

FINANCIAL DEVELOPMENT, ENDOGENOUS DEPENDENCE ON EXTERNAL FINANCING, AND TRADE*

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ABSTRACT

The influential papers on the effect of credit constraints on growth and international trade ([Manova, 2013](#); [Rajan and Zingales, 1998](#)) tend to assume that asset tangibility and the share of external borrowing are exogenous industry characteristics, which 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 the firm can provide (and thus implicitly on its asset tangibility). In order to compare these approaches, I construct country- and industry-specific measures of asset tangibility and external borrowing for 25 industries in 10 countries between 1987 and 2006 by using Compustat Global data. 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 that incorporates 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 export. The model offers theoretical predictions that are consistent with and provide an intuition for the above results. Furthermore, contrary to the results of [Manova \(2013\)](#), both the model and my empirical results demonstrate that industries with more tangible assets export relatively more from countries with higher levels of financial development.

JEL classification: F10, F14, G20, O14, O16

Keywords: Financial development, External finance dependence, Asset tangibility, International trade

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1 INTRODUCTION

The recent literature on growth and international trade has devoted much attention to the role of financial development in both. Financial development has been shown to increase economic growth (Beck et al., 2000; King and Levine, 1993a,b; Levine, 2005; Levine et al., 2000; Rajan and Zingales, 1998) and the ability of firms to export (Berman and Héricourt, 2010; Chaney, 2013; Greenaway et al., 2007; Manova, 2013; Muûls, 2008). Within a country, financial development has been found to be more important for financially vulnerable sectors—that is, sectors with greater need for external finance and sectors with fewer 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 In this literature, economists tend to assume that these industry characteristics are country- and time-invariant and, therefore, that asset tangibility (the ratio of tangible assets to total assets) and the share of external borrowing (relative to capital expenditure) that are calculated for the U.S. for the period 1986–1995 can be applied to other countries and time periods. Moreover, the share of external borrowing and asset tangibility are assumed to be independent of each other, thus conflicting with the finance literature, in which the share of external borrowing is typically endogenous and dependent on the amount of collateral and thus on asset tangibility.²

This paper departs from the previous studies on trade and finance that tended to rely on U.S. industry characteristics to approximate the global industry characteristics and, instead, attempts to measure the share of external finance and the tangibility of assets varying at

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. Tangible assets consist of assets that are directly related to the products being sold by the business, such as inventory and accounts receivable, or indirectly related to the products being sold, such as equipment or real estate. Since data on collateral are difficult to obtain at the industry level and tangible assets are easy to collateralize for debt, I use asset tangibility as a proxy for collateral.

² For the former argument, see Braun (2003) and Manova (2013). For the latter, see 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).

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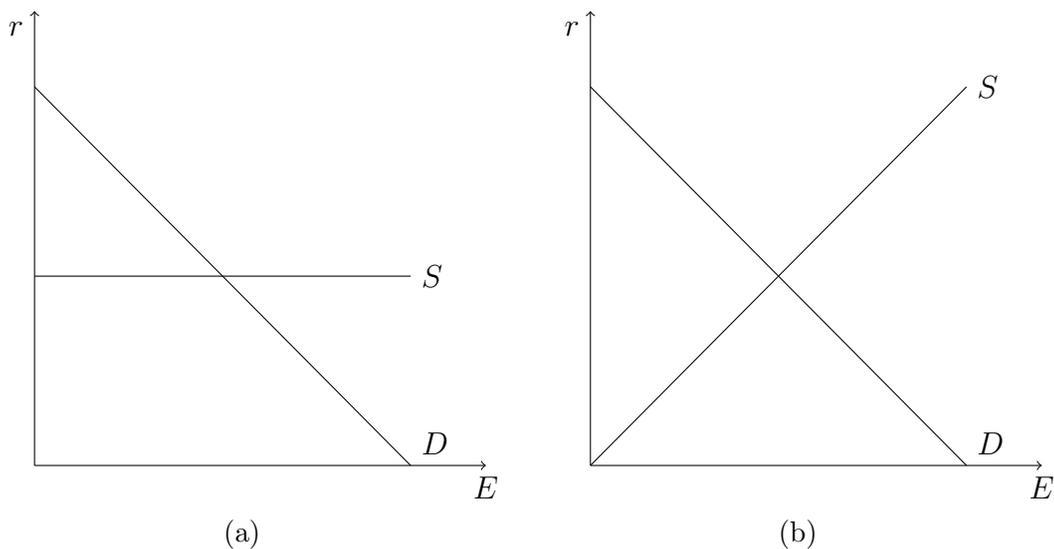


Figure 1: (a) Perfectly elastic supply of external finance (in the U.S.); (b) More inelastic supply of external finance (in less financially developed countries)

Note: E on the x-axis denotes the amount of external finance and r on the y-axis denotes the interest rate.

both the industry and country levels. The approach proposed here is motivated by the fact that firms' actual use of external finance depends on the characteristics of the financial markets in which these firms operate. In an advanced financial environment, the actual use of external funding by the median firm of an industry would equal the external finance requirement (Figure 1a). However, in a less financially developed country, the amount of external borrowing is more strongly determined by factors that affect the supply of loans, such as the availability of collateral, and the constraints faced in this process, based on the country-specific level of financial development (Figure 1b). Hence, financial dependence for U.S. firms in 1986–1995 may not be a valid benchmark for these countries. For the aforementioned reasons, I use Compustat Global data to explicitly construct country- and industry-specific measures of asset tangibility and external borrowing for 10 countries between 1987 and 2006. Moreover, this paper explores how the results of an influential paper by Manova (2013) and many other empirical trade studies would be affected by such a change to the assumptions about the industry measures. I find that while the measures of asset tangibility and the share of external finance are indeed rather stable over time for a given country, they are

unstable across countries, and thus these measures constructed for the U.S. may not be a valid benchmark for other countries.

This paper follows the approach favored in the finance literature and re-examines the result presented in the trade literature regarding the negative interaction effect between financial development and asset tangibility on exports. In order to address the question formally and provide a theoretical basis for the study, I develop a model providing a micro-foundation for the lending and borrowing decisions in which the interest rate endogenously changes according to the level of financial development and collateral availability. To be more specific, this paper builds on a model of heterogeneous firms developed by [Chaney \(2013\)](#) and [Muûls \(2008\)](#), who incorporate the credit constraints of firms in a [Melitz \(2003\)](#) framework. Contrary to the previous literature on trade and finance that assumes that the probability of default is exogenous ([Manova, 2013](#); [Muûls, 2008](#)), in my model, firms are deterred from defaulting in equilibrium because lenders apply adequate enforcement efforts, which make defaulting costly. Further, I allow for endogenous variation in the borrower's interest rate, depending on the amount of collateral and the level of financial development. This framework provides a micro-foundation for the lending and borrowing decisions, which offers a transparent explanation for otherwise less than intuitive complementarity between financial development and collateral—that is, the fact that industries with greater collateralizable assets benefit more from financial development. The model shows that the share of outside capital available to a firm does increase in the level of financial development and the degree of asset tangibility. Moreover, it predicts that in countries with more developed financial systems, the industries with high asset tangibility produce disproportionately more exports relative to industries that are poorly endowed in tangible assets. This is because firms with more tangible assets can raise much more external finance to cover trade costs, and benefit more from cheaper external finance when their financial system is better developed. Given that external finance is fundamentally difficult to obtain without substantial

tangible collateral, financial development will not help much in terms of increasing the external capital (and exports) of firms with very limited collateralizable assets. This novel result of the present paper differs from the predictions of [Manova \(2013\)](#) and other studies that assume exogenous variation in the degree to which firms depend on external finance.

I test the empirical implications of the model by following the empirical strategy of [Manova \(2013\)](#). However, owing to the positive relationship between the external finance share and asset tangibility, I exclude the external finance share and include only asset tangibility as a 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 further helps establish the causal effect of domestic financial development on the volume of international trade.³ The variation in the share 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 the higher foreign demand for sectors that are intensive in external funds increases the demand for loans in these sectors. The method presented here alleviates such a problem and helps to argue in favor of a causal effect running from credit constraints to exporting, because tangibility is independent of foreign demand fluctuations.⁴ To see whether it is indeed the case that 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, the higher tangibility of assets reinforces the positive effects and alleviates the negative effects on exports. The interaction effect is economically sizable: a one standard deviation increase in asset

³ 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 \(2013\)](#), 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](#)).

⁴ [Berger and Udell \(1990\)](#) and [John et al. \(2003\)](#) assume that collateral is exogenous.

tangibility would lead to a 42% increase in exports.

In line with the aforementioned theoretical contribution, the present study adds to the empirical literature using indices of financial vulnerability. A number of empirical studies in this literature have used the values of external financial dependence and asset tangibility as provided by [Rajan and Zingales \(1998\)](#) and [Braun \(2003\)](#). Few have attempted to reproduce the measure of external finance dependence. For example, [Laeven and Valencia \(2013\)](#) construct external finance dependence across industries in the U.S. over the period 1980–2006. [Buera et al. \(2011\)](#) construct the measure of external dependence of two broadly defined sectors (i.e., manufacturing and services) using the U.S. data for 1993–2003. [Chor \(2010\)](#) computes the median value of dependence on external capital across firms in each U.S. SIC-87 2-digit category over the period 1980–1989. The present paper departs from these approaches: instead of using the U.S. as the benchmark, I construct country- and industry-specific measures of the external finance share and asset tangibility for each sample of countries, which have not been available previously, based on the [Rajan and Zingales \(1998\)](#) method.

This paper also contributes to the literature on the differential impacts of financial development on trade across sectors. In particular, I delve 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. [Hur et al. \(2006\)](#) find a slightly positive correlation between the proxy for asset tangibility and the external finance share in their sample of 42 countries. The present paper also finds a positive relationship, but reaches a different conclusion that financial development leads to more exports in industries characterized by a higher share of tangible assets. This can be attributed to their higher ability to provide collateral, which results in better access to and use of external financing, regardless of the level of financial development. To the author’s knowledge, [Yousefi’s \(2011\)](#) study is the only one showing 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 increases in a country.⁵ However, he employs a U.S.-based measure of asset tangibility calculated by [Braun \(2003\)](#), which is inadequate to apply to less financially developed countries.

Lastly, this paper is also related to the large literature on the heterogeneity in factor intensity for a given industry across countries, especially given that asset tangibility is correlated with 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 have used 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 this study, I use the same definition to measure asset tangibility. In this sense, the result of this paper provides an interesting parallel to the result of studies performed in the standard Heckscher-Ohlin model that countries will export products that use their abundant and cheap factor(s) of production.

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.

⁵ The sample of countries includes Spain, Norway, Finland, Sweden, Japan, Indonesia, Korea, Malaysia, Philippines, Thailand, Argentina, Chile, Colombia, Mexico, and Turkey.

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 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 U.S.). 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).⁶

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.⁷ 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*).⁸ 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 contained in the Compustat database.

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

⁶ I would like to thank Luc Laeven for providing the industry concordance table.

⁷ 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).

⁸ See Appendix for details of the construction of the measure.

assets (Compustat item *at*) (i.e., the proportion of total assets that has collateral value). This proxy has been commonly used in the finance literature (e.g., [Campello and Giambona, 2013](#); [Frank and Goyal, 2003](#); [Johnson, 1997](#)). 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.⁹ [Myers and Majluf \(1984\)](#) argue that this proxy reflects the ability to use the assets as collateral, and can be associated with a higher debt capacity.

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 U.S.) that have more than 15 sectors in common with the U.S., with 5 or more firms in each industry.¹⁰ Those countries are China, France, Hong Kong, India, Japan, South Korea, Malaysia, Singapore, and Thailand.

The number of industries varies across countries from 16 sectors in France, Singapore, and Thailand to 25 sectors in the U.S. 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

⁹ [Rajan and Zingales \(1998\)](#) do not measure asset tangibility. [Braun \(2003\)](#) does so while adopting the measure of external financial dependence provided by [Rajan and Zingales \(1998\)](#). Several empirical studies in this literature, including [Manova \(2013\)](#), use the values of external financial 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.

¹⁰ Tests for significant positive association between measures for the U.S. industries in 1986–1995 that are constructed under different criteria for the number of firms (more than one firm in each industry vs. five or more firms in each industry) are calculated using the Spearman’s rank correlation coefficients. The correlation between the measures of external finance share is 0.4625 ($N = 22, p < 0.05$). The correlation between the measures of asset tangibility is 0.9424 ($N = 22, p < 0.01$).

describe the distribution of the share of external finance and asset tangibility measures for each ISIC industry across the available countries.

A potential source of measurement error is that some industries present in the U.S. are represented by no more than five active firms in some of the countries. To assess whether such measurement error has affected the main result, I perform a separate analysis only for countries with at least 20 sectors.¹¹ It turns out that the measurement error is too small to change the result significantly (results available upon request). Meanwhile, the problem of measurement error in developing country data is pervasive, but there is no clear solution. If asset tangibility is underestimated in developing countries, which is more likely to be the case, the results presented in this study would actually be reinforced.

Further details of the data analysis involving other variables can be found in Section 4.1.

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, and explain why we need to use country- and industry-specific measures. In particular, this analysis aims to show that (i) the sectoral rankings of the share of external finance and asset tangibility are not stable across countries, but relatively stable across years, and (ii) in several countries, a higher tangibility of assets is related to a higher share of external finance relative to capital expenditure.

The argument in earlier studies that the sectors' financial 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

¹¹ Those countries are China, Hong Kong, India, Japan, Malaysia, and the U.S.

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 U.S. 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%.

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.¹² 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. It 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. This suggests another advantage of my approach

¹² Spearman's rank correlation is useful for non-normally distributed data and/or small sample size.

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.

Furthermore, the correlation coefficients of measures constructed using more than one firm in each industry are weaker, on average, than those using at least five firms per industry (see Table A.5), which helps justify the use of the latter.

In addition, I find cross-country heterogeneity within individual industries.¹³ 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 proportion 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 U.S., 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 the 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

¹³ 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: External finance share and asset tangibility are defined in the text. I use Pearson correlation to compare the values of two measures. I calculate the Spearman rank correlation to compare the ranks of two measures. 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%.

terms of asset tangibility indicate that the rankings of industries are relatively stable for the sample of countries. I focus on two decades, 1987–2006, rather than one because of data availability. 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. Therefore, I use the asset tangibility measure calculated for 1987–2006 in the analysis.

2.4 RELATIONSHIP BETWEEN EXTERNAL FINANCE SHARE AND ASSET TANGIBILITY

As indicated earlier, my primary focus is on a possible positive relationship between asset tangibility and the share of external borrowing in a given country. Some papers have found a weak correlation between external finance share and asset tangibility. [Manova \(2013\)](#) states that two measures of external finance share and asset tangibility are only weakly correlated at -0.04. On the contrary, [Hur et al. \(2006\)](#) argue that the correlation between the proxies of external finance share and asset tangibility in their sample is weakly positive, 0.013. While

Table 3: Correlations between external finance share and asset tangibility for 1987–2006

	Pearson corr. of value	Spearman's rank corr.
China	-0.07	0.15
India	0.01	0.01
United States	0.02	0.03
Korea, Rep.	0.10	-0.08
Malaysia	0.12	-0.00
Thailand	0.15	-0.01
Singapore	0.30	0.25
France	0.32	0.20
Hong Kong	0.36	0.33
Japan	0.61***	0.60***

Notes: I use Pearson correlation to compare the values of two measures. I calculate the Spearman rank correlation to compare the ranks of two measures. Countries are ordered from lowest to highest, based on the Pearson correlation. Correlation is * significant at 10%; ** significant at 5%; *** significant at 1%.

the correlations are indeed negligible for the U.S., I find them to be non-negligible for many other countries; see Table 3, where the figures for Japan show a statistically significant positive correlation, while an insignificant but positive correlation is found for most other countries.¹⁴ This implies that the availability of collateral does matter for the firms' ability to raise external capital. Thus, this paper relies on cross-country and industry variation in the degree of asset tangibility and its relationship with the share of external capital to examine the effect of financial development on exports.

¹⁴ I find that after excluding Japan from the sample, the main regression results still hold, suggesting that Japan is not driving the results.

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. Contrary to earlier literature in trade and finance assuming that the probability of default is exogenous¹⁵, in this model, firms are deterred from defaulting because lenders apply effort to keep track of each borrower, which makes defaulting costly. I introduce collateral into the framework of [Galor and Zeira \(1993\)](#) whose model incorporates enforcement cost 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

¹⁵ The exogenous probability of default is often used as an indicator of financial development (see, e.g., [Manova, 2013](#); [Muûls, 2008](#)).

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

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

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

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

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

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

Everything else being equal, a 1% rise in $p(\omega)$ reduces demand $q(\omega)$ by $\sigma\%$. The amount

spent on each variety ω (or the revenue per variety) is

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

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 $w f_e$ 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:

$$c_d(q_d(x)) = q_d(x) \frac{w}{x} + w f_e. \quad (5)$$

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 stay there longer term. 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:

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

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 sectors (Braun, 2003; Manova, 2013). 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,

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

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

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

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

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

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 :

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

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

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

subject to

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

and

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

subject to

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

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

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)

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

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:

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

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

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

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

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

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, $w f_e$, which is a base for defining collateralized assets: $s(q_f(x)) = E(q_f(x))/w f_e$.¹⁶ Using (19), we can rewrite (16) as

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

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

¹⁶ Capital expenditure, which is supposed to be the denominator in the calculation of the external finance share, includes investments in fixed assets.

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.

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:

$$R_f(x) = \frac{\mu w^* L^*}{P^{*1-\sigma}} \left[\frac{\sigma}{\sigma-1} \frac{\tau w}{x} \frac{\nu-1}{\nu-1-\delta(\nu r_0+1)} \right]^{1-\sigma} \quad (21)$$

$$= \sigma \left[\frac{\{(\nu r_0+1)(1-\delta) + (\nu-1)\} \{w^* f_{ex} - wA - \pi_d(x)\} - t_s w f_e}{\nu-1-\delta(\nu r_0+1)} \right],$$

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 more tangible assets can raise much more external finance and benefit more from cheaper external financing. For firms with too few collateralizable assets whose constraints are too strong, financial development will not help much because external financing is fundamentally difficult to obtain without substantial tangible collateral.

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

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

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 :

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

This productivity cut-off x_D satisfies

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

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 $N \equiv wA \left(1 + \frac{\nu r_0+1}{\nu-1-\delta(\nu r_0+1)} \right) - w f_e \left(1 + \frac{\nu r_0+1}{\nu-1-\delta(\nu r_0+1)} \right) - \frac{\nu r_0+1}{\nu-1-\delta(\nu r_0+1)} w^* f_{ex} + \frac{t_s w f_e}{\nu-1-\delta(\nu r_0+1)}$.

Aggregating across firms, total exports in a sector are

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

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 higher 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 \(2004\)](#).

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 three traditional measures of the level of financial development: the ratios of private credit by deposit banks and other financial institutions to GDP, stock

market capitalization to GDP, and stock market total value traded to GDP.¹⁷ These data are taken from the 2013 version of the World Bank’s Financial Structure Database. In the robustness regressions, I use a measure of the quality of law enforcement—that is, the rule of law index based on the Worldwide Governance Indicators developed by the World Bank.¹⁸ In addition, since I focus on outcomes related to firm financing, I also use the financial markets access index that illustrates the ability of companies to access financial services, developed by [Svirydzenka \(2016\)](#). 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. I draw annual observations of other industry-level data in 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.6 presents the descriptive statistics for some variables used in this study and the number of trade partners for each country. 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

¹⁷ 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. Stock market total value traded to GDP is an indicator of market liquidity and is a complementary indicator to market capitalization.

¹⁸ Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Estimate ranges from -2.5 to 2.5.

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 correlation between the share of external finance 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. Second, my measure of asset tangibility is both country- and sector-specific, while it is only sector-specific in [Manova \(2013\)](#).

To study the differential effect of financial development, I interact asset tangibility with the indicator of financial development. The exporter-sector fixed effect is included to control for any unobserved heterogeneity within these groups that might influence the exports of a particular industry in a particular country. I do not estimate the direct effect of asset tangibility, as it is captured by the exporter-sector fixed effect.

The main regression specification is

$$\begin{aligned} \ln X_{ijst} = & \alpha + \beta_1 FinDev_{it} + \beta_2 (FinDev_{it} \times Tang_{is}) \\ & + \sum_{is} \lambda_{is} D_{is} + \sum_j \lambda_j D_j + \sum_t \lambda_t D_t + \gamma K + \varepsilon_{ij}. \end{aligned} \quad (26)$$

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_{is} , D_j , and D_t are the

exporter-sector, importer, 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 (log) distance. α is a constant and ε_{ij} 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.

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 standard firm-specific 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).¹⁹ 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.²⁰ Further, I incorporate a country-specific financial development indicator—private credit to GDP ratio in column (2) and rule of law in column (3)—to check the robustness of the results. In column (1) of [Table 4](#), which does not include the interaction term, I find that the share of external borrowing is higher for firms with more tangible assets, which is consistent with a large body of finance literature. The share of external finance is estimated to increase by 1 for every 100 percentage points increase in

¹⁹ 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 U.S.).

There is no formal model linking firm characteristics to the use of external financing.

²⁰ Firm size and sales growth are averaged over time.

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Table 4: Estimated coefficients from OLS models of the share of external finance by country- and industry-specific characteristics

Dependent variable: The share of external finance			
Indicator of Fin devt:		Private Credit	Rule of Law
	(1)	(2)	(3)
Fin devt		-0.520 (-2.52)**	-0.244 (-1.92)*
Fin devt × Tang		1.483 (2.42)**	0.734 (1.94)*
Tang	1.001 (1.94)*	-0.513 (-0.61)	0.346 (0.44)
Sales-to-asset ratio	0.283 (1.46)	0.297 (1.56)	0.289 (1.46)
Firm size	-0.108 (-2.15)**	-0.110 (-2.20)**	-0.117 (-2.29)**
Return on assets	-8.641 (-6.19)***	-8.868 (-6.61)***	-8.668 (-5.95)***
Sales growth	1.531 (5.63)***	1.498 (5.89)***	1.494 (5.35)***
Controls:			
Country, Sector FE	Y	Y	Y
R-squared	0.76	0.78	0.76
# observations	3,964	3,848	1,592

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.²¹ In column (2) of Table 4, the share of external finance is estimated to increase by 1.08 for every 100 percentage points increase in asset tangibility. The estimated marginal effect is calculated at the means of the variables and significant at the 5% level. This result supports the prediction of Proposition 1. Figure 2 displays the extent of the marginal effect of asset tangibility, based on the coefficients in column (2) of Table 4, over a varying range of levels of private credit to GDP. Dashed lines exhibit 95% confidence

²¹ The share of external finance has a mean of -0.13 and a standard deviation of 0.738.

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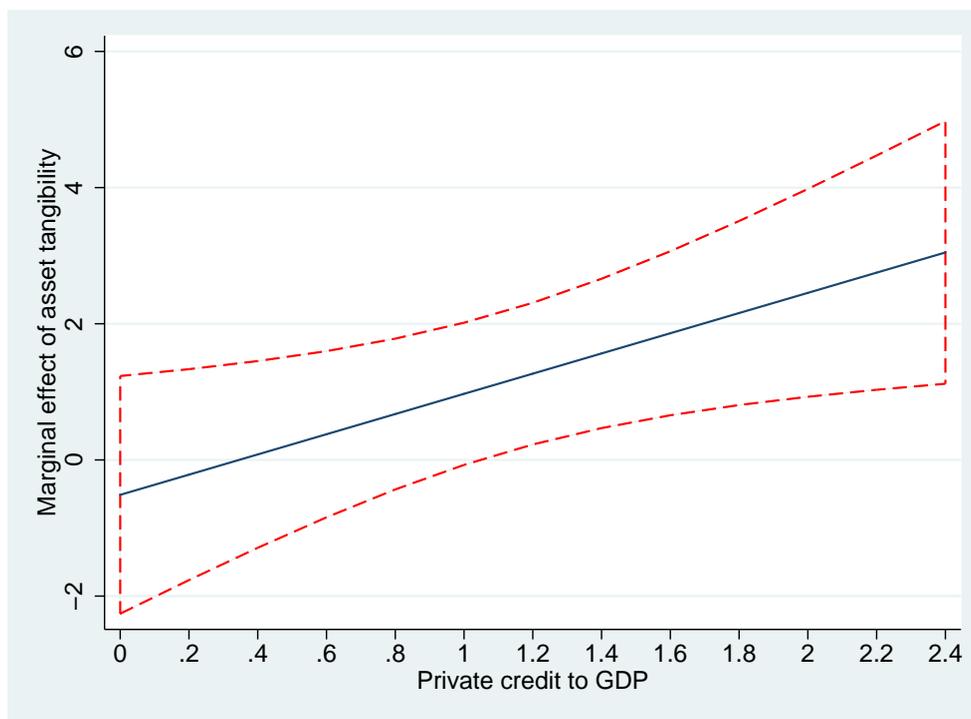


Figure 2: Marginal effect of asset tangibility on the share of external finance over a varying range of private credit to GDP with 95% CIs

intervals. This shows that as a country's financial system improves, the marginal effect of tangible assets on the share of external funds 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 cheaper access to external finance due to financial development. I observe that in column (2) of Table 4, the share of external capital is estimated to decrease by 0.017 for a

100 percentage points increase in private credit to GDP.²² However, the marginal effect is not statistically significant. An even 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 the negative effect of financial development can be avoided in the industries with a reasonably high level of asset tangibility.

In Table 4, I also find large explanatory power of firm profitability, which is proxied by return on assets. According to standard capital structure theories (e.g., Myers and Majluf, 1984), the more profitable the firm, the greater the availability of internal capital, and hence firms will opt for internal over external financing. Thus, there is a negative relationship between profitability and the share of external funds, which is consistent with the result in Table 4. In summary, the results presented in Table 4 suggest a significant role of asset tangibility and its interaction with financial development in firms' choice of external funding.

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) sample are shown in Table A.7, whereas the results for the sub-sample of 10 countries and 25 sectors considered in this paper are in Table A.8. We can see that the main results in Manova (2013) are unchanged when using the industry-specific measure of asset tangibility.

Table 5 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. This suggests that financial development alone may lead to lower exports, but it can be avoided in industries with a reasonably high level of asset tangibility which mitigates some of the constraints of exporting. Once the interaction effect is added, what is most crit-

²² Estimated marginal effect is evaluated at the means of the variables.

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Table 5: 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	-1.654 (-7.17)***	-0.718 (-3.50)***	-2.486 (-9.76)***
Fin devt × Tang	2.484 (4.74)***	2.104 (4.39)***	4.504 (7.60)***
(Log) # Establish	0.685 (21.47)***		0.696 (20.52)***
(Log) Output		0.541 (21.23)***	
p			0.009 (2.44)**
LGDPE	0.239 (1.42)	0.369 (2.91)***	0.069 (0.39)
LGDPI	0.662 (4.98)***	0.761 (6.69)***	0.631 (3.10)***
LDIST	-1.423 (-18.27)***	-1.386 (-25.29)***	-1.411 (-16.35)***
Controls:			
Exporter × Sector FE	Y	Y	Y
Importer FE	Y	Y	Y
Year FE	Y	Y	Y
R-squared	0.68	0.70	0.69
# 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, importer fixed effects, and cluster errors by exporter-importer pair. T-statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

ical is the significance of the interaction term, not the terms that are used to compute the interaction. Whether I center asset tangibility by subtracting its mean or not, the interaction term stays positive and significant. In addition, a qualitatively similar result is obtained using the rankings of asset tangibility, instead of its actual values.²³ This result does not depend on the inclusion of the interaction term between financial development and the share of external finance (results available upon request). To assess the economic significance of the interaction term, I consider a country and an industry with an average level of private credit to GDP and an average level of asset tangibility. Using the estimates in column (3) of Table 5, the mean of the private credit to GDP ratio is 0.9995 and the average level of asset tangibility is 0.3511. Therefore, “other chemicals” industry (ISIC 352) in Malaysia in 1993 is an example with values relatively close to the average levels of both variables. The estimates imply that a one standard deviation increase in asset tangibility (0.0935) would lead to an approximately 42% increase in bilateral exports—quite an economically significant effect.²⁴ A one standard deviation increase in asset tangibility would lead to an approximately 17% increase in bilateral exports at the first quartile of the distribution of private credit (South Korea in 1994) and a 45% increase at the third quartile (Hong Kong in 1996). This result suggests that the collateral role of tangibles is actually strengthened (rather than weakened) by improvements in financial markets which enable firms to pledge a broader variety of assets as collateral. It may be because financial development, resulting in a larger pool of loan applicants, also increases the amount of collateral which is required to distinguish low-risk from high-risk borrowers. A similar argument can be found in [Bester \(1987\)](#). 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 ulti-

²³ This exercise mitigates concerns with the stability of the measure across countries.

²⁴ This result comes from the following computation:

[Interaction coefficient \times Average private credit/GDP \times (Average asset tangibility + One standard deviation)] – [Interaction coefficient \times Average private credit/GDP \times Average asset tangibility]
= $4.504 \times 0.9995 \times 0.0935 \approx 0.42$. Similarly, I obtain 23% and 24% increase for columns (1) and (2).

mately 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.

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 has a significant negative effect on bilateral exports.²⁵ Recent research has 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.²⁶ One plausible 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. [Deidda \(2006\)](#) and [Tobin \(1984\)](#) suggest that there are several countries for which a smaller financial sector would actually be desirable. The developed countries' outsourcing of low-tech, labor-intensive production to developing countries seems to reflect this finding.

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. This result is the same as that obtained by [Manova \(2013\)](#).

Table 6 presents the coefficients of the interaction terms of financial development and

²⁵ This result is consistent with the negative sign of the financial development variable on exports in some of [Manova's \(2013\)](#) specifications.

²⁶ Although they are not directly related to trade, recent studies find similar results 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.

asset tangibility by sector. The columns correspond to those in Table 5. In column (2) of Table 6, 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.

I begin the robustness checks by reproducing all of the main results using alternative measures of financial development. The coefficients for the main interaction variable 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 Table A.9).

In addition, I 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.

In Table A.11, I show that the results are also robust across different sub-samples. I divide the importers into two groups based on whether real GDP is above or below the sample median in 2006. The previous literature finds that richer countries tend to import higher-quality products (Hallak, 2006). Since it is more costly to produce higher-quality products, financial frictions may be more important for firms exporting to richer countries. The coefficients on the interaction term tend to be slightly larger for the high income group, but the same qualitative pattern of results is obtained in the two sub-samples.

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.12, I include the interactions of tangibility with the log of real GDP and the private credit to GDP ratio of the exporting country. $Findevt \times Tang$ remains positive and significant at the 1% level, regardless of the inclusion of $LGDPE \times Tang$.

Table 6: 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 \times Sector, Importer, Year 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%.

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.13, I include the interactions of the private credit to GDP ratio with asset tangibility and return on assets. $Findevt \times Tang$ remains positive and significant at the 1% level, regardless of the inclusion of $Findevt \times Return\ on\ assets$.

Overall, the evidence suggests that relaxing the assumption of the 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, besides those focusing on the role of financial constraints in trade, such as [Manova \(2013\)](#).

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. In addition, the evidence that firms in developing countries tend to have a higher proportion of fixed assets and fewer intangibles than firms in developed countries ([Demirgüç-Kunt and Maksimovic, 1999](#); [Fabbri and Menichini, 2010](#)) suggests that financial sector development may matter more for developing countries with respect to increasing export values.

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 dis-

tributed across industries depending on the 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 arises 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 they 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. However, note that there is no other cross-country dataset, including both listed and non-listed firms, with wider coverage.

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.

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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 $s(q_f(x)) = E(q_f(x))/w f_e$, 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

$$\frac{\partial E(q_f(x))}{\partial \nu} = \frac{(D + (\nu - 1) \frac{\partial D}{\partial \nu}) [(\nu - 1) - \delta(\nu r_0 + 1)] - [(\nu - 1)D - \delta t_s w f_e](1 - \delta r_0)}{[(\nu - 1) - \delta(\nu r_0 + 1)]^2}. \quad (27)$$

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

Using these expressions, we can rewrite (27):

$$\frac{\partial E(q_f(x))}{\partial \nu} = \frac{-\delta(r_0+1)D + \delta^2 \frac{\tau w}{x} \sigma q_f(x)(r_0+1) + \delta t_s w f_e(1-\delta r_0)}{[\nu-1-\delta(\nu r_0+1)]^2}. \quad (28)$$

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

$$\frac{\partial^2 E(q_f(x))}{\partial \nu \partial t_s} = \frac{\delta w f_e(1-\delta r_0)}{[(\nu-1)-\delta(\nu r_0+1)]^2} > 0. \quad (29)$$

□

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 ,

$$\frac{\partial LHS}{\partial \nu} = \frac{\mu w^* L^*}{P^{*1-\sigma}} (1-\sigma) \left[\frac{\sigma}{\sigma-1} \frac{\tau w}{x} \frac{\nu-1}{\nu-1-\delta(\nu r_0+1)} \right]^{-\sigma} \frac{\sigma}{\sigma-1} \frac{\tau w}{x} \frac{-\delta(1+r_0)}{[\nu-1-\delta(\nu r_0+1)]^2} > 0. \quad (30)$$

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 ,

$$\frac{\partial RHS}{\partial \nu} = \frac{-(1+r_0)[w^* f_{ex} - wA - \pi_d(x)] + t_s w f_e (1-\delta r_0)}{[\nu-1-\delta(\nu r_0+1)]^2} \quad (31)$$

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

Taking the second cross-partial derivative,

$$\frac{\partial^2 RHS}{\partial \nu \partial t_s} = \frac{w f_e (1-\delta r_0)}{[\nu-1-\delta(\nu r_0+1)]^2} > 0. \quad (32)$$

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):

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

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

By Leibniz integral rule²⁷,

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

which is positive if

$$\begin{aligned}
 &\frac{\mu w^* L^*}{P^{*1-\sigma}} \left[\frac{\sigma}{\sigma-1} \tau w c_D \frac{\nu-1}{\nu-1-\delta(\nu r_0+1)} \right]^{1-\sigma} \frac{k}{c_M} \left(\frac{c_D}{c_M} \right)^{k-1} \frac{\partial c_D}{\partial \nu} > - \frac{\mu w^* L^*}{P^{*1-\sigma}} \left[\frac{\sigma}{\sigma-1} \tau w \frac{\nu-1}{\nu-1-\delta(\nu r_0+1)} \right]^{-\sigma} \\
 &\sigma \tau w \frac{\delta(1+r_0)}{[\nu-1-\delta(\nu r_0+1)]^2} \frac{k}{(c_M)^k} \frac{c_D^{1-\sigma+k}}{1-\sigma+k}.
 \end{aligned}$$

²⁷ $\frac{d}{dx} \left(\int_{a(x)}^{b(x)} f(x,t) dt \right) = f(x, b(x)) b'(x) - f(x, a(x)) a'(x) + \int_{a(x)}^{b(x)} \frac{\partial}{\partial x} f(x,t) dt$

That is,

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

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

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

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

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

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

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

where

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

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

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

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

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

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

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

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

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

which is positive.

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

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

which is positive when $\frac{\frac{\delta(\sigma-1)(1+r_0)}{\nu-1} - (1-\delta r_0)}{\nu-1-\delta(\nu r_0+1)} + (1-\sigma+k) \frac{1}{c_D} \frac{\partial c_D}{\partial \nu} - \frac{\frac{\partial M}{\partial \nu} c_D^{1-\sigma} + M(1-\sigma) c_D^{-\sigma} \frac{\partial c_D}{\partial \nu} + \frac{\partial N}{\partial \nu}}{M c_D^{1-\sigma} + N} < 0$.

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 (EF)

I sort firms into countries based on their headquarters location (*loc* in Compustat).²⁸ 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.²⁹

Cash flow from operation (CF) is defined as

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

²⁸ The results are virtually the same if I use the country of incorporation (*fic* in Compustat).

²⁹ Additions to property, plant, and equipment generally include material, labor and overhead.

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*).³⁰ 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 data³¹, *Funds From Operations - Total* is the sum of deferred taxes (*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 EF measure, both capital expenditures and cash flow are summed up over the relevant years. The industry-level measure is the EF 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](#)

³⁰ [Rajan and Zingales \(1998\)](#) do not indicate which exact variable they take for inventories, receivables and payables.

³¹ Since Compustat North America provides only limited data for the rest of the world, Compustat Global is used.

Zingales, 1998).

A.6 PATTERN OF EXTERNAL FINANCE SHARE AND ASSET TANGIBILITY ACROSS INDUSTRIES IN THE U.S.

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, the 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 (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	1987-2006	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	1987-1996	1997-2006	1987-2006	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).

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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.

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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

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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

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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

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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: 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.
China	-0.03	0.19	Singapore	0.31	0.22
Japan	-0.03	0.16	Thailand	0.48**	0.48**
France	0.02	0.03	Malaysia	0.56***	0.60***
Singapore	0.10	0.16	Hong Kong	0.65***	0.71***
Thailand	0.18	0.45**	Japan	0.65***	0.71***
Korea, Rep.	0.30	0.02	India	0.66***	0.67***
India	0.35*	0.09	Korea, Rep.	0.70***	0.82***
Hong Kong	0.73*	0.11	France	0.70***	0.80***
Malaysia	0.85***	0.42**	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 U.S. for countries that have more than 15 sectors in common with the U.S. with more than one firm 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%.

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Table A.6: Summary statistics

Country	Private credit to GDP		Real GDP (at 2005 constant prices; billions)		# Trade partners
	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

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

	Financial development measure: Private credit			Proxy for the sectoral price index p		
	Dependent variable: (log) bilateral total exports by sector			Importer's consumption by sector		
	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 (15.49)***	0.753 (12.30)***	0.743 (11.64)***	0.769 (12.58)***	0.840 (14.13)***	
Fin devt × Tang	-3.102 (-28.41)***	-2.394 (-18.13)***	-2.472 (-18.37)***	-2.465 (-18.30)***	-2.726 (-21.37)***	
(Log) # Establish	0.356 (42.85)***		0.360 (42.18)***	0.360 (42.91)***	0.360 (44.47)***	
(Log) Output		0.341 (18.93)***				
p			0.008 (7.00)***	0.170 (26.58)***		
LGDP	0.960 (16.89)***	1.087 (16.26)***	1.081 (16.15)***	1.091 (16.40)***	1.128 (16.73)***	
LGDP	0.940 (16.46)***	0.973 (14.29)***	0.935 (14.24)***	0.704 (10.18)***	0.994 (14.49)***	
LDIST	-1.368 (-78.69)***	-1.406 (-72.16)***	-1.407 (-74.10)***	-1.411 (-71.69)***	-1.440 (-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	0.58	0.57	0.60	
# observations	861,380	621,333	579,485	589,205	621,333	
# exporter-importer clusters	9343	7867	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.8: 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)

	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 (-1.36)	-0.840 (-5.94)***	-0.827 (-5.91)***	-0.783 (-5.60)***	-0.796 (-6.49)***
Fin devt × Tang	-1.927 (-7.34)***	-0.830 (-2.93)***	-0.977 (-3.41)***	-0.940 (-3.29)***	-1.126 (-5.55)***
(Log) # Establish		0.528 (25.84)***	0.535 (27.40)***	0.531 (26.89)***	0.558 (36.11)***
(Log) Output					
p		0.657 (40.83)***			
LGDP	1.618 (15.34)***	1.323 (9.33)***	0.005 (1.77)*	0.168 (11.25)***	1.438 (10.03)***
LGDP	1.203 (10.34)***	1.349 (10.09)***	1.159 (8.76)***	1.129 (8.50)***	1.330 (9.84)***
LDIST	-1.397 (-24.69)***	-1.422 (-14.60)***	-1.430 (-14.36)***	-1.430 (-14.61)***	-1.433 (-14.31)***
Controls:					
Exporter, Year FE	Y	Y	Y	Y	Y
Importer, Sector FE	Y	Y	Y	Y	N
Importer × Sector FE	N	N	N	N	Y
R-squared	0.64	0.63	0.65	0.64	0.70
# observations	182,370	121,364	113,439	115,070	121,364
# exporter-importer clusters	1,158	1,039	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%.

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Table A.9: Robustness: different financial indicators

Dependent variable: (log) bilateral total exports by sector	(1)	(2)	(3)
<i>Financial development measure: Stock market capitalization to GDP</i>			
Fin devt	-0.585 (-9.34)***	-0.602 (-9.67)***	-0.888 (-12.19)***
Fin devt × Tang	1.232 (7.51)***	1.160 (7.02)***	2.003 (10.53)***
R-squared	0.67	0.70	0.69
# observations	107,659	142,929	93,077
<i>Financial development measure: Stock market total value traded to GDP</i>			
Fin devt	-0.497 (-6.61)***	-0.456 (-6.13)***	-0.805 (-9.46)***
Fin devt × Tang	0.853 (4.60)***	0.666 (3.60)***	1.621 (7.74)***
R-squared	0.67	0.70	0.69
# observations	107,659	142,929	93,077
<i>Financial development measure: Rule of law</i>			
Fin devt × Tang	3.867 (3.50)***	3.090 (2.83)***	7.290 (5.91)***
R-squared	0.65	0.65	0.67
# observations	12,186	12,160	11,060
<i>Financial development measure: Financial Markets Access</i>			
Fin devt	-2.493 (-11.41)***	-0.538 (-3.64)***	-3.529 (-13.84)***
Fin devt × Tang	6.014 (10.12)***	0.957 (2.59)**	8.799 (12.72)***
R-squared	0.67	0.70	0.69
# 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 × Sector, Importer, Year 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%.

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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	0.578 (2.37)**	0.461 (2.14)**	-0.344 (-1.26)
Fin devt × Tang	0.714 (1.34)	1.950 (3.96)***	3.032 (4.82)***
(Log) # Establish	0.485 (16.41)***		0.481 (14.81)***
(Log) Output		0.454 (18.65)***	
p			0.007 (1.69)*
LGDPE	1.105 (5.55)***	0.362 (2.80)***	1.093 (5.33)***
LGDPI	0.585 (3.78)***	0.739 (5.72)***	0.580 (2.56)**
LDIST	-1.318 (-19.95)***	-1.345 (-25.38)***	-1.294 (-18.95)***
Controls:			
Exporter times Sector FE	Y	Y	Y
Importer FE	Y	Y	Y
Year FE	Y	Y	Y
R-squared	0.67	0.70	0.69
# 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%.

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Table A.11: Robustness: sample split based on importer real GDP

	Importer real GDP					
	High			Low		
	(1)	(2)	(3)	(1)	(2)	(3)
Fin devt	-1.775 (-5.45)***	-0.554 (-1.87)*	-2.651 (-7.54)***	-1.323 (-4.12)***	-0.619 (-2.18)**	-1.652 (-4.55)***
Fin devt × Tang	2.573 (3.73)***	1.758 (2.78)***	4.907 (6.30)***	2.024 (2.49)**	1.927 (2.62)***	2.396 (2.60)***
R-squared	0.72	0.75	0.74	0.52	0.55	0.55
# observations	63,922	81,044	57,835	61,819	87,140	50,006

Notes: The dependent variable is (log) bilateral exports (in \$1,000s) in a 3-digit ISIC sector and year 1987–2006. Exporter × Sector, Importer, Year 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 economic development

Financial development measure: Private credit			
Dependent variable: (log) bilateral total exports by sector			
	(1)	(2)	(3)
Fin devt	-1.508 (-5.90)***	-0.678 (-2.93)***	-1.903 (-6.91)***
Fin devt × Tang	2.073 (3.27)***	1.990 (3.30)***	2.863 (4.13)***
LGDPE × Tang	0.505 (1.02)	0.143 (0.29)	2.050 (3.52)***
R-squared	0.68	0.70	0.69
# observations	125,741	168,184	107,841
# exporter-importer cluster	1,511	1,546	1,277

Notes: The dependent variable is (log) bilateral exports (in \$1,000s) in a 3-digit ISIC sector and year 1987–2006. Exporter × Sector, Importer, Year 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%.

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Table A.13: 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	-2.583 (-9.01)***	-1.417 (-5.78)***	-3.270 (-10.89)***
Fin devt \times Tang	3.193 (5.84)***	2.557 (5.22)***	5.107 (8.43)***
Fin devt \times Return on assets	10.199 (6.30)***	7.862 (5.58)***	8.529 (5.19)***
R-squared	0.68	0.70	0.69
# 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 \times Sector, Importer, Year 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%.

A.7 FURTHER RESULTS

Asset tangibility, or the ratio of tangible fixed assets to total assets, may not account for the redeployability of tangible assets. Tangible assets that could be used within different industries should suggest higher debt capacity for the firm (Almeida and Campello, 2007; Benmelech et al., 2005; Braun, 2003). The impact of asset specificity (opposite of asset redeployability) will be analyzed in this subsection. Unlike Compustat North America, Compustat Global data does not break down tangible assets into their identifiable parts, such as land and building, machinery and equipment, and other assets. Due to this data constraint, I turn to total assets and look at how the specificity of assets interacts with financial development. It may make more sense given that banks today are making loans using intangible assets as collateral.

Firm-specific assets like R&D, tailored to the firm's strategy and technology, tend to be difficult for outsiders to monitor, understand, and evaluate. These assets are less redeployable to other uses and cannot be readily used as collateral for borrowing than general purpose assets (Balakrishnan and Fox, 1993; Kochhar, 1997; Močnik, 2001). Therefore, I proxy asset specificity by R&D intensity, which is defined as R&D expenditures divided by total capital expenditures. See Ilyina and Samaniego (2011) and Samaniego and Sun (2015). Considering that firms in R&D-intensive industries located in developing countries do not perform as much R&D as firms from the same industries in the U.S., I construct the country- and industry-specific measure of R&D intensity based on the Rajan and Zingales (1998) method.

Since higher R&D intensity implies higher asset specificity and lower ability to raise funds (asset tangibility), the basic prediction is that financial development will more adversely affect exports of industries with higher R&D intensity. In Table A.14, the coefficient of the interaction term of financial development and R&D intensity is significantly negative, as predicted. This result strengthens the collateral channel shown above in this paper.

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Table A.14: Estimated coefficients from OLS models of trade by financial constraints (using the country- and industry-specific measure of R&D intensity)

Financial development measure: Private credit			
Dependent variable: (log) bilateral total exports by sector			
	(1)	(2)	(3)
Fin devt	-1.026 (-8.41) ^{***}	-0.168 (-1.33)	-1.105 (-8.83) ^{***}
Fin devt × R&D intensity	-0.923 (-4.75) ^{***}	-0.656 (-3.65) ^{***}	-1.145 (-5.91) ^{***}
(Log) # Establish	0.834 (22.05) ^{***}		0.904 (22.67) ^{***}
(Log) Output		0.682 (22.18) ^{***}	
p			0.007 (1.62)
LGDPE	0.393 (2.26) ^{**}	0.423 (3.12) ^{***}	0.176 (0.97)
LGDPI	0.622 (4.32) ^{***}	0.736 (6.06) ^{***}	0.590 (2.75) ^{***}
LDIST	-1.469 (-18.77) ^{***}	-1.427 (-24.77) ^{***}	-1.454 (-16.69) ^{***}
Controls:			
Exporter × Sector FE	Y	Y	Y
Importer FE	Y	Y	Y
Year FE	Y	Y	Y
R-squared	0.68	0.71	0.70
# observations	99,122	140,203	84,923
# exporter-importer clusters	1392	1426	1177

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. R&D intensity is defined as R&D expenditures divided by total capital expenditures. *(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, importer fixed effects, and cluster errors by exporter-importer pair. T-statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.