Manova's (2013) specifications.

[28] Although they are not directly related to trade, recent studies find that there is a threshold beyond which financial development has a negative effect on output growth (Arcand et al., 2015; Cecchetti and Kharroubi, 2012). Using annual data of 31 provinces in China over the period 1986–2002, Hasan et al. (2009) find an inverse relationship between financial development and economic growth due to the soft-budget problem stemming from non-performing loans and continued bad lending practices.

Table 5: Interaction effects of financial development and asset tangibility on trade by sector

ISIC	Industry	Average Tang	(1)	(2)	(3)
390	Other manufactured products	0.2014	15.571**	4.990	18.784***
314	Tobacco	0.2189	(Omitted)	-286.652*	(Omitted)
385	Professional and scientific equipment	0.2207	2.404	2.557	3.448
324	Footwear	0.2305	-117.303*	-99.145***	-109.444*
322	Wearing apparel, except footwear	0.2430	-36.336**	31.158***	-37.818**
354	Miscellaneous petroleum and coal products	0.2558	(Omitted)	71.058	(Omitted)
383	Machinery, electric	0.2565	41.481***	20.626***	46.821***
382	Machinery, except electrical	0.2743	6.468*	6.582**	6.321*
342	Printing and publishing	0.3015	6.243**	6.968***	8.689***
352	Other chemicals	0.3024	-14.538*	-2.320	-13.856*
332	Furniture, except metal	0.3117	10.099**	16.453***	12.523**
381	Fabricated metal products	0.3171	17.766***	12.308***	19.905***
313	Beverages	0.3206	6.881	5.242	10.186
384	Transport equipment	0.3270	5.760	4.774	4.022
372	Non-ferrous metals	0.3379	10.579	11.152	10.386
311	Food products	0.3692	33.203***	14.378***	32.994***
355	Rubber products	0.3806	8.727***	5.923**	8.506***
371	Iron and steel	0.3811	-9.347	-16.573	-7.177
356	Plastic products	0.3882	34.276***	19.195***	38.330***
331	Wood products, except furniture	0.3888	-6.860	5.928	-9.566
321	Textiles	0.4103	-11.523	4.954	-8.958
369	Other non-metallic products	0.4326	3.640	7.144**	3.868
351	Industrial chemicals	0.4551	8.866**	11.958***	6.037*
341	Paper and products	0.4630	16.260**	16.133***	15.920*
353	Petroleum refineries	0.4654	-5.588	4.594	1.812

Notes: The dependent variable is (log) bilateral exports (in $1,000s) in a 3-digit ISIC sector and year 1987–2006. The measure of financial development is private credit. Exporter, year, and importer fixed effects as well as the constant, and the control variables – Fin devt, (Log) # Establish, (Log) Output, sectoral price index, LGDPE, LGDPI, and LDIST – estimates are not reported. * significant at 10%; ** significant at 5%; *** significant at 1%.

Each of the other control variables has a statistically significant relationship with exports and also has the expected sign. The bilateral exports increase with the number of active establishments and output in the exporting country and industry, the importer's price index, and the market size (GDP) of the two trade partners, but decrease with distance.

Table 5 presents the coefficients of the interaction term of financial development and asset tangibility by sector. The columns correspond to those in Table 4. In column (2) of Table 5, 12 manufacturing sectors have a significantly positive interactive effect, while 2 have a negative effect, and 11 have an ambiguous effect. It should be noted that the positive interactive effects are more often found in industries with a high average tangibility of assets.

5.1 Test of the Assumption of the Exogeneity of Asset Tangibility

The issue of endogeneity of asset tangibility has rarely been addressed in the relevant literature. One may argue that the value of collateral depends on economic conditions. The liquidity of the secondary market for machinery and equipment also has the potential to affect the value of collateral. Moreover, using the country- and industry-specific measure may introduce various sources of endogeneity bias.

I test the potential endogeneity of asset tangibility in my analysis. To conduct this type of test, I use two-stage regressions by setting the U.S. measure of asset tangibility calculated by Braun (2003) as an instrument variable for asset tangibility. The main results in Table 6 remain consistent with previously reported results. The first-stage F-statistic is above 6000, indicating that the results do not suffer from a weak instrument problem. The Durbin-Wu-Hausman test shows that we do not reject the hypothesis of exogeneity. This suggests that the difference between the OLS and IV estimates is small enough to allow us to treat asset tangibility as exogenous. That is, the issue of endogeneity is not sufficiently serious as to justify the application of the less efficient method of IV estimation. I can therefore legitimately treat the more precise OLS results in Table 4 as the preferred estimates.

5.2 Robustness Checks

Table 6: Estimated coefficients from IV regression models of trade by financial constraints

Financial development measure: Private credit Dependent variable: (log) bilateral total exports by sector			
	(1)	(2)	(3)
Fin devt	-1.447	-0.823	-1.529
	(-5.18)***	(-3.07)***	(-5.27)***
Fin devt × Tang	1.875	2.857	1.838
	(2.72)***	(4.34)***	(2.56)**
(Log) # Establish	0.787		0.795
	(24.93)***		(24.75)***
(Log) Output		0.861	
		(31.84)***	
p			0.010
			(2.57)**
LGDPE	-0.104	0.004	-0.202
	(-0.59)	(0.03)	(-1.09)
LGDPI	0.636	0.727	0.655
	(4.65)***	(5.81)***	(3.10)***
LDIST	-1.379	-1.314	-1.382
	(-13.52)***	(-20.80)***	(-12.37)***
Controls:			
Exporter, Year FE	Y	Y	Y
Importer, Sector FE	Y	Y	Y
R-squared	0.59	0.61	0.60
# observations	113,402	132,588	97,446
# exporter-importer clusters	1341	1368	1140

Notes: The dependent variable is (log) bilateral exports (in $1,000s) in a 3-digit ISIC sector and year 1987–2006. The measure of financial development is private credit. Asset tangibility (Tang) is defined in the text. (Log) # Establish and (Log) Output are the (log) number of domestic establishments and (log) output in the exporting country by year and sector. The sectoral price index in importing country (p) is proxied by the importer's consumer price index (CPI) and its interactions with sector dummies. LGDPE, LGDPI, and LDIST indicate the (log) real GDP (in $1,000s) of the exporting and importing country and the (log) kilometer distance between them. All regressions include a constant term, exporter, sector, year, and importer fixed effects, and cluster errors by exporter-importer pair. T-statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

5.2.1 Alternative Measures of Financial Development

I begin the robustness checks by reproducing all of the main results using alternative measures of financial development. The coefficients for the main interaction term are virtually unchanged in sign and significance when replacing private credit with other measures of the size of the financial system and institutional quality (see Tables A.8 and A.9).

5.2.2 Effect of Influential Observations

To show that the baseline results are not sensitive to influential observations, I exclude the countries with the extreme average values of financial development (India and Japan). From Table A.10, we are reassured that the coefficient estimates on the interaction term are essentially unchanged in size and significance.

5.2.3 Income Effect

Rajan and Zingales (1998) include the interaction of external finance dependence with the level of economic development to test for the income effect, and find that their original interaction is robust to the inclusion of this additional interaction. I revisit this test for asset tangibility. In Table A.11, I include the interactions of tangibility, respectively, with the log of real GDP and the private credit-to-GDP ratio of the exporting country. *Fin devt* $\times$ *Tang* remains positive and significant at the 1% level, regardless of the inclusion of *LGDPE* $\times$ *Tang*.

5.2.4 Effect of Internal Funds

I further control for internal funds proxied by profitability—that is, return on total assets—because poorly performing firms are more likely to encounter adverse outcomes. According to the pecking order theory, more profitable firms rely less on external funds because they are capable of generating funds internally to finance their exporting activities even when they have high levels of collateral availability. In Table A.12, I add the interaction of financial development and return on assets. *Fin devt* $\times$ *Tang* remains positive and significant at the 1% level, regardless of the inclusion of *Fin devt* $\times$ *Return on assets*.

Overall, the evidence suggests that relaxing the assumption of exogeneity of the industry-level external finance measure may change the results shown in the previous literature. Sectors with more collateralizable assets, and hence a greater ability to borrow, benefit to a greater extent from a country's financial development. The idea as well as the method of using country- and industry-specific measures can be applied to other research areas, such as economic growth and macroeconomic policies.

These empirical results are important from a policy perspective. Policymakers would have to bear the potential repercussions of financial development, as it strengthens the impact of tangibles-based financing. According to the results, firms need to invest more in tangible assets, which can serve as collateral and make more and cheaper bank financing available.

6 Conclusion

This paper contributes to the debate on the effect of financial development on exports by demonstrating that the benefits of a country's financial development are unequally distributed across industries depending on asset tangibility of firms. I focus on the level of financial development and the degree of asset tangibility as determinants of firms' external borrowing and exports. The model shows that the share of external borrowing varies endogenously in response to financial development and the tangibility of firms' assets, rather than being exogenously determined, and sectors with a high proportion of tangible assets export disproportionately more than sectors with fewer tangible assets in countries with well-developed or deeper financial systems. It is because those sectors are more capable of borrowing external capital, and hence the cost and availability of outside capital becomes more important. Using the country- and industry-specific measure of asset tangibility, I find statistically significant, economically important, and robust results that asset tangibility is crucial for a sector to benefit from the development of a country's financial system.

A potential drawback of the analysis is that the Compustat dataset includes only publicly listed firms. Consequently, the sample of firms is likely biased toward larger firms. This bias may cause us to underestimate the overall effect of financial development on smaller, non-listed firms because those firms, on average, have a higher proportion of tangible assets and would tend to benefit more from the improvement of the financial system.

There are several topics left to be considered in this line of research. First, it would be interesting to test the generality of the present conclusions in different applications. Second, while most papers on the link between trade and finance focus on the exporting country's financial development, new evidence suggests that foreign capital flows can compensate for an underdeveloped domestic financial system, and this topic remains relatively understudied. A detailed exploration of capital controls, which affect firms' financing constraints, and their impact in the presence of collateral constraints would be a useful extension of this research.

References

Acemoglu, D. and Zilibotti, F. (2001). Productivity Differences. *Quarterly Journal of Economics*, 116(2):563–606.

Almeida, H. and Campello, M. (2007). Financial Constraints, Asset Tangibility, and Corporate Investment. *Review of Financial Studies*, 20(5):1429–1460.

Amiti, M. and Weinstein, D. E. (2011). Exports and Financial Shocks. *Quarterly Journal of Economics*, 126(4):1841–1877.

Arcand, J. L., Berkes, E., and Panizza, U. (2015). Too Much Finance? *Journal of Economic Growth*, 20(2):105–148.

Beck, T. (2002). Financial Development and International Trade: Is There a Link? *Journal of International Economics*, 57(1):107–131.

Beck, T. (2003). Financial Dependence and International Trade. *Review of International Economics*, 11(2):296–316.

Beck, T., Levine, R., and Loayza, N. (2000). Finance and the Sources of Growth. *Journal of Financial Economics*, 58(1):261–300.

Berger, A. N. and Udell, G. F. (1990). Collateral, Loan Quality and Bank Risk. *Journal of Monetary Economics*, 25(1):21–42.

Berman, N. and Berthou, A. (2009). Financial Market Imperfections and the Impact of Exchange Rate Movements on Exports. *Review of International Economics*, 17(1):103–120.

Berman, N. and Héricourt, J. (2010). Financial Factors and the Margins of Trade: Evidence from Cross-Country Firm-level Data. *Journal of Development Economics*, 93(2):206–217.

Bernard, A., Stabilito, A., and Donghoon Yoo, J. (2010). Access to Finance and Exporting Behavior in Transition Countries.

Bernard, A. B. and Jones, C. I. (1996). Comparing Apples to Oranges: Productivity Convergence and Measurement across Industries and Countries. *American Economic Review*, pages 1216–1238.

Bradley, M., Jarrell, G. A., and Kim, E. H. (1984). On the Existence of an Optimal Capital Structure: Theory and Evidence. *Journal of Finance*, 39(3):857–878.

Braun, M. (2003). Financial Contractibility and Asset Hardness. Harvard University. Department of Economics Working Paper.

Braun, M. and Larrain, B. (2005). Finance and the Business Cycle: International, Inter-Industry Evidence. *Journal of Finance*, 60(3):1097–1128.

Campello, M. and Giambona, E. (2013). Real Assets and Capital Structure. *Journal of Financial and Quantitative Analysis*, 48(05):1333–1370.

Cecchetti, S. G. and Kharroubi, E. (2012). Reassessing the Impact of Finance on Growth.

Cezar, R. (2014). The Heterogeneous Effect of Finance on International Trade. *Applied Economics*, 46(24):2903–2919.

Chaney, T. (2013). Liquidity Constrained Exporters. NBER Working Paper.

Chinn, M. D. and Ito, H. (2006). What Matters for Financial Development? Capital Controls, Institutions, and Interactions. *Journal of Development Economics*, 81(1):163–192.

Chor, D. (2010). Unpacking Sources of Comparative Advantage: A Quantitative Approach. *Journal of International Economics*, 82(2):152–167.

Claessens, S. and Laeven, L. (2003). Financial Development, Property Rights, and Growth. *Journal of Finance*, 58(6):2401–2436.

Demirgüç-Kunt, A. and Maksimovic, V. (1999). Institutions, Financial Markets, and Firm Debt Maturity. *Journal of Financial Economics*, 54(3):295–336.

Do, Q.-T. and Levchenko, A. A. (2007). Comparative Advantage, Demand for External Finance, and Financial Development. *Journal of Financial Economics*, 86(3):796–834.

Dollar, D., Wolff, E. N., and Baumol, W. J. (1988). The Factor-Price Equalization Model and Industry Labor Productivity: An Empirical Test across Countries. *Empirical Methods for International Trade*, pages 23–47.

Dopuch, N. and Pincus, M. (1988). Evidence on the Choice of Inventory Accounting Methods: LIFO versus FIFO. *Journal of Accounting Research*, pages 28–59.

Fan, H., Lai, E. L.-C., and Li, Y. A. (2015). Credit Constraints, Quality, and Export Prices: Theory and Evidence from China. *Journal of Comparative Economics*, 43(2):390–416.

Fernandes, N. (2011). Global Convergence of Financing Policies: Evidence for Emerging-Market Firms. *Journal of International Business Studies*, 42(8):1043–1059.

Fisman, R. and Love, I. (2004). Financial Development and Intersectoral Allocation: A New Approach. *Journal of Finance*, 59(6):2785–2807.

Frank, M. Z. and Goyal, V. K. (2003). Testing the Pecking Order Theory of Capital Structure. *Journal of Financial Economics*, 67(2):217–248.

Galor, O. and Zeira, J. (1993). Income Distribution and Macroeconomics. *Review of Economic Studies*, 60(1):35–52.

Girma, S. and Shortland, A. (2004). The Political Economy of Financial Development.

Gompers, P. A. (1995). Optimal Investment, Monitoring, and the Staging of Venture Capital. *Journal of Finance*, 50(5):1461–1489.

Greenaway, D., Guariglia, A., and Kneller, R. (2007). Financial Factors and Exporting Decisions. *Journal of International Economics*, 73(2):377–395.

Hart, O. and Moore, J. (1994). A Theory of Debt Based on the Inalienability of Human Capital. *Quarterly Journal of Economics*, 109(4):841–879.

Hasan, I., Wachtel, P., and Zhou, M. (2009). Institutional Development, Financial Deepening and Economic Growth: Evidence from China. *Journal of Banking & Finance*, 33(1):157–170.

Hur, J., Raj, M., and Riyanto, Y. E. (2006). Finance and Trade: A Cross-Country Empirical Analysis on the Impact of Financial Development and Asset Tangibility on International Trade. *World Development*, 34(10):1728–1741.

John, K., Lynch, A. W., and Puri, M. (2003). Credit Ratings, Collateral, and Loan Characteristics: Implications for Yield. *Journal of Business*, 76(3):371–409.

Johnson, S. A. (1997). An Empirical Analysis of the Determinants of Corporate Debt Ownership Structure. *Journal of Financial and Quantitative Analysis*, 32(01):47–69.

King, R. G. and Levine, R. (1993a). Finance and Growth: Schumpeter Might Be Right. *Quarterly Journal of Economics*, 108(3):717–737.

King, R. G. and Levine, R. (1993b). Finance, Entrepreneurship and Growth. *Journal of Monetary Economics*.

La Porta, R., Lopez-de Silanes, F., Shleifer, A., and Vishny, R. (1998). Law and Finance. *Journal of Political Economy*, 106:1113–1155.

Levine, R. (2005). Finance and Growth: Theory and Evidence. *Handbook of Economic Growth*, 1:865–934.

Levine, R., Loayza, N., and Beck, T. (2000). Financial Intermediation and Growth: Causality and Causes. *Journal of Monetary Economics*, 46(1):31–77.

Lubatkin, M. and Chatterjee, S. (1994). Extending Modern Portfolio Theory into the Domain of Corporate Diversification: Does it Apply? *Academy of Management Journal*, 37(1):109–136.

Manova, K. (2008). Credit Constraints, Equity Market Liberalizations and International Trade. *Journal of International Economics*, 76(1):33–47.

Manova, K. (2013). Credit Constraints, Heterogeneous Firms, and International Trade. *Review of Economic Studies*, 80(2):711–744.

Melitz, M. J. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica*, 71(6):1695–1725.

Melitz, M. J. and Ottaviano, G. I. (2008). Market Size, Trade, and Productivity. *Review of Economic Studies*, 75(1):295–316.

Moore, J. and Kiyotaki, N. (1997). Credit Cycles. *Journal of Political Economy*, 105(2).

Muûls, M. (2008). Exporters and Credit Constraints: A Firm-level Approach.

Myers, S. C. and Majluf, N. S. (1984). Corporate Financing and Investment Decisions When Firms Have Information That Investors Do Not Have. *Journal of Financial Economics*, 13(2):187–221.

Nguyen, H. and Qian, R. (2012). The Cross-Country Magnitude and Determinants of Collateral Borrowing. *World Bank Policy Research Working Paper*, 6001.

Rajan, R. G. and Zingales, L. (1998). Financial Dependence and Growth. *American Economic Review*, 88(3):559–586.

Ramirez, A. and Tadesse, S. (2009). Corporate Cash Holdings, Uncertainty Avoidance, and the Multinationality of Firms. *International Business Review*, 18(4):387–403.

Schott, P. K. (2004). Across-Product versus Within-Product Specialization in International Trade. *Quarterly Journal of Economics*, pages 647–678.

Svaleryd, H. and Vlachos, J. (2005). Financial Markets, the Pattern of Industrial Specialization and Comparative Advantage: Evidence from OECD Countries. *European Economic Review*, 49(1):113–144.

Svirydzenka, K. (2016). *Introducing a New Broad-based Index of Financial Development*. International Monetary Fund.

Tong, H. and Wei, S.-J. (2011). The Composition Matters: Capital Inflows and Liquidity Crunch During a Global Economic Crisis. *Review of Financial Studies*, 24(6):2023–2052.

Wood, A. (1995). *North-South Trade, Employment, and Inequality: Changing Fortunes in a Skill-Driven World*. Oxford University Press on Demand.

Yousefi, S. R. (2011). International Trade and Financial Crises: The Role of Credit Conditions.

Appendix

A.1 Derivation of equation (16)

Firms set the optimal price as a constant markup over marginal costs:

$$p_f(x) = \frac{\sigma}{\sigma-1}\left[\frac{\tau w}{x} + \left(\frac{\partial r(q_f(x))}{\partial q_f(x)}E(q_f(x)) + r(q_f(x))\frac{dE(q_f(x))}{dq_f(x)}\right)\right].$$

Using equation (10),

$$\begin{aligned} p_f(x) &= \frac{\sigma}{\sigma-1}\frac{\tau w}{x} \\ &+ \frac{\sigma}{\sigma-1}\left[\frac{t_s w f_e}{E(q_f(x))(\nu-1)}\frac{dE(q_f(x))}{dq_f(x)} + \left(\frac{\nu r_0+1}{\nu-1} - \frac{t_s w f_e}{E(q_f(x))(\nu-1)}\right)\frac{dE(q_f(x))}{dq_f(x)}\right] \\ &= \frac{\sigma}{\sigma-1}\left[\frac{\tau w}{x} + \frac{\nu r_0+1}{\nu-1}\frac{dE(q_f(x))}{dq_f(x)}\right]. \end{aligned}$$

A.2 Proof of Proposition 1

Recall equation (19):

$$E(q_f(x)) = \frac{(\nu-1)[w^* f_{ex} + \delta q_f(x)\frac{\tau w}{x} - wA - \pi_d(x)] - \delta t_s w f_e}{(\nu-1) - \delta(\nu r_0+1)}$$

and the share of external finance $s(q_f(x)) = E(q_f(x))/wf_e$, which is increasing in the amount of external capital, $E(q_f(x))$. Therefore, it is sufficient to prove $\frac{\partial E(q_f(x))}{\partial \nu} > 0$. Let $D = w^* f_{ex} + \delta q_f(x)\frac{\tau w}{x} - wA - \pi_d(x)$. Taking the first derivative with respect to ν, and using (14), (19) and (20), I obtain

$$\frac{\partial E(q_f(x))}{\partial \nu} = \frac{\left(D + (\nu-1)\frac{\partial D}{\partial \nu}\right)[(\nu-1) - \delta(\nu r_0+1)] - [(\nu-1)D - \delta t_s w f_e](1-\delta r_0)}{[(\nu-1) - \delta(\nu r_0+1)]^2}. \tag{A.1}$$

$$\begin{aligned}
\frac{dp_f(x)}{d\nu} &= -\frac{\sigma}{\sigma-1}\frac{\tau w}{x}\frac{\delta(r_0+1)}{[\nu-1-\delta(\nu r_0+1)]^2} \\
\frac{dq_f(x)}{d\nu} &= -\sigma\frac{q_f(x)}{p_f(x)}\frac{dp_f(x)}{d\nu} \\
\frac{\partial D}{\partial \nu} &= \delta\frac{\tau w}{x}\frac{dq_f(x)}{d\nu} \\
&= \delta\frac{\tau w}{x}\sigma q_f(x)\frac{\delta(r_0+1)}{(\nu-1)[\nu-1-\delta(\nu r_0+1)]}
\end{aligned}$$

Using these expressions, we can rewrite (A.1):

$$\frac{\partial E(q_f(x))}{\partial \nu} = \frac{-\delta(r_0+1)D + \delta^2\frac{\tau w}{x}\sigma q_f(x)(r_0+1) + \delta t_s w f_e(1-\delta r_0)}{[\nu-1-\delta(\nu r_0+1)]^2}. \tag{A.2}$$

which is positive if $-(r_0+1)D+\delta\frac{\tau w}{x}\sigma q_f(x)(r_0+1)+t_s w f_e(1-\delta r_0) > 0$. This condition boils down to $t_s w f_e > \frac{r_0+1}{1-\delta r_0}[w^* f_{ex} - wA - \pi_d(x)]$, i.e., collateral is sufficiently large. It reflects the fact that external financing is fundamentally difficult to obtain without substantial tangible collateral.

Taking the second cross-partial derivative with respect to asset tangibility, we obtain

$$\frac{\partial^2 E(q_f(x))}{\partial \nu \partial t_s} = \frac{\delta w f_e(1-\delta r_0)}{[(\nu-1)-\delta(\nu r_0+1)]^2} > 0. \tag{A.3}$$

□

A.3 Proof of Proposition 2

Recall equation (21):

$$\begin{aligned}
R_f(x) &= \frac{\mu w^* L^*}{{P^*}^{1-\sigma}}\left[\frac{\sigma}{\sigma-1}\frac{\tau w}{x}\frac{\nu-1}{\nu-1-\delta(\nu r_0+1)}\right]^{1-\sigma} \\
&= \sigma\left[\frac{\{(\nu r_0+1)(1-\delta)+(\nu-1)\}\{w^* f_{ex} - wA - \pi_d(x)\} - t_s w f_e}{\nu-1-\delta(\nu r_0+1)}\right].
\end{aligned}$$

Let $LHS = \frac{\mu w^* L^*}{P^{*1-\sigma}} \left[\frac{\sigma}{\sigma-1}\frac{\tau w}{x}\frac{\nu-1}{\nu-1-\delta(\nu r_0+1)}\right]^{1-\sigma}$. Taking the first derivative of LHS with respect to ν,

$$\frac{\partial LHS}{\partial \nu} = \frac{\mu w^* L^*}{P^{*1-\sigma}}(1-\sigma)\left[\frac{\sigma}{\sigma-1}\frac{\tau w}{x}\frac{\nu-1}{\nu-1-\delta(\nu r_0+1)}\right]^{-\sigma}\frac{\sigma}{\sigma-1}\frac{\tau w}{x}\frac{-\delta(1+r_0)}{[\nu-1-\delta(\nu r_0+1)]^2} > 0. \tag{A.4}$$

Since LHS does not depend on t_s or the interaction term $t_s\nu$, I instead show $\frac{\partial^2 RHS}{\partial\nu\partial t_s} > 0$, where $RHS = \frac{\{(\nu r_0+1)(1-\delta)+(\nu-1)\}\{w^* f_{ex}-wA-\pi_d(x)\}-t_s w f_e}{\nu-1-\delta(\nu r_0+1)}$. Taking the first derivative of RHS with respect to ν,

$$\frac{\partial RHS}{\partial \nu} = \frac{-(1+r_0)[w^* f_{ex} - wA - \pi_d(x)] + t_s w f_e(1-\delta r_0)}{[\nu-1-\delta(\nu r_0+1)]^2} \tag{A.5}$$

which is positive with the condition in the proof of Proposition 1 that collateral is sufficiently large.

Taking the second cross-partial derivative,

$$\frac{\partial^2 RHS}{\partial\nu\partial t_s} = \frac{w f_e(1-\delta r_0)}{[\nu-1-\delta(\nu r_0+1)]^2} > 0. \tag{A.6}$$

The comparative statistics for the cut-off x_D are identical to those for x above. Hence, $\frac{\partial R_f(x)}{\partial \nu} > 0$ and $\frac{\partial^2 R_f(x)}{\partial\nu\partial t_s} > 0$. □

A.4 Proof of Proposition 3

Recall equation (25):

$$\begin{aligned} Q_f(c) &= \int_0^{c_D} \mu w^* L^* \left(\frac{p_f(c)}{P^*}\right)^{1-\sigma} dG(c) \\ &= \int_0^{c_D} \mu w^* L^* \left(\frac{p_f(c)}{P^*}\right)^{1-\sigma} \frac{k}{c_M}\left(\frac{c}{c_M}\right)^{k-1} dc \\ &= \frac{\mu w^* L^*}{P^{*1-\sigma}}\left[\frac{\sigma}{\sigma-1}\tau w \frac{\nu-1}{\nu-1-\delta(\nu r_0+1)}\right]^{1-\sigma}\frac{k}{c_M}\left(\frac{1}{c_M}\right)^{k-1}\frac{c_D^{1-\sigma+k}}{1-\sigma+k} \end{aligned} \tag{A.7}$$

Note that $1-\sigma+k>0$.

By Leibniz integral rule[29],

$$\begin{aligned}
\frac{\partial Q_f(c)}{\partial \nu} &= \mu w^* L^* \left(\frac{p_f(c_D)}{P^*}\right)^{1-\sigma} \frac{k}{c_M}\left(\frac{c_D}{c_M}\right)^{k-1}\frac{\partial c_D}{\partial \nu} \\
&+ \int_0^{c_D} \frac{\partial}{\partial \nu}\left(\mu w^* L^* \left(\frac{p_f(c)}{P^*}\right)^{1-\sigma} \frac{k}{c_M}\left(\frac{c}{c_M}\right)^{k-1}\right) dc \\
&= \frac{\mu w^* L^*}{{P^*}^{1-\sigma}}\left[\frac{\sigma}{\sigma-1}\tau w c_D \frac{\nu-1}{\nu-1-\delta(\nu r_0+1)}\right]^{1-\sigma} \frac{k}{c_M}\left(\frac{c_D}{c_M}\right)^{k-1}\frac{\partial c_D}{\partial \nu} \\
&+ \int_0^{c_D} \frac{\mu w^* L^*}{{P^*}^{1-\sigma}}\left[\frac{\sigma}{\sigma-1}\tau w c \frac{\nu-1}{\nu-1-\delta(\nu r_0+1)}\right]^{-\sigma} \sigma\tau w c \frac{\delta(1+r_0)}{[\nu-1-\delta(\nu r_0+1)]^2}\frac{k}{c_M}\left(\frac{c}{c_M}\right)^{k-1} dc \\
&= \frac{\mu w^* L^*}{{P^*}^{1-\sigma}}\left[\frac{\sigma}{\sigma-1}\tau w c_D \frac{\nu-1}{\nu-1-\delta(\nu r_0+1)}\right]^{1-\sigma} \frac{k}{c_M}\left(\frac{c_D}{c_M}\right)^{k-1}\frac{\partial c_D}{\partial \nu} \\
&+ \frac{\mu w^* L^*}{{P^*}^{1-\sigma}}\left[\frac{\sigma}{\sigma-1}\tau w \frac{\nu-1}{\nu-1-\delta(\nu r_0+1)}\right]^{-\sigma} \sigma\tau w \frac{\delta(1+r_0)}{[\nu-1-\delta(\nu r_0+1)]^2}\frac{k}{(c_M)^k}\frac{c_D^{1-\sigma+k}}{1-\sigma+k}
\end{aligned} \tag{A.8}$$

which is positive if
$\frac{\mu w^* L^*}{{P^*}^{1-\sigma}}\left[\frac{\sigma}{\sigma-1}\tau w c_D \frac{\nu-1}{\nu-1-\delta(\nu r_0+1)}\right]^{1-\sigma} \frac{k}{c_M}\left(\frac{c_D}{c_M}\right)^{k-1}\frac{\partial c_D}{\partial \nu} > -\frac{\mu w^* L^*}{{P^*}^{1-\sigma}}\left[\frac{\sigma}{\sigma-1}\tau w \frac{\nu-1}{\nu-1-\delta(\nu r_0+1)}\right]^{-\sigma}$
$\sigma\tau w \frac{\delta(1+r_0)}{[\nu-1-\delta(\nu r_0+1)]^2}\frac{k}{(c_M)^k}\frac{c_D^{1-\sigma+k}}{1-\sigma+k}$.
That is,

$$\frac{\partial c_D}{\partial \nu} > \frac{1-\sigma}{\nu-1}\frac{\delta(1+r_0)}{\nu-1-\delta(\nu r_0+1)}\frac{c_D}{1-\sigma+k}.$$

[29] $\frac{d}{dx}\left(\int_{a(x)}^{b(x)} f(x,t)dt\right) = f(x,b(x))b'(x) - f(x,a(x))a'(x) + \int_{a(x)}^{b(x)} \frac{\partial}{\partial x} f(x,t)dt$

The equilibrium free entry condition determines the cost cut-off c_D:

$$\begin{aligned}
&\int_0^{c_D} (p_f(c)q_f(c) + wA + \pi_d(c) - q_f(c)\tau wc - r(q_f(x))E)dG(c) \\
&= \int_0^{c_D} \frac{\mu w^* L^*}{P^{*1-\sigma}} \left[\frac{\sigma}{\sigma-1}\tau wc \frac{\nu-1}{\nu-1-\delta(\nu r_0+1)}\right]^{1-\sigma} \frac{1}{\sigma} + wA\left(1 + \frac{\nu r_0+1}{\nu-1-\delta(\nu r_0+1)}\right) \\
&+ \left[\frac{\mu wL}{P^{1-\sigma}}\left(\frac{\sigma}{\sigma-1}wc\right)^{1-\sigma}\frac{1}{\sigma} - wf_e\right]\left(1 + \frac{\nu r_0+1}{\nu-1-\delta(\nu r_0+1)}\right) \\
&- \frac{\nu r_0+1}{\nu-1-\delta(\nu r_0+1)}w^* f_{ex} + \frac{t_s w f_e}{\nu-1-\delta(\nu r_0+1)}dG(c) \\
&= w^* f_{ex}
\end{aligned} \tag{A.9}$$

Let $M \equiv \frac{\mu w^* L^*}{P^{*1-\sigma}}\left[\frac{\sigma}{\sigma-1}\tau w \frac{\nu-1}{\nu-1-\delta(\nu r_0+1)}\right]^{1-\sigma}\frac{1}{\sigma} + \frac{\mu wL}{P^{1-\sigma}}\left(\frac{\sigma}{\sigma-1}w\right)^{1-\sigma}\frac{1}{\sigma}\left(1+\frac{\nu r_0+1}{\nu-1-\delta(\nu r_0+1)}\right)$ and $N \equiv wA\left(1+\frac{\nu r_0+1}{\nu-1-\delta(\nu r_0+1)}\right) - wf_e\left(1+\frac{\nu r_0+1}{\nu-1-\delta(\nu r_0+1)}\right) - \frac{\nu r_0+1}{\nu-1-\delta(\nu r_0+1)}w^* f_{ex} + \frac{t_s w f_e}{\nu-1-\delta(\nu r_0+1)}$, and rewrite the above equation:

$$\begin{aligned}
&\int_0^{c_D} (Mc^{1-\sigma} + N)dG(c) \\
&= \int_0^{c_D} (Mc^{1-\sigma} + N)\left(\frac{k}{c_M}\right)\left(\frac{c}{c_M}\right)^{k-1} dc \\
&= (Mc_D^{1-\sigma} + N)\left(\frac{c_D}{c_M}\right)^k - \int_0^{c_D}\left(\frac{c}{c_M}\right)^k M(1-\sigma)c^{-\sigma}dc \\
&= \left(\frac{c_D}{c_M}\right)^k \left(\frac{k}{1-\sigma+k}M{c_D}^{1-\sigma} + N\right) \\
&= w^* f_{ex}
\end{aligned} \tag{A.10}$$

Hence, the cost cut-off c_D satisfies $\left(\frac{c_D}{c_M}\right)^k \left(\frac{k}{1-\sigma+k}M{c_D}^{1-\sigma} + N\right) = w^* f_{ex}$.

Let $LHS = \left(\frac{c_D}{c_M}\right)^k \left(\frac{k}{1-\sigma+k}M{c_D}^{1-\sigma} + N\right)$. Taking the first derivative of LHS with respect to ν, I obtain

$$\begin{aligned}\frac{\partial LHS}{\partial \nu} =& k\left(\frac{c_D}{c_M}\right)^{k-1}\frac{1}{c_M}\frac{\partial c_D}{\partial \nu}\left(\frac{k}{1-\sigma+k}M{c_D}^{1-\sigma}+N\right)\\ &+\left(\frac{c_D}{c_M}\right)^{k}\left[\frac{k}{1-\sigma+k}\frac{\partial M}{\partial \nu}c_D^{1-\sigma}+\frac{k}{1-\sigma+k}M(1-\sigma)c_D^{-\sigma}\frac{\partial c_D}{\partial \nu}+\frac{\partial N}{\partial \nu}\right]\end{aligned} \tag{A.11}$$

where

$$\begin{aligned}\frac{\partial M}{\partial \nu} =& \frac{\mu w^* L^*}{{P^*}^{1-\sigma}}\left[\frac{\sigma}{\sigma-1}\tau w\frac{\nu-1}{\nu-1-\delta(\nu r_0+1)}\right]^{-\sigma}\tau w\frac{\delta(1+r_0)}{[\nu-1-\delta(\nu r_0+1)]^2}\\ &-\frac{\mu w L}{P^{1-\sigma}}\left(\frac{\sigma}{\sigma-1}w\right)^{1-\sigma}\frac{1}{\sigma}\frac{1+r_0}{[\nu-1-\delta(\nu r_0+1)]^2}\\ \frac{\partial N}{\partial \nu} =& -(wA-wf_e-w^*f_{ex})\frac{1+r_0}{[\nu-1-\delta(\nu r_0+1)]^2}-\frac{t_s w f_e(1-\delta r_0)}{[\nu-1-\delta(\nu r_0+1)]^2}\\ =& \frac{1}{\nu-1}\left[E+\frac{(\nu-1)\left(-\delta q_f\frac{\tau w}{x}+\frac{R_d(x)}{\sigma}\right)+\delta t_s w f_e}{\nu-1-\delta(\nu r_0+1)}\right]\frac{1+r_0}{\nu-1-\delta(\nu r_0+1)}\\ &-\frac{t_s w f_e(1-\delta r_0)}{[\nu-1-\delta(\nu r_0+1)]^2}\\ >& \frac{1}{\nu-1}\left[t_s w f_e+\frac{(\nu-1)\left(-\delta q_f\frac{\tau w}{x}+\frac{R_d(x)}{\sigma}\right)+\delta t_s w f_e}{\nu-1-\delta(\nu r_0+1)}\right]\frac{1+r_0}{\nu-1-\delta(\nu r_0+1)}\\ &-\frac{t_s w f_e(1-\delta r_0)}{[\nu-1-\delta(\nu r_0+1)]^2}\\ =& t_s w f_e\underbrace{\left\{\frac{1}{\nu-1}\left[1+\frac{\delta}{\nu-1-\delta(\nu r_0+1)}\right]\frac{1+r_0}{\nu-1-\delta(\nu r_0+1)}-\frac{1-\delta r_0}{[\nu-1-\delta(\nu r_0+1)]^2}\right\}}_{>0 \quad \because \nu-1-\delta(\nu r_0+1)>0}\\ &+\frac{-\delta q_f\frac{\tau w}{x}+\frac{R_d(x)}{\sigma}}{\nu-1-\delta(\nu r_0+1)}\frac{1+r_0}{\nu-1-\delta(\nu r_0+1)}\\ >& 0.\end{aligned}$$

Rearranging $\frac{\partial LHS}{\partial \nu}=0$ yields

$$\frac{\partial c_D}{\partial \nu}=-\frac{c_D\left(\frac{k}{1-\sigma+k}\frac{\partial M}{\partial \nu}c_D^{1-\sigma}+\frac{\partial N}{\partial \nu}\right)}{k(Mc_D^{1-\sigma}+N)}<0. \tag{A.12}$$

Taking the first derivative of LHS with respect to t_s, I obtain

$$\begin{aligned}\frac{\partial LHS}{\partial t_s} =& k\left(\frac{c_D}{c_M}\right)^{k-1}\frac{1}{c_M}\frac{\partial c_D}{\partial t_s}\left(\frac{k}{1-\sigma+k}M{c_D}^{1-\sigma}+N\right)\\ &+\left(\frac{c_D}{c_M}\right)^{k}\left[\frac{k}{1-\sigma+k}M(1-\sigma)c_D^{-\sigma}\frac{\partial c_D}{\partial t_s}+\frac{\partial N}{\partial t_s}\right].\end{aligned} \tag{A.13}$$

Rearranging $\frac{\partial LHS}{\partial t_s}=0$ yields

$$\frac{\partial c_D}{\partial t_s} = -\frac{\frac{wf_e}{\nu-1-\delta(\nu r_0+1)}c_D}{k(Mc_D^{1-\sigma}+N)} < 0. \tag{A.14}$$

Taking the second cross-partial derivative with respect to ν, I obtain

$$\begin{aligned}\frac{\partial^2 c_D}{\partial t_s\partial\nu} =& -\frac{\left[-\frac{wf_e(1-\delta r_0)}{\{\nu-1-\delta(\nu r_0+1)\}^2}c_D+\frac{wf_e}{\nu-1-\delta(\nu r_0+1)}\frac{\partial c_D}{\partial\nu}\right]}{k(Mc_D^{1-\sigma}+N)}\\ &+\frac{\frac{wf_e}{\nu-1-\delta(\nu r_0+1)}c_D k\left[\frac{\partial M}{\partial\nu}c_D^{1-\sigma}+M(1-\sigma)c_D^{-\sigma}\frac{\partial c_D}{\partial\nu}+\frac{\partial N}{\partial\nu}\right]}{[k(Mc_D^{1-\sigma}+N)]^2}\end{aligned} \tag{A.15}$$

which is positive.

Taking the second cross-partial derivative of $Q_f(c)$, I obtain

$$\begin{aligned}\frac{\partial^2 Q_f(c)}{\partial\nu\partial t_s} =& \frac{\mu w^* L^*}{{P^*}^{1-\sigma}}\frac{k}{c_M}\left(\frac{1}{c_M}\right)^{k-1}\left[\frac{\sigma}{\sigma-1}\tau w\frac{\nu-1}{\nu-1-\delta(\nu r_0+1)}\right]^{1-\sigma}c_D^{-\sigma+k}\\ &\left[\frac{\sigma-1}{\nu-1}\frac{\delta(1+r_0)}{\nu-1-\delta(\nu r_0+1)}\frac{\partial c_D}{\partial t_s}+(-\sigma+k)\frac{1}{c_D}\frac{\partial c_D}{\partial\nu}\frac{\partial c_D}{\partial t_s}+\frac{\partial^2 c_D}{\partial t_s\partial\nu}\right]\\ =&\frac{\mu w^* L^*}{{P^*}^{1-\sigma}}\frac{k}{c_M}\left(\frac{1}{c_M}\right)^{k-1}\left[\frac{\sigma}{\sigma-1}\tau w\frac{\nu-1}{\nu-1-\delta(\nu r_0+1)}\right]^{1-\sigma}c_D^{-\sigma+k}\frac{\partial c_D}{\partial t_s}\\ &\left[\frac{\frac{\delta(\sigma-1)(1+r_0)}{\nu-1}-(1-\delta r_0)}{\nu-1-\delta(\nu r_0+1)}+(1-\sigma+k)\frac{1}{c_D}\frac{\partial c_D}{\partial\nu}-\frac{\frac{\partial M}{\partial\nu}c_D^{1-\sigma}+M(1-\sigma)c_D^{-\sigma}\frac{\partial c_D}{\partial\nu}+\frac{\partial N}{\partial\nu}}{Mc_D^{1-\sigma}+N}\right]\end{aligned} \tag{A.16}$$

which is positive when $\frac{\frac{\delta(\sigma-1)(1+r_0)}{\nu-1}-(1-\delta r_0)}{\nu-1-\delta(\nu r_0+1)}+(1-\sigma+k)\frac{1}{c_D}\frac{\partial c_D}{\partial\nu}-\frac{\frac{\partial M}{\partial\nu}c_D^{1-\sigma}+M(1-\sigma)c_D^{-\sigma}\frac{\partial c_D}{\partial\nu}+\frac{\partial N}{\partial\nu}}{Mc_D^{1-\sigma}+N}<0$. That is, $1+\frac{(\sigma-1)\delta(1+r_0)}{1-\delta r_0}<\nu$. It implies that financial development helps to reduce the credit constraints if a country is at a sufficiently high level of financial development.

□

A.5 The construction of industry-level measures of external finance share

I sort firms into countries based on their headquarters location (loc in Compustat).[30] Capital expenditures correspond to *capx* in Compustat North America. This item represents cash outflow or funds used for additions to the company's property, plant, and equipment, excluding amounts arising from acquisitions.[31]

Cash flow from operation (CF) is defined as

$$CF = fopt + invch + recch + apalch$$

for cash flow statements with format code 1, 2, or 3. For format code 7,

$$CF = ibc + dpc + txdc + esubc + sppiv + fopo + invch + recch + apalch.$$

In words, cash flow from operation is the sum of funds from operations (*fopt*) plus decreases in inventories (*invch*), decreases in accounts receivable (*recch*), and increases in accounts payable (*apalch*).[32] This is basically in line with standard calculation of cash flow in the finance literature where outstanding payables increase a firm's liquidity, while increasing inventories and receivables diminish it. When *fopt* is unavailable, funds from operations are defined as the sum of the following variables: Income before extraordinary items (*ibc*), depreciation and amortization (*dpc*), deferred taxes (*txdc*), equity in net loss/earnings (*esubc*), sale of property, plant and equipment and investments-gain/loss (*sppiv*), and funds from operations-other (*fopo*).

In Compustat Global data[33], *Funds From Operations - Total* is the sum of deferred taxes

[30] The results are virtually the same if I use the country of incorporation (fic in Compustat).
[31] Additions to property, plant, and equipment generally include material, labor and overhead.
[32] Rajan and Zingales (1998) do not indicate which exact variable they take for inventories, receivables and payables.
[33] Since Compustat North America provides only limited data for the rest of the world, Compustat Global

(*txdc*), depreciation and amortization (*dpc*), extraordinary items and discontinued operations (*xidoc*), income before extraordinary items (*ibc*), provisions (*prv*), reserves (*rv*), and sale of tangible fixed assets (*stfixa*) and sale of property, plant and equipment and investments-gain/loss (*sppiv*):

$$CF = txdc + dpc + xidoc + ibc + prv + rv + stfixa + sppiv + invch + recch + apch.$$

Following Rajan and Zingales (1998) procedure for constructing the measure of external finance dependence, both capital expenditures and cash flow are summed up over the relevant years. The industry-level measure is the external finance dependence of the median firm. This method allows us to obtain a measure which is not too heavily influenced by large fluctuations over time and outliers (Rajan and Zingales, 1998).

A.6 Pattern of external finance share and asset tangibility across industries in the United States

Tables A.1 and A.2 depict external finance share and asset tangibility figures computed at the three-digit ISIC industry level, using data for the U.S. firms for the time periods 1987–1996, 1997–2006 and 1987–2006. The values of the two measures taken from the original papers by Rajan and Zingales (1998) and Braun (2003) are provided for comparison.

Obviously, sectors differ significantly in their need for external finance and asset tangibility. For example, the external finance share of the U.S. firms varies from -3.74 (tobacco) to 3.23 (miscellaneous petroleum and coal products) in the period 1987–2006. The asset tangibility of the U.S. firms varies from 0.12 (professional and scientific equipment) to 0.58 (petroleum refineries) in the period 1987–2006. The tobacco industry is largely independent of external finance. In contrast, the professional equipment sector tends to rely more heavily on external finance. In general, industries operating on large scales with high R&D or high working capital needs tend to be more dependent (Braun and Larrain, 2005; Rajan and Zingales, 1998). The industries with the lowest level of tangibility are wearing apparel

is used.

(including footwear) and professional and scientific equipment. The industries that have the most tangible assets are petroleum refineries, paper and products, iron and steel, and industrial chemicals. These observations are quite consistent with earlier reports (Manova, 2013). Furthermore, a comparison between 1987–1996 and 1997–2006 indicates that the sectoral characteristics reflected in the measures are consistent over time in the U.S.

Table A.1: External finance share of U.S. industries

ISIC	Industrial sectors	RZ's EF	Newly constructed EF		
		1986-1995	1987-1996	1997-2006	1987-2006
311	Food products	0.1368	-0.5838	-0.7960	-0.7018
313	Beverages	0.0772	-0.4411	-0.5116	-0.3576
314	Tobacco	-0.4512		-4.2915	-3.7422
321	Textiles	0.4005	-0.0098	-0.7556	-0.4710
322	Wearing apparel, except footwear	0.0286	-1.0107	-1.2648	-0.9474
323	Leather products	-0.1400			
324	Footwear		0.0785	-1.9172	-1.5640
331	Wood products, except furniture	0.2840	-0.0091	-0.6972	-0.4567
332	Furniture, except metal	0.2357	-0.6908	-1.5051	-1.2792
341	Paper and products	0.1756	-0.3200	-1.0346	-0.7634
342	Printing and publishing	0.2038	-1.6689	-1.7278	-1.3784
352	Other chemicals	0.2187	-0.5533	-0.7551	-0.5258
353	Petroleum refineries	0.0420	-0.0775	-0.6396	-0.5564
354	Miscellaneous petroleum and coal products	0.3341		3.2312	3.2312
355	Rubber products	0.2265	-0.2186	-0.0873	-0.2097
356	Plastic products	1.1401	-0.1430	-0.0283	-0.2132
361	Pottery, china, earthenware	-0.1459			
362	Glass and products	0.5285			
369	Other non-metallic products	0.0620	-0.5457	-0.0610	-0.1094
371	Iron and steel	0.0871	-0.0495	-0.2062	-0.3378
372	Non-ferrous metals	0.0051	-0.6494	-0.3861	-0.4174
381	Fabricated metal products	0.2371	-0.6891	-0.9962	-0.9112
382	Machinery, except electrical	0.4453	-0.4892	-0.7785	-0.6540
383	Machinery, electric	0.7675	0.0550	-0.0238	0.0016
384	Transport equipment	0.3069	-0.4334	-0.4977	-0.5192
385	Professional and scientific equipment	0.9610	0.3469	0.4767	0.4722
390	Other manufactured products	0.4702	-0.0716	-0.0530	0.0670
351	Industrial chemicals	0.2050	-0.1938	-0.6131	-0.3806

Notes: External finance share (EF) is defined in the text. Following Braun (2003), I compute the figure for the industrial chemicals industry (351) as the average of the two subsectors: synthetic resins (3513) and basic industrial chemicals excluding fertilizers (3511).

Table A.2: Asset tangibility of U.S. industries

ISIC	Industrial sectors	Braun's Tang	Newly constructed Tang		
		1986-1995	1987-1996	1997-2006	1987-2006
311	Food products	0.3777	0.3951	0.2516	0.2700
313	Beverages	0.2794	0.3045	0.2570	0.2532
314	Tobacco	0.2208		0.1762	0.1898
321	Textiles	0.3730	0.3750	0.3520	0.3514
322	Wearing apparel, except footwear	0.1317	0.1451	0.1232	0.1419
323	Leather products	0.0906			
324	Footwear		0.1643	0.1369	0.1435
331	Wood products, except furniture	0.3796	0.4930	0.4173	0.4585
332	Furniture, except metal	0.2630	0.2576	0.2660	0.2603
341	Paper and products	0.5579	0.5008	0.4829	0.5072
342	Printing and publishing	0.3007	0.3579	0.2054	0.2315
352	Other chemicals	0.1973	0.2536	0.2184	0.2062
353	Petroleum refineries	0.6708	0.6721	0.5454	0.5797
354	Miscellaneous petroleum and coal products	0.3038		0.2085	0.2191
355	Rubber products	0.3790	0.4242	0.3063	0.3063
356	Plastic products	0.3448	0.3535	0.2588	0.2526
361	Pottery, china, earthenware	0.0745			
362	Glass and products	0.3313			
369	Other non-metallic products	0.4200	0.4311	0.3196	0.3344
371	Iron and steel	0.4581	0.4129	0.4165	0.4265
372	Non-ferrous metals	0.3832	0.3615	0.3427	0.3602
381	Fabricated metal products	0.2812	0.2980	0.2406	0.2444
382	Machinery, except electrical	0.1825	0.2140	0.1784	0.1887
383	Machinery, electric	0.2133	0.2298	0.1440	0.1486
384	Transport equipment	0.2548	0.2552	0.2167	0.2169
385	Professional and scientific equipment	0.1511	0.1411	0.1155	0.1232
390	Other manufactured products	0.1882	0.2026	0.1366	0.1453
351	Industrial chemicals	0.4116	0.3836	0.3845	0.4098

Notes: Asset tangibility (Tang) is defined in the text. Following Braun (2003), I compute the figure for the industrial chemicals industry (351) as the average of the two subsectors: synthetic resins (3513) and basic industrial chemicals excluding fertilizers (3511).

Table A.3: Number of industries in sample countries and number of firms in each industry, 1987–2006

ISIC	China	France	Hong Kong	India	Japan	Korea	Malaysia	Singapore	Thailand	US
311	47	12	22	139	104	30	53	23	35	65
313	32	12	8	17	12	8	6			25
314				6						5
321	53		12	190	31	12		8	12	13
322	19	9	33	43	26	17	10	6	5	30
324			8	7						6
331	5	5	6	13	16	5	31	5		19
332	6		6		13		17	6		20
341	31	5	18	60	32	17	18	5	9	30
342	14	5	16	17	34		10	9	11	33
352	35	12	11	106	63	27	8		5	73
353	7			11	9				6	19
354				9						9
355	14		7	23	25	9	6		6	9
356	20	6	9	59	19	10	24	10	12	25
369	42	6	6	66	36	14	20	7	14	15
371	45		5	141	45	22	24	8	19	19
372	58	5	9	44	33	10	17	11		24
381	24	10	11	48	60	15	25	17	12	47
382	107	14	24	104	199	29	28	23	8	120
383	197	27	82	124	200	105	42	41	18	304
384	85	16	9	109	99	47	17	17	6	94
385	28	17	13	22	80		9	9		242
390	17	9	26	32	38		6			29
3511	14			30	17					19
3513	30			25	28	9	7		5	14
# industries	22	16	21	24	22	17	20	16	16	25

Notes: This table lists the industries and with the respective number of firms included in the sample of the study. Since the figure for the industrial chemicals industry (351) is the average of the two subsectors, synthetic resins (3513) and basic industrial chemicals excluding fertilizers (3511), the respective number of firms is reported.

Table A.4: Pattern of external finance share and asset tangibility across industries

ISIC	Industrial sectors		EF	Tang
311	Food products	Mean	-0.085	0.369
		Std. Dev.	0.466	0.070
		Median	-0.126	0.378
		Min	-0.781	0.243
		Max	0.554	0.490
		Obs.	10	10
313	Beverages	Mean	-0.400	0.321
		Std. Dev.	0.697	0.094
		Median	-0.367	0.327
		Min	-1.500	0.155
		Max	0.616	0.455
		Obs.	8	8
314	Tobacco	Mean	-2.993	0.219
		Std. Dev.	1.060	0.041
		Median	-2.993	0.219
		Min	-3.742	0.190
		Max	-2.243	0.248
		Obs.	2	2
321	Textiles	Mean	0.078	0.410
		Std. Dev.	0.603	0.066
		Median	0.334	0.389
		Min	-1.142	0.330
		Max	0.622	0.523
		Obs.	8	8
322	Wearing apparel, except footwear	Mean	-0.359	0.243
		Std. Dev.	0.951	0.068
		Median	-0.325	0.259
		Min	-2.064	0.110
		Max	1.070	0.330
		Obs.	10	10
324	Footwear	Mean	-0.840	0.230
		Std. Dev.	0.812	0.075
		Median	-0.994	0.273
		Min	-1.564	0.144
		Max	0.037	0.275
		Obs.	3	3
331	Wood products, except furniture	Mean	0.078	0.389
		Std. Dev.	0.712	0.112
		Median	0.190	0.382
		Min	-1.141	0.195
		Max	0.916	0.591
		Obs.	9	9
332	Furniture, except metal	Mean	-0.346	0.312
		Std. Dev.	0.793	0.071
		Median	-0.218	0.302
		Min	-1.279	0.245

Table A.4 (Continued)

		Max	0.467	0.445
		Obs.	6	6
341	Paper and products	Mean	-0.054	0.463
		Std. Dev.	0.546	0.068
		Median	-0.034	0.472
		Min	-0.938	0.328
		Max	0.716	0.550
		Obs.	10	10
342	Printing and publishing	Mean	-0.394	0.302
		Std. Dev.	0.627	0.129
		Median	-0.283	0.315
		Min	-1.378	0.020
		Max	0.529	0.496
		Obs.	9	9
351	Industrial chemicals	Mean	-0.272	0.455
		Std. Dev.	0.719	0.082
		Median	-0.290	0.432
		Min	-1.604	0.323
		Max	0.425	0.552
		Obs.	7	7
352	Other chemicals	Mean	-0.356	0.302
		Std. Dev.	0.680	0.086
		Median	-0.397	0.323
		Min	-1.390	0.127
		Max	0.464	0.406
		Obs.	9	9
353	Petroleum refineries	Mean	-0.557	0.465
		Std. Dev.	0.342	0.076
		Median	-0.556	0.440
		Min	-1.072	0.377
		Max	-0.120	0.580
		Obs.	5	5
354	Miscellaneous petroleum and coal products	Mean	1.529	0.256
		Std. Dev.	2.408	0.052
		Median	1.529	0.256
		Min	-0.174	0.219
		Max	3.231	0.293
		Obs.	2	2
355	Rubber products	Mean	0.029	0.381
		Std. Dev.	0.901	0.063
		Median	0.405	0.386
		Min	-1.849	0.295
		Max	0.778	0.472
		Obs.	8	8
356	Plastic products	Mean	0.110	0.388
		Std. Dev.	0.393	0.077
		Median	0.108	0.396
		Min	-0.611	0.253
		Max	0.606	0.491

Table A.4 (Continued)

		Obs.	10	10
369	Other non-metallic products	Mean	0.040	0.433
		Std. Dev.	0.321	0.074
		Median	-0.031	0.450
		Min	-0.464	0.333
		Max	0.584	0.559
		Obs.	10	10
371	Iron and steel	Mean	0.220	0.381
		Std. Dev.	0.525	0.075
		Median	0.315	0.403
		Min	-0.770	0.230
		Max	0.945	0.486
		Obs.	9	9
372	Non-ferrous metals	Mean	0.118	0.338
		Std. Dev.	0.431	0.082
		Median	0.157	0.341
		Min	-0.589	0.157
		Max	0.686	0.457
		Obs.	9	9
381	Fabricated metal products	Mean	-0.185	0.317
		Std. Dev.	0.590	0.091
		Median	-0.156	0.304
		Min	-0.911	0.187
		Max	0.575	0.452
		Obs.	10	10
382	Machinery, except electrical	Mean	-0.047	0.274
		Std. Dev.	0.469	0.084
		Median	0.141	0.273
		Min	-0.958	0.119
		Max	0.478	0.430
		Obs.	10	10
383	Machinery, electric	Mean	0.039	0.256
		Std. Dev.	0.430	0.063
		Median	0.074	0.260
		Min	-0.769	0.149
		Max	0.653	0.344
		Obs.	10	10
384	Transport equipment	Mean	-0.189	0.327
		Std. Dev.	0.454	0.092
		Median	-0.382	0.330
		Min	-0.666	0.174
		Max	0.406	0.463
		Obs.	10	10
385	Professional and scientific equipment	Mean	0.020	0.221
		Std. Dev.	0.703	0.106
		Median	0.393	0.210
		Min	-1.474	0.096
		Max	0.497	0.432
		Obs.	8	8

Table A.4 (Continued)

390	Other manufactured products	Mean	-0.185	0.201
		Std. Dev.	1.223	0.067
		Median	0.067	0.208
		Min	-2.477	0.111
		Max	1.479	0.284
		Obs.	7	7

Table A.5: Summary statistics

	Private credit to GDP		Real GDP (at 2005 constant prices; billions)		# Trade partners
Country	Avg	St Dev	Avg	St Dev	
China	0.90	0.18	2980	1560.0	224
France	0.87	0.05	1670	200.0	241
Hong Kong	1.45	0.13	168	35.8	206
India	0.27	0.05	1710	575.0	237
Japan	1.92	0.19	3620	299.0	233
Korea	0.69	0.16	747	233.0	244
Malaysia	1.08	0.23	179	64.6	245
Singapore	1.00	0.11	120	43.8	238
Thailand	1.05	0.30	339	78.1	239
United States	1.46	0.28	9760	1870.0	236

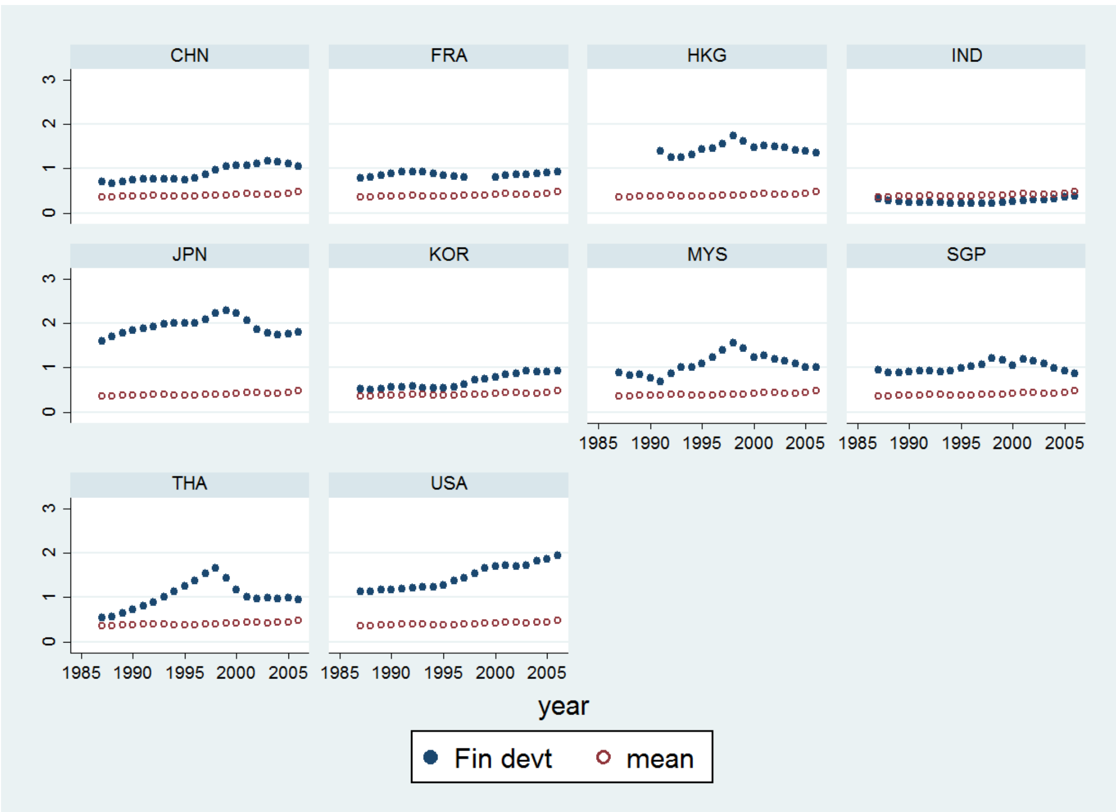

Figure A.1: The ratio of private credit to GDP with the world mean

Table A.6: Financial constraints and trade (replication of Table 1 in Manova (2013) using the industry-specific measure of asset tangibility)

Financial development measure: Private credit
Dependent variable: (log) bilateral total exports by sector

				Proxy for the sectoral price index p		
	Total effect of credit constraints	Controlling for selection into domestic production		CPI and interactions with sector FE	Importer's consumption by sector	Importer × sector FE
Fin devt	0.839	0.753	0.581	0.743	0.769	0.840
	(15.49)***	(12.30)***	(9.33)***	(11.64)***	(12.58)***	(14.13)***
Fin devt × Tang	-3.102	-2.394	-2.426	-2.472	-2.465	-2.726
	(-28.41)***	(-18.13)***	(-19.86)***	(-18.37)***	(-18.30)***	(-21.37)***
(Log) # Establish		0.356		0.360	0.360	0.360
		(42.85)***		(42.18)***	(42.91)***	(44.47)***
(Log) Output			0.341			
			(18.93)***			
p				0.008	0.170	
				(7.00)***	(26.58)***	
LGDPE	0.960	1.087	0.649	1.081	1.091	1.128
	(16.89)***	(16.26)***	(9.00)***	(16.15)***	(16.40)***	(16.73)***
LGDPI	0.940	0.973	0.935	1.032	0.704	0.994
	(16.46)***	(14.29)***	(14.24)***	(16.16)***	(10.18)***	(14.49)***
LDIST	-1.368	-1.406	-1.407	-1.416	-1.411	-1.440
	(-78.69)***	(-72.16)***	(-74.10)***	(-70.24)***	(-71.69)***	(-73.30)***
Controls:						
Exporter, Year FE	Y	Y	Y	Y	Y	Y
Importer, Sector FE	Y	Y	Y	Y	Y	N
Importer × Sector FE	N	N	N	N	N	Y
R-squared	0.56	0.57	0.59	0.58	0.57	0.60
# observations	861,380	621,333	703,743	579,485	589,205	621,333
# exporter-importer clusters	9343	7867	8031	7452	7813	7867

Notes: All regressions include a constant term, exporter, year, importer, and sector fixed effects, and cluster errors by exporter-importer pair. Importer-sector fixed effects replace the importer and sector fixed effects in Column 6. T-statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A.7: Financial constraints and trade (replication of Table 1 in Manova (2013) using the industry-specific measure of asset tangibility for the subsample of 10 countries and 25 sectors)

Financial development measure: Private credit
Dependent variable: (log) bilateral total exports by sector

				Proxy for the sectoral price index p		
	Total effect of credit constraints	Controlling for selection into domestic production		CPI and interactions with sector FE	Importer's consumption by sector	Importer × sector FE
Fin devt	-0.179	-0.840	-1.207	-0.827	-0.783	-0.796
	(-1.36)	(-5.94)***	(-8.50)***	(-5.91)***	(-5.60)***	(-6.49)***
Fin devt × Tang	-1.927	-0.830	0.109	-0.977	-0.940	-1.126
	(-7.34)***	(-2.93)***	(0.37)	(-3.41)***	(-3.29)***	(-5.55)***
(Log) # Establish		0.528		0.535	0.531	0.558
		(25.84)***		(27.40)***	(26.89)***	(36.11)***
(Log) Output			0.657			
			(40.83)***			
p				0.005	0.168	
				(1.77)*	(11.25)***	
LGDPE	1.618	1.323	0.615	1.284	1.307	1.438
	(15.34)***	(9.33)***	(5.59)***	(9.29)***	(9.58)***	(10.03)***
LGDPI	1.203	1.349	1.185	1.159	1.129	1.330
	(10.34)***	(10.09)***	(9.85)***	(8.76)***	(8.50)***	(9.84)***
LDIST	-1.397	-1.422	-1.417	-1.430	-1.430	-1.433
	(-24.69)***	(-14.60)***	(-24.55)***	(-14.36)***	(-14.61)***	(-14.31)***
Controls:						
Exporter, Year FE	Y	Y	Y	Y	Y	Y
Importer, Sector FE	Y	Y	Y	Y	Y	N
Importer × Sector FE	N	N	N	N	N	Y
R-squared	0.64	0.63	0.66	0.65	0.64	0.70
# observations	182,370	121,364	166,563	113,439	115,070	121,364
# exporter-importer clusters	1,158	1,039	1,158	987	1,039	1,039

Notes: All regressions include a constant term, exporter, year, importer, and sector fixed effects, and cluster errors by exporter-importer pair. Importer-sector fixed effects replace the importer and sector fixed effects in Column 6. T-statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A.8: Robustness: different financial indicators

Dependent variable: (log) bilateral total exports by sector			
	(1)	(2)	(3)
Financial development measure: Stock market capitalization to GDP			
Fin devt	-0.240	-0.131	-0.443
	(-3.42)***	(-1.82)*	(-6.32)***
Tang	1.873	0.722	1.388
	(6.78)***	(3.17)***	(4.98)***
Fin devt × Tang	0.438	0.140	0.888
	(2.18)**	(0.68)	(4.54)***
Controls:			
Exporter, Year FE	Y	Y	Y
Importer, Sector FE	Y	Y	Y
R-squared	0.59	0.64	0.61
# observations	107,659	142,929	93,077
Financial development measure: Financial Institutions (Depth, Access, Efficiency)			
Fin devt	-2.482	-1.685	-2.802
	(-9.97)***	(-8.29)***	(-10.95)***
Tang	0.376	-1.268	-0.018
	(1.02)	(-4.02)***	(-0.05)
Fin devt × Tang	4.429	3.758	5.051
	(5.99)***	(6.63)***	(6.59)***
Controls:			
Exporter, Year FE	Y	Y	Y
Importer, Sector FE	Y	Y	Y
R-squared	0.59	0.64	0.61
# observations	133,033	175,476	113,963

Notes: The dependent variable is (log) bilateral exports (in $1,000s) in a 3-digit ISIC sector and year 1987–2006. Exporter, year, importer, and sector fixed effects as well as the constant, and the control variables – (Log) # Establish, (Log) Output, sectoral price index, LGDPE, LGDPI, and LDIST – estimates are not reported. Errors clustered by exporter-importer pair. T-statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A.9: Robustness: measures of financial contractibility

Dependent variable: (log) bilateral total exports by sector			
	(1)	(2)	(3)
Financial development measure: Repudiation of contracts			
Tang	-1.517	-3.438	-0.725
	(-1.64)	(-4.23)***	(-0.75)
Fin devt × Tang	0.492	0.498	0.371
	(4.06)***	(4.99)***	(2.90)***
Controls:			
Exporter, Year FE	Y	Y	Y
Importer, Sector FE	Y	Y	Y
R-squared	0.59	0.64	0.61
# observations	132,568	175,476	113,566
Financial development measure: Accounting standards			
Tang	-1.889	-6.955	-2.198
	(-1.29)	(-4.99)***	(-1.51)
Fin devt × Tang	0.062	0.111	0.064
	(2.86)***	(5.44)***	(3.00)***
Controls:			
Exporter, Year FE	Y	Y	Y
Importer, Sector FE	Y	Y	Y
R-squared	0.59	0.64	0.61
# observations	132,568	175,476	113,566
Financial development measure: Risk of expropriation			
Tang	-10.544	-8.447	-7.949
	(-7.44)***	(-7.49)***	(-5.46)***
Fin devt × Tang	1.526	1.014	1.201
	(9.06)***	(7.99)***	(6.94)***
Controls:			
Exporter, Year FE	Y	Y	Y
Importer, Sector FE	Y	Y	Y
R-squared	0.59	0.64	0.61
# observations	132,568	175,476	113,566

Notes: The dependent variable is (log) bilateral exports (in $1,000s) in a 3-digit ISIC sector and year 1987–2006. Exporter, year, importer, and sector fixed effects as well as the constant, and the control variables – (Log) # Establish, (Log) Output, sectoral price index, LGDPE, LGDPI, and LDIST – estimates are not reported. Errors clustered by exporter-importer pair. T-statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A.10: Robustness: excluding the countries with the extreme values of Fin devt

Financial development measure: Private credit Dependent variable: (log) bilateral total exports by sector			
	(1)	(2)	(3)
Fin devt	-0.330	0.187	-1.112
	(-0.96)	(0.69)	(-3.44)***
Tang	-0.498	-2.319	-2.520
	(-0.56)	(-3.49)***	(-3.07)***
Fin devt × Tang	1.360	2.118	3.269
	(1.70)*	(3.35)***	(4.41)***
(Log) # Establish	0.895		0.906
	(26.12)***		(26.45)***
(Log) Output		0.880	
		(32.19)***	
p			0.003
			(0.70)
LGDPE	0.072	-0.445	0.068
	(0.36)	(-3.51)***	(0.33)
LGDPI	0.528	0.690	0.534
	(3.49)***	(5.45)***	(2.38)**
LDIST	-1.280	-1.303	-1.259
	(-19.94)***	(-25.47)***	(-19.12)***
Controls:			
Exporter, Year FE	Y	Y	Y
Importer, Sector FE	Y	Y	Y
R-squared	0.61	0.65	0.63
# observations	82,420	124,863	71,728
# exporter-importer clusters	1162	1197	985

Notes: The dependent variable is (log) bilateral exports (in $1,000s) in a 3-digit ISIC sector and year 1987–2006. Errors clustered by exporter-importer pair. T-statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A.11: Robustness: controlling for economic development

Financial development measure: Private credit Dependent variable: (log) bilateral total exports by sector			
	(1)	(2)	(3)
Fin devt	-1.397	-0.199	-1.543
	(-8.67)***	(-1.30)	(-9.27)***
Tang	-11.266	-9.429	-9.520
	(-5.15)***	(-5.08)***	(-4.30)***
Fin devt × Tang	1.898	1.528	1.987
	(5.95)***	(5.07)***	(5.99)***
LGDPE × Tang	0.602	0.421	0.506
	(5.56)***	(4.58)***	(4.64)***
Controls:			
Exporter, Year FE	Y	Y	Y
Importer, Sector FE	Y	Y	Y
R-squared	0.59	0.64	0.61
# observations	125,741	168,184	107,841
# exporter-importer clusters	1511	1546	1277

Notes: The dependent variable is (log) bilateral exports (in $1,000s) in a 3-digit ISIC sector and year 1987–2006. Exporter, year, importer, and sector fixed effects as well as the constant, and the control variables – (Log) # Establish, (Log) Output, sectoral price index, LGDPE, LGDPI, and LDIST – estimates are not reported. Errors clustered by exporter-importer pair. T-statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A.12: Robustness: controlling for internal funds measured by return on assets

Financial development measure: Private credit Dependent variable: (log) bilateral total exports by sector			
	(1)	(2)	(3)
Fin devt	-2.437	-1.048	-2.604
	(-12.33)***	(-5.42)***	(-13.10)***
Tang	0.855	-0.776	0.651
	(2.68)***	(-2.67)***	(1.98)**
Fin devt × Tang	1.992	2.005	2.099
	(6.06)***	(6.61)***	(6.26)***
Return on assets	-19.974	-13.602	-20.096
	(-12.85)***	(-9.29)***	(-12.51)***
Fin devt × Return on assets	15.204	9.740	15.396
	(11.63)***	(7.98)***	(11.29)***
Controls:			
Exporter, Year FE	Y	Y	Y
Importer, Sector FE	Y	Y	Y
R-squared	0.59	0.64	0.61
# observations	125,741	168,184	107,841
# exporter-importer clusters	1511	1546	1277

Notes: The dependent variable is (log) bilateral exports (in $1,000s) in a 3-digit ISIC sector and year 1987–2006. Exporter, year, importer, and sector fixed effects as well as the constant, and the control variables – Return on assets, (Log) # Establish, (Log) Output, sectoral price index, LGDPE, LGDPI, and LDIST – estimates are not reported. Errors clustered by exporter-importer pair. T-statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.