# Trade and Firm Financing

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**Abstract**
Financial frictions can pose a barrier to export entry by altering a firm's long-term capital structure. The focus on long-term firm financing is motivated by our empirical finding that exporting firms tend to be more leveraged than non-exporting firms in terms of long-term debt, as distinct from short-term working capital. We explain this fact by marrying a corporate finance model of capital structure, featuring an endogenous choice between equity and long-term debt, with a trade model featuring heterogeneous firms and export entry. The model predicts that exporting firms will prioritize reducing the cost of long-term capital over relaxing a short-term working capital constraint to scale up production.

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## 1. Introduction

The trade collapse during the global financial crisis of 2007-9 served to highlight the importance of financial considerations in shaping international trade.[1] Numerous works in the trade literature have studied how limited access to short-term external financing, as working capital to cover the costs of production and shipping, creates a barrier to exporting. (See, for example, Amiti and Weinstein, 2011; Manova, 2013; Manova, et al., 2015; Minetti and Zhu, 2011.) In particular, Kohn et al. (2016) presents this short-term financial friction as an alternative to the one-time sunk export entry cost, which is the more standard barrier to export entry in earlier trade literature.[2]

This paper raises the question of how firms go about financing the payment of the one-time sunk entry costs. It argues that the implications of long-term firm financing used to pay sunk entry costs are also consequential for export participation. Intuitively, if external financing is needed for working capital to pay for labor or shipping costs before sales are realized later in a given period, then the role for external financing likely is even more relevant when a one-time sunk entry cost needs to be paid long in advance of the stream of future profits that motivates the entry decision. However, existing trade literature studying financial frictions generally models only the external financing of short-term working capital recurring each period, not the financing of the long run, one-time sunk cost. Even while sunk entry costs often are present in these models, there typically is no discussion of how firms pay for them.[3]

As motivation for emphasizing long-term firm financing, we present empirical

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[1] See for example Chor and Manova (2012).
[2] See for example Das et al. (2007); Alessandria and Choi (2014).
[3] Even though Kohn et al. (2016) posit a general theoretical model with sunk cost in the working capital constraint, this is only a device to nest their two cases; the models they simulate either include a sunk cost or financial frictions, never both together. Further, we will argue that the financing of sunk cost should be viewed as a combination of equity and long-term debt, not financed out of short-term working capital. Chaney (2016) also considers entry costs to be covered by external borrowing, but precludes any capital structure choice.

evidence, using financial data of public U.S. manufacturing firms which distinguish between long-term debt with maturities of greater than a year and shorter-term debt like working capital. Not only is it immediately clear that the average firm's long-term debt is multiple times larger than the short-term debt, but we find that exporters on average have higher leverage ratios in terms of long-term debt compared to non-exporters, while we do not find this for short-term debt. Regression analysis indicates that this higher leverage is associated with the larger size of exporting firms. This "size effect" is not surprising, since the corporate finance literature has documented that larger firms tend to choose a capital structure with more leverage, combined with the fact that the trade literature has documented that exporters tend to be larger than non-exporters.[4] In addition, we find that the effect of size on leverage is even stronger for exporting firms than for non-exporters. Overall, regression estimates imply that export activity raises long-term leverage for firms large enough for the size effect to be strong, while it may lower leverage for small firms.

The theoretical contribution of the paper is to develop a model that is consistent with the findings above, by marrying a corporate finance model featuring a capital structure choice between equity and long-term debt, with a trade model featuring heterogeneous firms and export entry.[5] In particular, the model includes a standard short-term working capital constraint, where access to intratemporal debt to finance current production must be secured with collateral in the form of firm equity. Importantly, working capital must cover per-period fixed production costs and fixed trade costs. Firms also face a capital structure decision regarding long-term firm financing, issuing both intertemporal (interest bearing) debt as well as selling firm equity. The choice between debt and equity financing has consequences for real economic activity in our model, since tax benefits of debt

[4] See Xu, 2012; Kurshev and Strebulaev, 2015.
[5] The model builds on the closed economy model of Bergin, Feng and Lin (2018a), but studies heterogeneous firms, as well as an open economy setting with financing related to export activity.

suspend the Modigliani-Miller (MM) theorem.[6] The firm capital structure decision involves a tradeoff: long-term debt is cheaper than equity financing due to tax advantages, but it also lowers the equity collateral available to secure short-term working capital.

An entry condition specifies that firms enter the domestic market if the expected firm value equals a one-time sunk entry cost; likewise for entering the export market, if the additional value of exporting exceeds a one-time sunk export entry cost. Given that the entry condition equates entry cost to firm value, and the firm financing decision divides this firm value into debt and equity, these conditions together describe the means by which the marginal firm finances payment of the sunk entry cost.

We study the long-run implications for participation in the export market by solving for the general equilibrium of the model in steady state. We find that endogenizing the capital structure actually makes it easier to solve for equilibrium, as it allows us to apply the standard approach of Melitz (2003) to aggregate over heterogeneous firms even in the presence of firm financial constraints.

The model provides a ready explanation for the empirical finding above that exporting firms are more leveraged. As the size of firm sales grows with the firm-specific productivity level, profits and hence firm value grow proportionately. But the presence of fixed costs implies that the need for working capital to finance production costs grows less than proportionately with sales. So there is less benefit from issuing equity as collateral to secure short-term working capital, and the firm instead issues long-term debt to reap tax benefits, thus raising firm leverage. This logic applies in particular to exporters, since the entry condition implies more productive and hence larger firms with greater firm value self-select into exporting, and because of additional fixed costs associated with exporting.

[6] This is consistent with developments in the corporate finance literature, where there is ample empirical evidence of failure in Modigliani-Miller (see Rajan and Zingales (1995) for example), as well as extensive research on capital restructuring between debt and equity (see Strebulaev and Whited (2011) for a survey).

A lesson from the model regards the tradeoff firms face between short-term and long-term financing: when capital structure is endogenous, it is generally optimal for firms to adjust the level of equity collateral to nearly fully offset any changes in the tightness of the short-term financing (working capital) constraint. One implication is that larger and financially stronger firms should not take advantage of their more relaxed financial constraints to scale up production closer to the unconstrained optimal, but they instead should increase long-term leverage to reap the tax benefits. A second implication is that even if exporters tend to face higher working capital needs than non-exporters, optimal capital structure will tend to adjust to augment equity collateral. This result emphasizes that firms optimizing capital structure have ways to work around the short-term financial constraints emphasized in recent research. However, we show that this capital restructuring raises the cost of long-term capital used to pay sunk entry investment, which poses a different financial constraint on export participation than that emphasized in recent work.

Our paper finds motivation in the extensive empirical literature studying how financial frictions influence international trade. Part of this literature finds that firm financial health and financial market access increase export market participation, using firm-level data from a variety of countries (Bellone, et al. (2010), Berman and Héricourt (2010), Muûls (2015), Paravisini et al. (2015)), or using sector-level or aggregate trade flow data (Manova (2008)).[7] However, the literature also includes work showing a relationship that runs the other direction, finding that stronger firm financial health may be a consequence of export status. This includes Greenaway et al. (2007), as well as Campa and Shaver (2002), Bridges and Guariglia (2008), and Blalock and Roy (2007).[8] This mix of empirical findings points

[7] See the online appendix 3 for a more complete literature survey of these papers.

[8] The fact we distinguish between short-term and long-term finance allows us to be consistent with the finding of Greenaway et al. (2007). They study short-term debt, and their finding of lower leverage for exporters is consistent with our empirical estimates of short-term leverage; however, we find that overall leverage is greater for exporters than non-exporters, and this is driven by the fact that long-term leverage is much higher, and this dominates the overall result.

to the need for theory to understand how measures of financial health, in particular leverage, are endogenous results of firm decisions rather than exogenous firm characteristics.

Our work is also related to recent theoretical research. Kohn et al. (2016) examines the relevance of financial frictions on working capital in shaping new exporter dynamics. Brooks and Dovis (2020) show that allowing future profitability to affect firms' ability to borrow can help account for the fact that access to credit affects both export participation and export value. Manova (2013) and Chaney (2016) show that more productive firms and less credit-constrained firms will be more likely to export. We differ from all these in introducing a capital structure choice between debt and equity for long-term firm financing and studying the financing of sunk entry costs.[9]

Our theoretical argument has roots in the large corporate finance literature studying capital structure as an optimal choice, which contrasts with recent work on trade financing, in that high firm leverage can reflect financial strength rather than weakness. Early work focusing on "tradeoff theory" argued that international diversification of sales should strengthen a firm's credit-worthiness, and that firms could take advantage of this financial strength to reap the tax benefits of debt (Shapiro, 2013). This effect can be offset by agency costs of business in a foreign country, which could reduce credit-worthiness.[10]

Broadly speaking, empirical estimates of the effect of internationalization on leverage in the corporate finance literature vary by country. Work on U.S. firm data has found that internationalization tends to lower firm leverage, especially when size is controlled (see Burgman (1996) and Chen et al. (1997)). But work studying firm data from other countries

[9] Our result focusing on the long run is complementary rather than contradictory to that of Kohn et al. (2016), which focus on transition dynamics. For example, if we augment our model with adjustment costs for changing dividends, in order to introduce meaningful dynamics, the short-run of the model would be consistent with the result of Kohn et al. (2016). We also are related to theoretical work in Russ and Valderrama (2012) and Cho et al. (2019); however, they study a different financial choice, between alternative forms of debt finance, rather than equity versus debt.

[10] An alternative theoretical approach focuses on "pecking order," in which firms turn to external debt financing only as a last resort, so that leverage is a sign of financial weakness.

has found that internationalization raises firm leverage. (See Mittoo and Zhang (2008) for Canada, Saito and Hiramoto (2010) for Brazil, and Kwok and Reeb (2000) for a multi-country data set.) Most intriguingly, several recent papers find a nonlinear relationship, in which an initial level of internationalization reduces firm leverage, but a rising degree of internationalization is associated with higher leverage. (See Singh and Nejadmalayeri (2004) and Pacheco (2016); Chen et al. (1997) characterizes this finding as an empirical puzzle.) Our theory can be viewed as providing a theoretical explanation to this financial puzzle, derived from a standard international trade model.

The next section of the paper presents empirical work supporting our stylized fact. Section 3 presents the benchmark theoretical model. Section 4 uses numerical solutions to demonstrate the model can explain the key facts, along with sensitivity analysis to explore the mechanism. Section 5 discusses implications for how financial frictions interact with endogenous capital structure to pose a barrier to export entry. Section 6 concludes.

## 2. Empirical Motivation

We use a panel dataset which covers the financial data of public U.S. manufacturing firms from 1975 to 2014 to study the relationships of financial choice, firm size and trade behavior. Financial data come from Compustat.[11] Since our interest focuses on firms' choice between debt and equity financing, the leverage ratio in the benchmark model is defined as book debt to total assets, where book debt is defined as total asset minus book equity. We also consider measures of debt with varying maturities: short-term borrowing, long-term debt, debt in current liabilities, and book debt minus short-term borrowing.[12]

[11] The sample includes manufacturing firms (SIC: 2000-3999), where we drop firms that appear only once in the sample, have missing values for explanatory variables, and have negative values for the foreign income variable. See Appendix Table 4.1 (in the online appendix) for details of how the sample changes over time.

[12] Short-term borrowing represents the approximate average aggregate short-term financing outstanding during the company's reporting year, which is usually in the form of lines of credit with banks. Long-term debt represents debt obligations due more than one year from the company's balance sheet date or due after the current operating cycle. Debt in current liabilities represents the total amount of short-term notes and the

Table 1a reports summary statistics for the full sample of firms, and subsamples based on firms' export market participation.[13] Comparison of columns (2) and (3) indicates a clear pattern in terms of leverage among these groups. Exporters tend to be more leveraged than non-exporters in terms of a leverage ratio of overall book debt to overall firm value. As a metric for future comparison, the average leverage ratio of exporters divided by that for non-exporters is 1.062. A battery of difference-in-means tests in Table 1b all reject at the 1% significance level the null of equal average leverage ratios for exporters and non-exporters. Higher leverage among exporters applies also to the two categories listed as long-term debt and book debt minus short-term debt.

In contrast, exporters are less leveraged in measures of debt labeled as short term or current liabilities. We infer that the greater overall leverage of exporters compared to non-exporters is due to longer-term debt, and not due to greater short-term debt. This contrasts with the usual focus in the trade literature on working capital and trade credit, included in short-term debt, and instead suggests additional focus should be placed on the decisions determining longer-term forms of debt financing. To be clear, our data indicate that the absolute level of short-term debt per firm indeed is larger on average for exporting firms than non-exporters, but taken as ratio to total assets, short term debt is smaller for exporters.

Columns (4) and (5) report results for subsamples of newly exporting firms, and continuing exporting firms (where the former are defined as firms that export in year *t* but not *t-1*). The leverage ratios of these exporters are very similar to each other, and hence to the full sample of exporters discussed above. For our purposes, this supports the choice to use a model that does not focus on dynamics of new entry for the current issue at hand.

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current portion of long-term debt that is due in one year.

[13] We identify exporters as firms with positive values for the Compustat measure of firm-wide foreign income. Although a firm's foreign income may include income from exporting, FDI or both, we rely upon empirical findings that indicate that firms with positive FDI also tend to export (see Oberhofer and Pfaffermayr (2008) and Conconi et al. (2016)).

To investigate this pattern more systematically, we estimate panel regressions below:

$$Y_{j,t} = \alpha_0 + \alpha_1 size_{j,t} + \alpha_2 D\_\exp_{j,t} + F_j + \phi t + \varepsilon_{j,t}$$

where $Y_{j,t}$ is the leverage ratio of firm *j*, and $size_{j,t}$ is measured as the log of net sales of firm *j*. The regressor $D\_\exp_{j,t}$ indicates if the firm is an exporter. We include a firm fixed effect $F_j$ to control for the large set of firm-specific characteristics that the corporate finance literature has found to influence a firm's choice of leverage, such as industry and other firm characteristics that do not vary over time. A time fixed effect $t$ is included to help control for common trends and business cycle fluctuations.

Estimates of Eq. (1) are presented in Column (1) of Table 2, indicating that size is significantly and positively correlated with the leverage ratio ($\alpha_1 > 0$, significant at the 1% level). The estimate indicates that as the firm size doubles, the leverage ratio increases about 1.2 percentage points on average. This is not a surprise, as a standard finding in the corporate finance literature on firm capital structure is that firm size raises leverage (see Xu, 2012). Regression results also indicate that if the firm is an exporter, it has a higher overall book leverage ratio ($\alpha_2 > 0$, significant at the 1% level).

To discuss how the maturities of debt affect the results, we replace the leverage ratio in the benchmark regression by other measure of leverage ratios. Results in Table 2 indicate that firm size and the exporter dummy are not significantly correlated with short-term borrowing to total assets (see columns (2) and (4) in Table 2). However, as the term of debt becomes longer, the ratios of debt to total assets are consistently positively correlated with size and being an exporter (see Columns (3) and (5) in Table 2).

To allow for the possibility that firm size has a distinct effect on the leverage of exporters and non-exporters, we also estimate the following equation, which introduces a term interacting the measure of firm size with the firm's export status:

$$Y_{j,t} = \alpha_0 + \alpha_1 size_{j,t} + \alpha_2 D\_\exp_{j,t} + \alpha_3 size_{j,t} D\_\exp_{j,t} + F_j + \phi t + \varepsilon_{j,t}.$$

Results in Table 3 indicate that not only is the effect of size still significantly positive for overall leverage and for the two measures of long term leverage, but so is the interaction term of size with export status. This indicates that leverage rises with firm size faster for exporters than for non-exporters. However, the coefficient on export status alone has switched signs. This indicates that for small exporters, leverage is lower than for corresponding non-exporters, but for sufficiently large exporters, leverage for exporters is higher than for non-exporters.

The critical size at which an exporter will begin to have higher leverage is easily computed as $-\alpha_2/\alpha_3$. Regarding the level of overall book leverage in column (1), this critical size cutoff is 4.57; examination of average firm characteristics from Table 1a indicates that for an exporting firm with average size, their leverage is higher than if they were a non-exporter. This conclusion applies also to both measures of long-term leverage in columns (3) and (5); it is mixed for our measures of short-term leverage, applying to column (4) but not column (2). We conclude that for an exporter of average size, its export status will make it more leveraged than if it were not an exporter. Further, this higher leverage of exporters can be attributed to the nonlinear effect of firm size on leverage for exporters.[14]

## 3. Benchmark Model

The model considers a small open economy, where the home country is in financial autarky, but trades goods with the rest of world. The analysis will focus on the steady state solution to the dynamic model defined below, in which aggregate variables do not change over time.

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[14] See online Appendix 4 for empirical extensions. Appendix Table 4.2 shows that a higher value of a proxy for fixed costs raises a firm's short-term debt. This supports our model's specification of fixed costs in the working capital constraint. Appendix Table 4.3 reports results when including PPE (property, plant and equipment) in our benchmark regression, which show these costs are financed primarily in the form of long-term debt. This supports our view that PPE has similar implications to the sunk cost in our model. Similar results prevail when inventories are included (Appendix Table 4.4).

**3.1 Goods market structure**

The final good ( $Y_t$ ) is produced under perfect competition using intermediate goods, both domestically produced and imported, with a CES production function $Y_t \equiv \left[\left(Y_t^D\right)^{\frac{\sigma-1}{\sigma}} + \left(Y_t^{X*}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$. $Y_t^{X*}$ represents foreign exports (home imports), which we treat as a standardized unit without varieties; $Y_t^D$ is a composite of all domestically produced varieties of intermediate goods.

Among intermediates, we assume a one-to–one correspondence between a home variety and a firm producing it, indexed by $i$. Firms are heterogeneous in productivity, $z_i$. Let $I_t^x$ represent the set of indexes of firms that export, and $I_t^{nx}$ the set that are non-exporters. For an exporting firm, $i \in I_t^x$, we denote the amount of production sold in the domestic market as $y_t^{xd}(z_i)$, and the amount for export as $y_t^{xx}(z_i)$. Production of a non-exporting firm is $y_t^{nx}(z_i)$. The aggregator for domestically produced goods ( $Y_t^D$ ) is: $Y_t^D = \left(\int_{i\in I_t^{nx}} \left(y_t^{nx}(z_i)\right)^{\sigma} di + \int_{i\in I_t^x} \left(y_t^{xd}(z_i)\right)^{\sigma} di\right)^{\frac{\sigma}{\sigma-1}}$. The corresponding price index ( $P_t$ ) is:

$$P_t = \left(\int_{i\in I_t^{nx}} \left(p_t^{nx}(z_i)\right)^{1-\sigma} di + \int_{i\in I_t^x} \left(p_t^{xd}(z_i)\right)^{1-\sigma} di + \left(P_t^{x*}\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}}, \tag{1}$$

and the implied relative demand functions for different products are

$$y_t^{nx}(z_i) = \left(p_t^{nx}(z_i)/P_t\right)^{-\sigma} Y_t \tag{2}$$

$$y_t^{xd}(z_i) = \left(p_t^{xd}(z_i)/P_t\right)^{-\sigma} Y_t \tag{3}$$

and

$$Y^x = \left(P^x/P^*\right)^{-\sigma^*} Y^*, \tag{4}$$

where $p_t^{nx}(z_i)$, $p_t^{xd}(z_i)$, and $P_t^{x*}$ are the domestic market prices of the products produced by a home non-exporter, home exporter and foreign exporter, respectively.

The corresponding foreign market demand for domestic exports ( $y_t^{xx}(z_i)$ ) is

$$y_t^{xx}(z_i) = \left(p_t^{xx}(z_i)/P_t^*\right)^{-\sigma^*} Y_t^* = \left(p_t^{xx}(z_i)/P_t\right)^{-\sigma^*} \left(P_t/P_t^*\right)^{-\sigma^*} Y_t^*, \tag{5}$$

where $p_t^{xx}(z_i)$ is the foreign market price for home exporter with a productivity $z_i$, and $P_t^*$ is the Foreign price index. $Y_t^*$ is the foreign market size. The elasticity of demand facing firms in the world market ($\sigma^*$) is distinct from that in the home market ($\sigma$).

### 3.2 Intermediate goods sector

#### 3.2.1 Firm dynamics

Following Chaney (2008), we assume that the total mass of potential new entrants, $M_{et}$, is proportional to the national income.[15] Firms are assigned a random productivity level, $z_i$, from a common cumulative distribution function $G(z)$.[16] Entrants then pay a one-time sunk cost, $K_t^E$, if they wish to produce and sell in the domestic market, and pay an additional one-time sunk export entry cost, $K_t^{EX}$ if they wish to sell in the foreign market.[17] Since we limit our study to the steady-state case in which there are no aggregate shocks and in which firm productivity remains fixed, we follow Melitz (2003) in specifying endogenous firm exit only at the initial point of the productivity draw; the only reason for exit of a producing firm is if the firm is hit by an exogenous death shock.

The entry decisions to domestic and export markets define the cut-off productivity levels of the marginal domestic producers (represented by the notation, $d$), $z_{dt}$, and the marginal exporters (represented by $x$), $z_{xt}$, respectively. As a result, $Ne_t$ new entrants successfully enter the domestic market, and $Ne_t^x$ new exporters enter the foreign market.

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[15] The particular value of the proportionality $M_e/Y$ has no effect on results we present, provided it is large enough to keep the domestic cutoff margin greater than the minimum value for which the Pareto productivity distribution, $G(z)=1-z^{-\theta}$, is defined ($z_d$ >1). As Chaney (2008) offers no suggestion for a value, we choose one to ensure consistent scaling to facilitate numerical solution: a value of $M_e/Y = 0.05$ ensures that for the range of $z_d$ in our exercises, the total mass of firms will be increasing with the income level.

[16] As discussed in Chaney (2008), this specification differs from Melitz (2003) which requires a sunk cost in order to take a productivity draw. It greatly simplifies analysis of domestic entry, and it is similar to Eaton and Kortum (2002) where the set of goods is exogenously given.

[17] We view both of these sunk costs as including a mix of intangible and physical capital. Augmenting our empirical regression with gross PPI (property, plant and equipment) suggests this more standard type of capital resembles our sunk cost in raising long-term debt (see Appendix 4). Including standard physical capital would be a worthwhile extension of the model, but is beyond the scope of the current paper.

After entry, a total mass $M_t = N_{t-1} + Ne_t$ of firms, including incumbents and new entrants, issue corporate bonds and stocks to adjust capital structure, hire labor and produce goods. When all markets clear, an exogenous death shock hits these firms with probability $\lambda$. The mass of firms and exporters surviving the death shock becomes $N_t$ and $N_t^x$, respectively, with $N_t = (1-\lambda)M_t$. Firm dynamics are thus characterized as follows:

$$N_t = (1-\lambda)\left(N_{t-1} + Ne_t\right), \tag{6}$$

$$N_t^x = (1\text{-}\lambda)\left(N_{t-1}^x + Ne_t^x\right), \tag{7}$$

$$Ne_t = p_{in,t} M_{et} \quad \text{with} \quad p_{in,t} = 1\text{-}G\left(z_{dt}\right), \tag{8}$$

$$\frac{N_t^x}{N_t} = \frac{1\text{-}G\left(z_{xt}\right)}{1\text{-}G\left(z_{dt}\right)}, \tag{9}$$

and

$$N_t^{nx} = N_t \text{-} N_t^x, \tag{10}$$

where $N_t^{nx}$ is the number of non-exporters surviving the death shock at the end of period $t$.

### 3.2.2 Firm enforcement constraint

Following Jermann and Quadrini (2009, 2012), we assume that firm $i$ uses debt ($b_t(z_i)$) and equity to finance production, where debt is preferred to equity because of a tax advantage. The effective gross interest rate for the debt is $R_t = 1 + r_t(1-\tau)$, where $\tau$ is the tax rate on corporate income. Additionally, each period a firm must pay a fixed cost $w_t f_t^d$ to produce domestically, and an extra fixed cost $w_t f_t^x$ if the firm also exports.

Firms must make factor payments, including variable and fixed production costs, at the beginning of each period before the realization of revenue. In addition to the inter-temporal debt, $b_t^k(z_i)$, $k = x, nx$ as described above, a firm must borrow an intra-period loan to pay a certain portion of the labor cost in advance ($\phi^d$ for domestic production and $\phi^x$ for export production), that is, $loan_t^{nx}(z_i) = \phi^d w_t l_t^{nx}(z_i) + \phi^d w_t f_t^d$ for non-exporter $nx$ and $loan_t^x(z_i) = \phi^d w_t\left(l_t^{xd}(z_i) + f_t^d\right) + \phi^x w_t\left(l_t^{xx}(z_i) + f_t^x\right)$ for exporter $x$, where $w_t$ is the level of real wage, and $l_t^k(z_i), k = nx, x$ is the labor input used by non-exporters and exporters. The intra-period loan is repaid at the end of each period and there is no interest.

Because firms may default on their debt repayments, their access to intratemporal loans to use as working capital is restricted by an enforcement constraint:

$$\xi E_t\left(m_{t+1}V_{t+1}^{nx}\left(b_t^{nx}(z_i)\right)\right) \geq \phi^d\left(w_t l_t^d(z_i) + w_t f_t^d\right) \text{ for non-exporters, and}$$

$$\xi E_t\left(m_{t+1}V_{t+1}^{x}\left(b_t^{x}(z_i)\right)\right) \geq \phi^d\left(w_t l_t^{xd}(z_i) + w_t f_t^d\right) + \phi^x\left(w_t l_t^{xx}(z_i) + w_t f_t^x\right) \tag{11}$$

for exporters. As in Bergin et al. (2018a), the collateral available to firms in securing their working capital is the end-of-period firm value, $E_t\left(m_{t+1}V_{t+1}^{k}\left(b_t^{k}(z_i)\right)\right)$, where

$m_{t+1} = \beta(1-\lambda)U_{C_{t+1}}/U_{C_t}$ is the discount factor, as the firms are owned by the household.

### 3.2.3 Firm production and pricing

Each firm produces a unique variety, requiring one factor, labor, with production function:

$$y_t^k(z_i) = A_t z_i l_t^k(z_i) \qquad \text{for } k = nx, xd$$

$$y_t^k(z_i) = A_t z_i l_t^k(z_i)(1-\tau_x) \text{ for } k = xx, \tag{12}$$

where $A_t$ is the aggregate productivity common to all firms, $\tau_x$ is the iceberg cost for firms engaged in exports, $l_t^{xx}(z_i)$ and $l_t^{xd}(z_i)$ are the labor inputs by exporters for the production in the export and domestic markets, respectively. Firm dividends ($d_t^k(z_i)$) are:

$$d_t^{nx}(z_i) = p_t^{nx}(z_i)y_t^{nx}(z_i)/P_t - w_t\left(l_t^{nx}(z_i) + f_t^d\right) - \left(b_{t-1}^{nx}(z_i) - b_t^{nx}(z_i)/R_t\right) \tag{13}$$

$$\begin{aligned} d_t^x(z_i) = {} & p_t^{xd}(z_i)y_t^{xd}(z_i)/P_t + p_t^{xx}(z_i)y_t^{xx}(z_i)/P_t - w_t\left(l_t^{xd}(z_i) + l_t^{xx}(z_i)\right) \\ & - b_{t-1}^x(z_i) + b_t^x(z_i)/R_t - w_t\left(f_t^d + f_t^x\right). \end{aligned} \tag{14}$$

A firm with productivity $z_i$ chooses pricing rule, $p_t^k(z_i)$, dividend payout, $d_t^k(z_i)$, and new debt, $b_t^k(z_i)$, to maximize the beginning-of-period firm value ($V_t^k\left(b_{t-1}(z_i)\right)$):

$$V_t^k\left(b_{t-1}^k(z_i)\right) = \max_{p_t^k(z_i), d_t^k(z_i), b_t^k(z_i)}\left(d_t^k(z_i) + E_t(m_{t+1}V_{t+1}^k\left(b_t^k(z_i)\right)\right), \quad k = nx, x, \tag{15}$$

subject to the enforcement constraint, (Eq. 11), market demand, (Eqs. 2-5), production technology (Eq. 12), and cash flow, (Eq. 13 - 14).

The optimization implies the following pricing rules

$$\frac{p_t^{nx}(z_i)}{P_t}=\frac{\sigma}{\sigma-1}\frac{w_t}{A_t z_i}\left(1+\phi^d \mu_t^{nx}(z_i)\right), \tag{16}$$

$$\frac{p_t^{xd}(z_i)}{P_t}=\frac{\sigma}{\sigma-1}\frac{w_t}{A_t z_i}\left(1+\phi^d \mu_t^{x}(z_i)\right), \tag{17}$$

$$\frac{p_t^{xx}(z_i)}{P_t}=\frac{\sigma^*}{\sigma^*-1}\frac{1}{(1\text{-}\tau_x)}\frac{w_t}{A_t z_i}1+\phi^x \mu_t^{x}(z_i), \tag{18}$$

$$\mu_t^k(z_i)=\frac{1/R_t-E_t m_{t+1}}{\xi_t E_t m_{t+1}} \qquad k=nx,x \tag{19}$$

where $\mu_t^k(z_i)$ is the Lagrange multiplier associated with the enforcement constraint. From Eq. (19), it can be seen that $\mu_t^{nx}=\mu_t^x=\mu_t$, independent of firm productivity and export activity. $\mu_t$ is the shadow price of the intra-period loan on firm value, and measures the relative cost of bond financing ($R_t$) to equity financing ($1/E_t m_{t+1}$), adjusted by the financial market condition ($\xi_t$). Additionally, given $R=1+r(1\text{-}\tau)$ and $m=\frac{1}{1+r}$, Eq. (19) shows that, in steady state it is always the case that $\mu>0$ (the constraint is binding), as firms prefer bond financing, which is cheaper due to its tax advantage. It is also worth noting that the markup in export prices in Eq. (18) can differ from that for domestic sales in Eq. (17), depending on the elasticity ($\sigma^*$) facing exporters abroad.

### 3.2.4 The entry condition for the marginal firm

The existence of the one-time sunk production cost, $K_t^E$, paid after the productivity level is known implies the following entry condition, where only firms whose values net of entry cost are non-negative will produce for the domestic market:[18]

[18] In general, the value function could include the possibility that a firm might become an exporter in the future. However, given that we study only the steady state in which there are no aggregate shocks, and in which firm productivity draws are fixed (and in which there is an additional sunk cost for exporting), we can conclude that the marginal entrant will not be an exporter, but only produce for the domestic market.

$$p_t^{nx}(z_d)\,y_t^{nx}(z_d)/P_t - w_t\left(l_t^{nx}(z_d)+f_t^{d}\right)+b_t^{nx}(z_d)/R_t + E_t(m_{t+1}V_{t+1}^{nx}\left(b_t^{nx}(z_d)\right) - K_t^{E} = 0\,. \quad (20)$$

The term $E_t(m_{t+1}V_{t+1}^{nx}\left(b_t^{nx}(z_d)\right)$ represents the end-of-period firm value, and the three preceding terms compute dividends paid in the initial period, so together they represent beginning-of-period firm value, for comparison with the sunk entry cost, the last term.

An additional one-time sunk export entry cost, $K_t^{EX}$ implies a marginal exporter for which the profit earned from the foreign market plus the additional value of bond and equity issuance for being an exporter must equal the sunk export entry cost,

$$\left(p_t^{xx}(z_x)\,y_t^{xx}(z_x)/P_t - w_t l_t^{xx}(z_x)\right) - w_t f_t^{x} + \left(b_t^{x}(z_x) - b_t^{nx}(z_x)\right)/R_t + \left(q_t^{x}(z_x) - q_t^{nx}(z_x)\right) = K_t^{EX}\,. \quad (21)$$

These entry conditions with the financial enforcement constraint generate the cut-off productivity levels, $z_d$ and $z_x$, for being a non-exporter and an exporter, respectively.

### 3.3 Household preferences and optimization

There is a continuum of homogeneous households who derive utility from consuming the basket of goods ($C_t$) and disutility from labor ($L_t$), and maximize expected lifetime utility,

$$\max\; E_0\sum_{t=0}^{\infty}\beta^t U(C_t, L_t), \qquad with \qquad U(C_t, L_t) = \frac{C_t^{1-\rho}}{1-\rho} - \kappa\frac{L_t^{1+\psi}}{1+\psi},$$

where $\rho$ is the households' degree of risk aversion, $\beta$ is the subjective discount factor, and $\kappa$ and $\psi$ are the relative weight of labor and inverse Frisch elasticity.

Households derive labor income at the real wage rate ($w_t$), and also receive payments from holding the corporate bond portfolio ($\tilde{b}_{t-1}$) and receive dividends ($\tilde{d}_t$) from holding the share ($s_{t-1}$) of the equity portfolio of the $N_{t-1}$ existing firms that survive from the death shock which takes place at the end of each period. Households also update their asset portfolio, including a mutual fund of corporate bonds at price $1/(1+r_t)$ and equity investments at a price of $\tilde{q}_t$, for the set of incumbent firms $(N_{t-1})$ and newly entering firms $(Ne_t)$.The period budget constraint thus may be written as:

$$C_t + \left(N_{t\text{-}1}\text{+}Ne_t\right)\tilde{b}_t/\left(1+r_t\right) + s_t\tilde{q}_t\left(N_{t\text{-}1}\text{+}Ne_t\right) + T_t \le w_t L_t + N_{t\text{-}1}\tilde{b}_{t-1} + N_{t-1}s_{t-1}\left(\tilde{q}_t + \tilde{d}_t\right),$$

where $\tilde{b}_t$, $\tilde{q}_t$ and $\tilde{d}_t$ are the average values across firms of corporate bonds, equities and dividends respectively. $T_t$ is a lump-sum tax used to finance the tax benefits for firms issuing bonds ($T_t = \left(N_{t\text{-}1}\text{+}Ne_t\right)\left(\tilde{b}_t/R_t - \tilde{b}_t/\left(1+r\right)\right)$).

The households maximize expected lifetime utility subject to the budget constraint, implying the following first-order conditions:

$$U_{C_t} w_t + U_{L_t} = 0, \tag{22}$$

$$\beta\left(1\text{-}\lambda\right)E_{\text{t}}\left[U_{C_{t+1}}\left(1+r_t\right)\right] = U_{C_t}, \tag{23}$$

$$\beta\left(1\text{-}\lambda\right)E_{\text{t}}\left[U_{C_{t+1}}\left(\tilde{q}_{t+1} + \tilde{d}_{t+1}\right)\right] = U_{C_t}\tilde{q}_t, \tag{24}$$

where Eq. (22) is the labor-leisure tradeoff condition, Eqs. (23) and (24) are the Euler equations for holding the corporate bond portfolio and equity portfolio (where $\left(1-\lambda\right)$ comes from the relationship defined in equation (6)).

### 3.4 Aggregation and equilibrium

We close the model with market clearing conditions for the labor and goods markets, and imposing balanced trade that $N^x \tilde{p}^{xx} \tilde{y}^{xx} = P^{X^*} Y^{X^*}$.

For the small open economy, $P^{x^*}$ and $P^*$ are exogenous. We normalize $P^{x^*}\text{=}1$, and calibrate $P^*$ below. See Appendix Table 1.1 in the online appendix for the full list of equilibrium conditions in steady state.

We follow the aggregation in Melitz (2003), as we likewise study only the steady state of the model, which greatly simplifies aggregation.[19] As in Melitz (2003), steady state implies an aggregate stability condition in which the mass $p_{in}M_e$ of successful new

[19] Simplification due to steady state analysis is especially helpful in the case of our model, where multiple sunk costs imply potentially complex dynamics involving option value and effects of firm history that prevent aggregation by simply integrating over the exogenous productivity distribution.

entrants must exactly replace the mass $\lambda M$ of dying incumbents: $p_{in} M_e = \lambda M$. With this aggregate stability condition, the equilibrium distribution of productivity $[z_d, \infty)$ will remain unchanged.[20]

For the numerical analysis firms' idiosyncratic productivity follows a Pareto distribution with a cumulative distribution function (CDF) of $G(z)$ where $G(z) = 1 - z^{-\theta}$. Correspondingly, the probability density function (pdf) would be that $g(z) = \theta z^{-\theta-1}$. Using the pricing rule, Eq. (1), as in Melitz (2003), we can define the average productivity level for non-exporters, $\tilde{z}_t^{nx}$, and the average productivity level for the exporters based on weights from domestic sales, $\tilde{z}_t^{xd}$, and based on weights from export sales, $\tilde{z}_t^{xs}$:[21]

$$\tilde{z}_t^{nx} = \left( \frac{1}{G(z_{dt}) - G(z_{xt})} \int_{z_{dt}}^{z_{xt}} z_i^{\sigma-1} dG(z_i) \right)^{\frac{1}{\sigma-1}}, \tag{25}$$

$$\tilde{z}_t^{xd} = \left( \frac{1}{1 - G(z_{xt})} \int_{z_{xt}}^{\infty} z_i^{\sigma-1} dG(z_i) \right)^{\frac{1}{\sigma-1}}, \tag{26}$$

$$\tilde{z}_t^{xs} = \left( \frac{1}{1 - G(z_{xt})} \int_{z_{xt}}^{\infty} z_i^{\sigma^*-1} dG(z_i) \right)^{\frac{1}{\sigma^*-1}}. \tag{27}$$

## 4. Quantitative Analysis of the Leverage Ratio

This section presents quantitative results. The first part provides selected analytical results to aid interpretation of subsequent simulations. The second part explains the parameterization for numerical simulations. The next two parts demonstrate that the parameterized model can replicate earlier empirical findings, and explore the mechanism using sensitivity analysis. The last part interprets the mechanism's economic significance.

### 4.1 Some analytical relationships

[20] It can be shown that in steady state this aggregate stability condition is consistent with Eq. (6), the establishment dynamics in the domestic market.

[21] A separate average applies for export sales due to the distinct substitution elasticity among exports.

This section presents selected analytical results to assist interpretation of subsequent simulation output. Full derivations of these results are provided in the online Appendix 2, which solves for the cross-section of leverage, and other firm variables, as functions of exogenous firm productivity. The appendix finds the following derivative of long-term leverage for non-exporting firms with respect to firm productivity:[22]

$$\frac{\partial LR^{nx}(z_i)}{\partial z_i} = \frac{R}{R-1}\frac{1}{q^{nx}(z_i)^2}\left(\frac{\sigma}{\sigma-1}\frac{w\left(1+\phi^d\mu\right)}{Az_i}\right)^{1-\sigma}\frac{\sigma-1}{z_i}\frac{w}{\xi}f^d\phi^d Y\,. \qquad (28)$$

A similar derivative applies to exporters, assuming they have the same parameterization of working capital requirement and markups as non-exporters ($\phi^d = \phi^x = 1$, $\sigma = \sigma^*$):[23]

$$\frac{\partial LR_1^X(z_i)}{\partial z_i} = \frac{R}{R-1}\frac{1}{q^X(z_i)^2}\frac{w}{\xi}\left(f^d + f^x\right)\frac{\sigma-1}{z_i}\left(\frac{\sigma}{\sigma-1}\frac{w}{Az_i}(1+\mu)\right)^{1-\sigma}\left(Y + \left(\frac{1}{1\text{-}\tau_x}\right)^{1-\sigma^*}\left(\frac{P}{P^*}\right)^{-\sigma^*}Y^*\right). \quad (29)$$

These equations provide insight into the central role of fixed costs in determining leverage ratios in our model. First, in the absence of fixed costs ($f^d = f^x = 0$), there is no variation in leverage ratios among firms, by size or export status: $\partial LR^{nx}(z_i)/\partial z_i = \partial LR^x(z_i)/\partial z_i = 0$. Second, the presence of a domestic fixed cost generates a size effect for all firms, in that leverage ratio rises with productivity: $\partial LR^{nx}(z_i)/\partial z_i > 0$ and $\partial LR^x(z_i)/\partial z_i > 0$. Third, an export fixed cost augments this size effect for exporters: $\partial LR^x(z_i)/\partial z_i$ rises for greater $f^x$.

The reason fixed costs have these effects is their presence in the working capital constraint, which implies that the tradeoff between equity and bonds differs for firms of different sizes. Profits and hence overall firm value grow in proportion to the size of a firm's sales; however, the need for working capital grows less than proportionally with

[22] This is equation (A.5) in Appendix 2 section 4. Appendix 2 section 5 shows that log sales are linear in firm productivity, so that the above two equations, written in terms of productivity, can be read in terms of firm sales. Appendix 2 section 3 shows that the derivative of short-term leverage does not vary with firm size, so that the equations for long-term leverage are sufficient for evaluating overall leverage.

[23] This expression comes from equation (A.6) in Appendix 2 section 4. This appendix also provides the longer, more general version without the requirements that $\phi^d = \phi^x = 1$ or $\sigma = \sigma^*$.

sales due to the fixed component. As a result, a larger firm can allocate a smaller fraction of firm value to equity to secure the working capital needed for production, and can allocate a larger share of firm value to bonds to reap the tax benefits. This mechanism also helps explain higher leverage ratios for exporters compared to non-exporters, since only firms with sufficient productivity and size will find it profitable to pay the export sunk entry cost.

**4.2 Parameter values**

Most trade-related parameters are taken from the literature. Following Ghironi and Melitz (2005), the Pareto distribution parameter and domestic substitution elasticity are set at $\theta = 3.8$ and $\sigma = 3.8$, respectively. Following Bergin et al. (2018b), the iceberg trade cost is set at $\tau_x = 0.16$. The sunk cost of domestic firm entry is normalized ($K^E = 1$), as its absolute level does not affect the model implications for the ratios reported below. We follow trade literature in setting the rest of world income at 5 times that of the small open economy ($Y^* = 5Y$, see Feenstra et al., 2018).

Regarding parameters related to firm financing, some values we take directly from the finance literature. We follow Jermann and Quadrini (2012) to set the tax benefit parameter at $\tau = 0.35$, which differentiates debt from equity financing. The exogenous death shock probability is set to $\lambda = 0.005$.[24] Following the norm in the literature (Perri and Quadrini, 2016, Bergin et al., 2018a), firms in the benchmark model calibration are required to finance the full value of working capital for domestic production ($\phi^d = 1$), and likewise for exports ($\phi^x = 1$). Sensitivity analysis will explore implications of differing financing requirements for exports and domestic sales.

Values for standard macro parameters are taken directly from the macro literature. The inverse of the labor supply elasticity is set at $\psi = 0.5$, following Hall (2009). We set

[24] This value is taken from Atkeson and Burstein (2010), who match the average annual employment-based failure rate of U.S. firms with more than 500 employees, 1997-2002.

$\beta = 0.96$ to coincide with an annual frequency. Risk aversion is set at $\rho = 2$. The weight of the disutility of labor is $\kappa = 3.409$ to account for working hours around 1/3 of a day.

The remaining six parameters are chosen to maximize the model fit to a set of six key cross-sectional moments from our data. These parameters are the sunk cost of exporting ($K^{EX}$=0.667), domestic and export fixed costs ($f^d$ = 3.27e-4, $f^x$=8.37e-3), the fraction of firm value usable as collateral ($\xi$=0.124), foreign price level ($P^*$=0.0988), and the elasticity of substitution among home exports in the foreign market ($\sigma^*$=2.26).[25] The set of six moments includes four related to firm leverage: the average leverage ratio for exporters and for non-exporters, as well as the regression coefficients from Table 3 on size and that on the interaction of size with export status. See the next section for a description of how well the model matches these moments of interest. This calibration also targets two moments to ensure empirically reasonable trade shares: the share of firms that export (0.239 in model and in our data), and the average ratio of exports to total sales for exporting firms (0.17 in model and 0.14 in Bernard et al. (2007) based on U.S. Census of Manufactures data, since we have no direct data on this moment).

As a check, the model does a fair job in replicating another cross-sectional moment not targeted in the calibration. The ratio of the geometric mean of exporter size to the geometric mean of non-exporters (the exporter size premium in terms of domestic sales) is 3.9 in our simulation and 4.0 in our data. (Ruhl and Willis (2017) find a similar 3.7.)

Our fitted parameter values appear generally reasonable when compared to estimates elsewhere in the related literature. The ratio of sunk export cost to median firm sales (where the median firm is a non-exporter) takes the value 3.47 in our benchmark parameterization, which is comparable to the approximately 3.0 implied by estimates in Das et al. (2007).[26]

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25 Parameters are chosen by an algorithm minimizing a weighted sum of squared percent differences between moments for our data and moments generated from the model. See replication files for details of the minimization algorithm.

26 Reading from figure 3 in Das et al. (2007), for the basic chemicals sector the median plant profit is

It is somewhat higher than estimates in Ruhl and Willis (2017), which range from 0.53 to 1.23 depending on the version of their model. Our estimate of export fixed cost is 0.096 of median firm sales, which is somewhat higher than the range 0.034-0.075 in Ruhl and Willis (2017).[27] Calibrated domestic fixed costs represent 0.37% of median firm sales.[28]

The calibration of the elasticity of substitution for home goods in the foreign market is lower than that for the home market ($\sigma^* < \sigma$), implying a higher price markup of home goods when exported.[29] There is extensive empirical support in the literature for higher export markups, with some work suggesting it could be due in part to differing elasticities of substitution; our estimates of the extra markup are within the range estimated in this literature (see for example De Loecker and Warzynski, 2012; Bellone et al, 2016).[30] We assume that market segmentation prevents international arbitrage of price differences for differentiated goods, as is common in the macro literature modeling international price dispersion (see for example Bergin and Feenstra, 2001).

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approximately 2 mil. 1986 pesos, while the sunk cost estimate is around 60 mil 1986 pesos in figure 1. Given that the elasticity used in table 1 is 12, this implies that the ratio of sunk cost to sales is 60/(11*2) = 2.7. For knitting mills the corresponding ratio is 61/(9*2) = 3.4. An average of these two sector values is around 3.

27 A small fixed export cost potentially could limit the ability of the model to match export entry dynamics if extended to a full dynamic setting.

28 While there is not clear guidance in the trade literature regarding this parameter, Atkeson and Burstein (2010) choose a larger value (10% of the sunk cost). We are unable to fully adopt this calibration, as it implies large negative leverage ratios for small firms. Nonetheless, robustness experiments indicate that raising $f^d$ serves to further strengthen our main mechanism raising leverage in response to firm size.

29 Our calibrations of both elasticities are smaller than empirical estimates in the trade literature, but our value of $\sigma$ was chosen because it is the standard in the firm dynamics literature, and is taken directly from Ghironi and Melitz (2005), who defend the reasonableness of the calibration on pages 885-6. Our value for $\sigma^*$ is somewhat lower still, but we show below that given the value of $\sigma$, this value of $\sigma^*$ is reasonable based on empirical estimates of the implied exporter markup premium.

30 De Loecker and Warzynki (2012) find significant and robustly higher markups for exporting firms, even when controlling for productivity differences, and note that one explanation "…could be that the elasticity of demand is different on the export market, or that consumers have different valuation for the good" (p. 2462). They provide an estimate of exporter premium in the level of the markup of 0.163. Bellone et al. (2016) find a similar result, arguing that even if global completion might depress prices, this appears to be overcome by the effects of higher quality of exported goods, in which the scope for quality differentiation is higher in export markets. They estimate the exporter markup premium to be 0.037. If we compute an exporter premium in the markup over marginal cost in the same way as the above papers, taking a weighted average over destinations of an exporting firm, our values imply $\left[\sigma^x/\left(\sigma^x-1\right)*0.17+\sigma/\left(\sigma-1\right)*0.83\right]-\left[\sigma/\left(\sigma-1\right)\right]=$ 0.074, which is between the two estimates from the literature cited above.

### 4.3 Benchmark simulation results

This section reports the model's main implications for leverage ratios, and the degree to which the model can replicate the facts uncovered in the empirical section. Given that the empirical facts were cross-sectional in nature, our strategy is to solve numerically for the steady state of the model, which gives a stationary distribution of leverage ratios.

Figure 1 plots the cross-sectional distribution for several variables. The top left panel shows that the log level of total real firm sales (domestic plus exports) grow with the firm productivity index, with a jump at the productivity cutoff for the marginal exporter.[31] The rest of the panels plot the cross sections of financial variables against the log level of real firm sales rather than against productivity index, as this facilitates comparison with our empirical results, where regressions used the log of real sales as a regressor. Firm profits and firm value grow nearly linearly in firm sales (all in logs). While equity and bond issues both grow in firm size, bond issue drops slightly for the marginal exporter then rises more steeply with size compared to the trend for non-exporters. As a result, the ratio of bond to equity ($b(z_i)/q(z_i)$) and the total leverage ratio, defined as $\frac{loan(z_i)+b(z_i)}{q(z_i)+loan(z_i)+b(z_i)}$, grow in firm size for non-exporters, drop discontinuously for the marginal exporter, and then rise even more steeply with size.[32] The plot shows that small exporters have a lower leverage ratio than similarly sized non-exporters, but that large exporters have higher leverage than any non-exporter in the figure. The figure thus qualitatively reflects the four key findings of the empirical section: leverage ratio rises with size; it rises even faster with

[31] In simulations, non-exporters cover the productivity range $[z_d, z_x)$ and exporters the productivity range to $[z_x, \infty)$. Since there is no finite upper bound on the distribution of productivities and sales for exporters, figures necessarily do not report the full range of exporters. The full range of sales for exporters is used when reporting statistics on the average leverage ratios among firms in the simulation, and for regressions on simulated data a random sampling of 200 firms from the full Pareto distribution is taken.

[32] Figure 1 also shows the leverage ratio exhibits concavity when plotted against log sales, the reason for which will be discussed in the following section. We find empirical support for concavity in our data: Appendix Table 4.5 indicates a negative coefficient on the square of firm size.

size for exporters; small exporters are less leveraged than comparable non-exporters, but for large exporters the exporter-size effect raising leverage ratio dominates.

More formally, the model is able to mostly match the values of the key moments from the empirical section. (See column 2 of Table 5.) This is not surprising, as some parameters were calibrated to optimize the model's fit to a set of moments including these. Nonetheless, the degree to which the model actually matches the moments is a measure of model fit, and is an indicator of whether our standard trade model is sufficient to explain the financial behavior of exporters in our data. Recall from Table 1a that the empirical ratio of average leverage of exporters to non-exporters equals 1.062; the corresponding ratio in our simulated data is 1.044, reflecting the key fact that exporters on average have higher leverage ratios than non-exporters. The model also does a reasonable job matching most regression coefficients when we estimate a regression on the cross-sectional data generated by the model simulation. The regression coefficient on size is 0.0130, close to the empirical value of 0.0110, and that on the interaction of size with export status is 0.0089 in model, compared to the empirical value of 0.0101. The coefficient on the exporter dummy is -0.0096 for the simulated data, compared to the empirical value of -0.0462. While there is a gap between model and estimation for this value, both agree on the sign.

### 4.4 Sensitivity analysis

This section explores through sensitivity analysis the mechanism driving leverage ratios in our model, focusing on the roles of fixed costs and firm markups. The logic is that the leverage ratio chosen by a firm reflects a tradeoff between allocating overall firm value between debt and equity, in which debt offers a tax benefit, but equity offers collateral to relax the working capital constraint.

Panel 1 of Figure 2 shows that when there are no fixed costs and markups are the same for exporters and non-exporters ( $f^d = f^x = 0$ and $\sigma^* - \sigma = 0$ ), the leverage ratio is constant for all firms, regardless of size or export status (the solid line is flat). This finding directly reflects the first of the analytical results in section 4.1. Without fixed costs, firm size does not affect the tradeoff between debt and equity in our model, so the optimal leverage ratio does not vary by firm size. It is immediately obvious that this simulation fails to match the key empirical regularities: the ratio of leverage of exporters and non-exporters is 1.0 rather than our empirical value of 1.062, and all three of the regression coefficients are zero. (See Column (3) of Table 5 to compare values across simulations.)

Panel 2 shows the effect of the domestic fixed cost in isolation ( $f^d > 0$ , while $f^x = 0$ and $\sigma^* - \sigma = 0$ ). The dashed line repeats the benchmark case for comparison, and the solid line reports the alternative parameterization (in this panel the two cases overlap for non-exporters). The domestic fixed cost raises working capital needs for all firms, which works to push down optimal long-term firm leverage relative to the solid line in panel 1 -- but the figure shows this effect diminishes with firm size, and has a noticeable effect only for smaller firms. Profits and hence overall firm value grow in proportion to the size of a firm's sales; however, the need for working capital grows less than proportionally with sales due to the fixed component. As a result, a larger firm can allocate a smaller fraction of firm value to equity to secure the working capital needed for production, and can allocate a larger share of firm value to bonds to reap the tax benefits. This logic explains why fixed costs generate a size effect, in which firm size raises the leverage ratio.[33] This size effect arising from domestic fixed costs also contributes to explaining higher leverage ratios on average for exporters. Like the rest of the trade literature with heterogeneous firms and free entry, our model implies that exporting firms tend to be more productive and larger,

[33] This logic also explains the concavity of the leverage ratio in firm size in the figure, as the size effect diminishes with size as fixed costs become arbitrarily small relative to firm value of large firms.

since only firms with sufficient profits will pay the sunk export entry cost.

While panel 2 indicates that the domestic fixed production cost should help explain the empirical moments, the moments reported in column (4) of Table 5 still fall short of their empirical values. The ratio of leverage of exporters to non-exporters is 1.0198 rather than our empirical value of 1.062. Further, domestic fixed costs do not help explain the stronger size effect for exporters. While the regression coefficient on size is close to the empirical value, the coefficient on size interacted with export status is the wrong sign.

The fact that exporters may face an additional fixed cost specific to exporting works to amplify the size effect on leverage for exporting firms. So comparing two exporters of differing size, leverage would rise faster with size than for two non-exporters, yielding a steeper slope in the leverage ratio against size for exporters. However, the additional fixed export cost also raises the level of working capital needed for all exporters, which tends to push downward the level of optimal long-term leverage for exporters comparing to non-exporters of any given size. These competing effects of the fixed export cost imply that for small exporters the level effect dominates, and their greater need for working capital will drive down long-term leverage; but for sufficiently large exporters the size effect dominates, and their larger size raises leverage compared to non-exporters.

Panel 3 of Figure 2 illustrates the effect of including the additional export fixed cost at its calibrated value ( $f^d > 0$ and $f^x > 0$ but $\sigma^* - \sigma = 0$ ). Exporting firms have a lower long-term leverage ratio compared to the benchmark case, or even compared to the case of just a domestic fixed cost in panel 2. Leverage drops more for firms with small size, which implies a steeper profile of leverage ratio in firm size for exporters; this helps to better match the negative regression coefficient on the interaction term of size and export status (see column (5) of Table 5). But it lowers the average leverage for exporters compared to the previous case, so that it is about the same as that for non-exporters. In principle, the stronger size effect for exporters could lead to a higher average leverage ratio than non-exporters due to the much larger size of exporters. But we did not find a combination of fixed cost parameterizations to match both this moment and the higher regression coefficient on size for exporters.

The model allows for an additional amplification mechanism affecting exporters: reflecting evidence in the literature as discussed in section 4.2, the model implies an export markup premium for a calibration with $\sigma^* - \sigma < 0$. So exporting raises firm profits and hence firm value relative to production. Similar to the size effect discussed above, this feature implies that exporters have higher firm value relative to working capital needs, which allows them to reduce equity collateral and reap tax benefits of higher leverage.

Panel 4 shows the effect on leverage of higher price markups for exports ($\sigma^* - \sigma < 0$ but $f^d = f^x = 0$). In comparison with the case with no fixed cost or extra markup in panel 1, the introduction of the extra markup works to raise the long-term leverage of all exporters, though the effect is larger for small exporters.[34] This mechanism is helpful for raising the average level of leverage for exporters, but works against matching the stronger size effect for exporters. The benchmark calibration employs a combination of export fixed cost and higher export markup to match both of these moments to empirical counterparts.[35]

### 4.5 Interpreting the mechanism for firm financing strategy

We conclude this discussion of our main mechanism by interpreting its implications for the tradeoff firms face between short-term and long-term debt. Given that the fixed cost

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[34] This is attributable to the fact that the higher markup is due to a lower degree of substitutability between home export varieties; this implies that a rise in firm productivity generates a larger rise in home sales than export sales relative to less productive firms, which in turn limits the effect of exporter size on leverage.

[35] Appendix 6 reports results for two alternative calibrations of trade costs. When $K^{EX}$ and $f^x$ are chosen to fit trade moments without considering financial moments, the model still explains higher average leverage of exporters, but the lower value of $f^x$ precludes the extra size effect for exporters in the regression coefficient. When values for these two parameters are taken from outside literature (see Ruhl and Willis, 2017), a higher value of $f^x$ implies an overly strong size effect, but lower average leverage for exporters.

implies the need for working capital grows less than proportionately with firm sales and hence firm value, one might have conjectured that a large firm would take advantage of this position to enjoy the benefit of a looser working capital constraint and scale up production closer to the unconstrained optimal level. But our main result shows that this will not occur; instead large and financially strong firms choose to reduce the share of equity in firm value, and thereby not relax the working capital constraint.

The underlying reason for the choice not to loosen the working capital constraint can be seen in the Euler equation arising from the capital structure optimality problem (Eq. 19), which indicates in steady state that $\xi\mu = (1/R - m)/m$. In this equation $\mu$ is the Lagrange multiplier on the working capital constraint and measures the degree of tightness, and it is common to all firms. Literally, it is the shadow value of one unit of equity as collateral, by relaxing the working capital constraint and allowing higher production and profits. So, multiplied by the collateral share parameter, $\xi$, the left-hand side of the Euler equation measures the shadow value of one unit of equity as collateral. The right-hand side of the equation is the difference between the return on bonds and the household discount factor, which represents the tax benefit of bonds over equity. Of course, in a more standard model setting with no distinction between bonds and equity in terms of collateral value of equity or tax benefit of bonds, the Euler equation would require the interest rate equal the reciprocal of the stochastic discount factor; but in our setting the difference is the tax benefit of bonds. Note that in our model this difference on the right-hand side of the equation is constant for all firm productivity indexes, as it is determined by the marginal utilities of the households that supply both debt and equity financing. This implies that the tightness of the short-term borrowing constraint on the left-hand side of the equation is the same for all firms, regardless of size or export status.

This Euler condition is fundamental for generating our leverage ratio result. If one were to consider firms progressively higher in the productivity and size distribution, while hypothetically keeping capital structure fixed, the fixed cost component in working capital would imply that the working capital constraint becomes looser. But the Euler equation indicates it is not optimal for firms to let this outcome stand, but mandates an adjustment in capital structure to lower the share of equity relative to sales and hence firm value, which implies an increase in tightness of the working capital constraint to the same level as for all other firms. In other words, as firm size grows, the marginal benefit of equity as collateral falls, but the marginal cost in terms of lost tax benefits is constant.

## 5. Financial frictions as a barrier to exporter entry

This section discusses how endogenous capital structure alters the manner in which a standard financial constraint poses a barrier to export entry. Rather than constraining the scale of export sales and hence reducing the benefit of exporting, it tends to discourage entry by making it more difficult to finance the sunk cost of entry.

Consider an experiment in which policy aims to encourage exporting by mandating a lower collateral requirement for export activity (lower $\phi^x$ in our model). Figure 3 plots cross-sectional distributions for three values of $\phi^x$: 0.5, 0.75 and 1.0. To maintain the assumption that collateral requirements are never higher for domestic sales than exports, we recalibrate $\phi^d$ to 0.5, half its benchmark value. The calibrated value of $\xi$ is likewise cut approximately in half (to 0.0645), so in the case where $\phi^x$ = 0.5, the experiment replicates the result under the benchmark calibration.

Panel 1 shows that as the exporter working capital requirement is reduced (from $\phi^x = 1$ to $\phi^x = 0.5$), the average leverage ratio for exporting firms rises 10.3% (from 0.399 to 0.440). Exporting firms choose to trade away the benefit of a looser short-term working capital constraint in order to reap the tax benefits of more long-term debt.

Panels 2 and 3 show small effects of the policy on firm sales. While the figure plots three different lines for the three different values of $\phi^x$, these lines are nearly indistinguishable for total firm sales (exports plus domestic sales), and very close together for firm export sales. To be precise, we can track an individual firm that exports under all three cases (firm with productivity $z = 2.3029$). The cut in $\phi^x$ from 1 to 0.5 induces very little change in total sales of this firm (reduced by 0.4%, from 0.482 to 0.480) and real exports (raised by 0.9% from 0.0968 to 0.0977). In contrast, there is a much more substantial rise in some economy-wide aggregates: overall exports rise 14.4% (from 0.0680 to 0.0778) and the number of exporting firms ($N^x$) rises 20.6% (from 0.471 to 0.568). But changes in aggregate production and consumption are very small, under 0.1% (from 1.118 to 1.119, and from 1.104 to 1.105, respectively).

One lesson from these simulation results is that lowering working capital requirements for exports in our model has large effects on firm capital structure but rather small effects on firm-level production. This conclusion is very similar to the finding in Jermann and Quadrini (2012) and Bergin et al. (2018a) for the case of a loosened working capital constraint due to a rise in the collateral value of assets ($\xi$ in our model). As explained in those papers, when firms are able to adjust the mix of debt and equity, it is optimal to alter the level of equity to nearly completely offset the change in its collateral value, thus nearly completely insulating the firm's ability to procure working capital and carry on production. The same logic applies here to a lower $\phi^x$ that otherwise would loosen the working capital constraint of exporters. There is still some effect raising firm exports, due to firms substituting between domestic sales and exports, given the lower relative financial cost, as emphasized in Kohn et al. (2016).

We are not able to run a counterfactual exercise by simulating a version of the model that excludes endogenous capital structure, as our use of the aggregation strategy of Melitz

(2003) to deal with the distribution of heterogeneous firms depends upon this.[36] But one way to formulate a partial equilibrium counterfactual is to examine the working capital constraint when such capital structure adjustment is ruled out. Put simply, consider (11) with a fall in $\phi^x$, holding all else constant other than financing for export sales -- that is, $\phi^x w\, l^{xx}$. (In particular, rule out changes in equity value on the left hand side which could result from capital structure adjustment. One must hold constant domestic production, price and wage, as well as abstract from export fixed costs by setting $\gamma^{xx}=0$, $f^x=0$). In this artificial case it becomes clear that a 50% reduction in $\phi^x$ from 1 to 0.5 requires an exactly offsetting reduction in labor costs expended on export production of 50%. The rise in firm export value by 0.9% for the survivor in our experiment with endogenous capital structure is clearly much smaller.

A second lesson from these quantitative results is that the rise in exports occurs at the extensive margin rather than the intensive margin, the average sales per firm.[37] Action primarily at the extensive margin is consistent with the mechanism discussed in Bergin et al. (2018a) that links capital structure to entry, and which can be summarized in the present context by noting that capital structure directly affects firm value, and firm value comprises one side of the export entry equation (21). Intuitively, if one dollar of additional debt is issued to retire equity, that is, reallocated between the equity and bond components of equation (21), this capital restructuring lowers equity value by less than a dollar. The capital structure response raises firm value, the sum of equity plus debt, meaning that the range of firms has expanded that have firm value sufficient to justify export entry.

We conclude by briefly considering implications of our mechanism for a trade

[36] Heterogeneous values of $\mu$ in addition to heterogeneous productivity in the pricing and output decisions would invalidate the Pareto distribution that permits analytical aggregation.

[37] If we run this experiment in an alternative version of our model that exogenously holds constant the share of exporting firms, by fixing the margins of domestic and export entry, the rise in aggregate exports is a similar 7.35% (from 0.068 to 0.073), but this occurs all at the intensive margin rather than extensive margin.

liberalization. Suppose a reduction in iceberg trade cost ( $\tau_x$ ) from the benchmark calibration of 0.16 to 0.10. Simulations indicate that aggregate trade rises at the extensive margin, with the value of aggregate trade rising 7.4% (from the benchmark 0.0775 to 0.0832) and the number of exporters rising 7.2% (from 0.567 to 0.608). The effect on leverage ratio of exporters is minimal, which remains approximately constant at 0.441. The result differs from Kohn et al. (2016), which finds that a similar working capital financial constraint limits the expansion of trade at the extensive margin because new entrants have insufficient collateral to reap the benefits of scale. Our financial setup differs in two respects. First, firms can generate additional collateral by capital restructuring. And second, collateral takes the form of firm equity, the value of which rises automatically in response to changes in expectations for future export opportunities. The fact that capital structure does not need to adjust in our simulation indicates it is the latter mechanism that explains our large extensive margin response in steady state.

## 6. Conclusion

This paper adds to the literature studying the impact of finance on trade by studying the capital structure decision of exporters. We find empirically that exporters tend to be more leveraged than non-exporters in terms of long-term debt, as distinct from short-term debt. We contribute theoretically by showing how to marry a corporate finance model of capital structure, featuring an endogenous choice between equity and long-term debt, with a trade model featuring heterogeneous firms, fixed costs, and export entry.

A lesson is that when capital structure is endogenous, it is generally optimal for firms to adjust the level of equity collateral to offset changes in the tightness of the short-term financial constraint. One implication is that larger firms that are financially stronger and have easier access to working capital should not use this advantage to reap the benefit of a relaxed working capital constraint by scaling up production closer to the unconstrained optimal; they instead should increase long-term leverage to cash in on its tax benefits. A second implication is that even if exporters tend to face higher working capital needs than non-exporters, optimal capital structure will adjust to augment equity collateral, thereby relaxing the tightness of the short-term financial constraint to be the same as non-exporters.

More broadly, we believe it is important for the literature to take into consideration how firm leverage is the endogenous product of an optimizing decision, and to consider the tradeoffs firms face between competing short-term and long-term financing needs. We show that this tradeoff has implications for steady state firm capital structure; future work may find it fruitful to explore its implications for the dynamics of firms' responses.

## 7. References


Alessandria, G., and H. Choi, 2014. "Establishment heterogeneity, exporter dynamics, and the effects of trade liberalization," *Journal of International Economics* 94 207–23.

Amiti, M. and D.E. Weinstein, 2011. "Exports and financial shocks," *The Quarterly Journal of Economics* 126, 1841-1877.

Atkeson, Andrew and Ariel Burstein, 2010. "Innovation, Firm Dynamics, and International Trade" *Journal of Political Economy* 118(3) 433-484.

Bellone, Flora, Patrick Musso, Lionel Nesta, and Stefano Schiavo, 2010. "Financial constraints and firm export behavior," *World Economy* 33, 347–373.

Bellone, Flora, Patrick Musso, Lionel Nesta, and Frederic Warzynski., 2016. "International trade and firm-level markups when location and quality matter," *Journal of Economic Geography 16, 67–91.*

Bergin, Paul R. and Robert C. Feenstra, 2001. "Pricing-to-market, staggered contracts, and real exchange rate persistence," *Journal of International Economics* 54(2), 333-359.

Bergin, Paul R., Feng, Ling and Lin, Ching-Yi, 2018a. "Firm dynamics and financial frictions," *The Economic Journal* 128, 510-540.

Bergin, Paul R., Feng, Ling and Lin, Ching-Yi, 2018b. "Financial frictions and trade dynamics," *IMF Economic Review* 66, 480-526.

Berman, N. , Héricourt, J. , 2010. “Financial factors and the margins of trade: evidence from cross-country firm-level data,” *Journal of Development Economics* 93, 206–217.

Bernard, Andrew B., Bradford Jensen, Stephen J. Redding, and Peter K. Schott, 2007. ”Firms in International Trade, *Journal of Economic Perspectives* 21(3), 105-130.

Blalock, Garrick and Sonali Roy, 2007. "A firm-level examination of the exports puzzle: why East Asian exports didn't increase after the 1997–1998 financial crisis," *The World Economy* 30(1), 39-59.

Bridges, Sarah and Alessandra Guariglia, 2008. "Financial constraints, global engagement, and firm survival in the United Kingdom: evidence from micro data," *Scottish Journal of Political Economy* 55(4), 444-464.

Brooks, Wyatt and Alessandro Dovis, 2020. “Credit market frictions and trade liberalizations,” *Journal of Monetary Economics* 111, 32-47.

Burgman, T. A., 1996. “An empirical examination of multinational corporate capital structure,” *Journal of International Business Studies* 27(3), 553-570.

Campa, J.M., Shaver, J.M., 2002. “Exporting and capital investment: on the strategic behavior of exporters,” IESE Business School, University of Navarra.

Chaney, Thomas, 2008. “Distorted gravity: the intensive and extensive margins of international trade,” *American Economic Review* 98(4), 1707–1721.

Chaney, Thomas, 2016. "Liquidity constrained exporters," *Journal of Economic Dynamics and Control* 72(C), 141-154.

Chen, C. J. P., Cheng, C. S. A., He, J., and Kim, J., 1997. “An investigation of the relationship between international activities and capital structure,” *Journal of International Business Studies* 28(3), 563-577.

Cho, I., S. Contessi, K. Russ and D. Valderrama, 2019. “Financial Choice and International Trade,” *Journal of Economic Behavior and Organization* 157, 297-319.

Chor, D. & K. Manova, 2012. "Off the cliff and back? Credit conditions and international trade during the global financial crisis."*Journal of International Economics* 87,117-133.

Conconi, Paola, Sapir, André and Zanardi, Maurizio, 2016. "The internationalization process of firms: From exports to FDI," *Journal of International Economics* 99, 16-30.

Das, S., M.J. Roberts and J.R. Tybout, 2007. “Market entry costs, producer heterogeneity, and export dynamics,” *Econometrica* 75, 837–73.

De Loecker, Jan and Frederic Warzynski, 2012. “Markups and firm-level export status,” *The American Economic Review* 102(6), 2437-2471.

Eaton, Jonathan, and Samuel Kortum, 2002. “Technology, geography, and trade,” *Econometrica* 70(5), 1741–79.

Feenstra, R. C., P. Luck, M. Obstfeld, and K.N. Russ, 2018. "In search of the Armington elasticity," *The Review of Economics and Statistics* 100(1), 135-150.

Ghironi, F. and M. J. Melitz, 2005. "International trade and macroeconomic dynamics with heterogeneous firms," *The Quarterly Journal of Economics* 120(3), 865-915.

Greenaway, David, and Guariglia, Alessandra & Kneller, Richard, 2007. "Financial factors and exporting decisions," *Journal of International Economics* 73, 377-395.

Hall, Robert E., 2009. "By how much does GDP rise if the government buys more output," *Brookings Papers on Economic Activity* 2: 183 – 231.

Jermann, Urban and Quadrini, Vincenzo, 2009. "Macroeconomic effects of financial shocks," *NBER Working Paper 15338*.

Jermann, Urban and Quadrini, Vincenzo, 2012. “Macroeconomic effects of financial shocks,” *American Economic Review* 102(1), 238-271.

Kohn, David, Fernando Leibovici, and Michal Szkup, 2016. "Financial frictions and new exporter dynamics*," International Economic Review* 57(2), 453-486.

Kurshev, Alexander and Ilya A. Strebulaev, 2015. “Firm size and capital structure,” *Quarterly Journal of Finance* 5(3).

Kwok, C. C. Y., and D. M. Reeb, 2000. “Internationalization and firm risk: An upstream-downstream hypothesis,” *Journal of International Business Studies* 31(4), 611-629.

Manova, Kalina, 2008. "Credit constraints, equity market liberalizations and international trade," *Journal of International Economics* 76, 33-47.

Manova, Kalina, 2013. "Credit constraints, heterogeneous firms, and international trade," *Review of Economic Studies* 80, 711-744.

Manova, Kalina, Shang-Jin Wei, and Zhiwei Zhang, 2015. "Firm exports and multinational activity under credit constraints," *The Review of Economics and Statistics* 97, 574-588.

Melitz, M. J., 2003. “The impact of trade on intra-industry reallocations and aggregate industry productivity,” *Econometrica* 71(6), 1695-1725.

Minetti, R. and S.C. Zhu, 2011. "Credit constraints and firm export: Microeconomic evidence from Italy," *Journal of International Economics* 83(2), 109-125.

Mittoo, U. R. and Z. Zhang, 2008. “The capital structure of multinational corporations: Canadian versus U.S. evidence,” *Journal of Corporate Finance* 14(5), 706-720.

Muûls, Mirabelle, 2015. "Exporters, importers and credit constraints," *Journal of International Economics* 95(2), 333-343.

Oberhofer, Harald and Michael Pfaffermayr, 2008. "FDI versus exports substitutes or complements? A three nations model and empirical evidence," FIW Working Paper 012.

Pacheco, L., 2016. "Capital structure and internationalization: The case of Portuguese industrial SMEs," *Research in International Business and Finance* 38, 531-545.

Paravisini, Daniel, Veronica Rappoport, Philipp Schnabl, and Daniel Wolfenzon, 2015. "Dissecting the effect of credit supply on trade: Evidence from matched credit-export data," *The Review of Economic Studies* 82(1), 333-359.

Perri, Fabrizio and Vincenzo Quadrini, 2016, "International Recessions," *American Economic Review* 108 (4-5), 935-84.

Rajan, R. G., and Zingales, L., 1995. "What do we know about capital structure? some evidence from international data," *The Journal of Finance* 50(5), 1421-60.

Ruhl, Kim J. and Jonathan L. Willis, 2017. "New exporter dynamics," *International Economic Review* 58, 703-726.

Russ, Katheryn N. and Valderrama, Diego, 2012. "A theory of bank versus bond finance and intra-industry reallocation," *Journal of Macroeconomics* 34, 652-673.

Saito, R., and E. Hiramoto, 2010. "Foreign activity effects and capital structure: Brazilian evidence," A*cademia - Revista Latinoamericana de Administracion* 45, 59-75.

Shapiro Alan. 2013. *Multinational Financial Management*. Wiley: New Jersey.

Singh, M. and A. Nejadmalayeri, 2004. "Internationalization, capital structure, and cost of capital: evidence from French corporations," *Journal of Multinational Financial Management* 14 (2), 153–169.

Strebulaev, I. A., and Whited, T. M., 2011. "Dynamic models and structural estimation in corporate finance," *Foundations and Trends in Finance* 6(1-2), 1-163.

Xu, Jin, 2012. "Profitability and capital structure: Evidence from import penetration," *Journal of Financial Economics* 106 (2), 427-446.

Table 1a. Summary Statistics

| | (1) total sample | (2) not exporting | (3) exporting | (4) newly exporting | (5) continuing exporting |
|---|---|---|---|---|---|
| means: | | | | | |
| log of size | 4.791 | 4.221 | 6.609 | 5.897 | 6.797 |
| Book Leverage ratio | 0.425 | 0.419 | 0.445 | 0.448 | 0.445 |
| Short-term borrowing to total assets | 0.054 | 0.055 | 0.047 | 0.046 | 0.047 |
| Long-term debt to total assets | 0.152 | 0.150 | 0.161 | 0.160 | 0.161 |
| Debt in current liabilities to total assets | 0.057 | 0.061 | 0.043 | 0.047 | 0.042 |
| Book debt minus short-term borrowing to total assets | 0.358 | 0.351 | 0.391 | 0.383 | 0.394 |
| standard deviation of size (within) | 0.854 | 0.810 | 0.554 | 0.504 | 0.517 |
| Observations | 74647 | 56909 | 17921 | 3738 | 14183 |

Note: we drop firms appearing only once in the sample.

Table 1b. Dfference in Means Tests

| | Statistic | F(df1, | df2) | = F | Prob>F |
|---|---|---|---|---|---|
| Wilks' lambda | 0.9971 | 1.0 | 74645.0 | 215.79 | 0.0000 |
| Pillai's trace | 0.0029 | 1.0 | 74645.0 | 215.79 | 0.0000 |
| Lawley-Hotelling trace | 0.0029 | 1.0 | 74645.0 | 215.79 | 0.0000 |
| Roy's largest root | 0.0029 | 1.0 | 74645.0 | 215.79 | 0.0000 |

Note: This table tests hypothesis of equal average leverage ratios for exporters and non-exporters, comparing columns (2) and (3) in the second row of Table 1a.

Table 2: Linear Panel Regressions

| | (1)<br>Book Leverage ratio | (2)<br>Short-term borrowing to total assets | (3)<br>Long-term debt to total assets | (4)<br>Debt in current liabilities to total assets | (5)<br>Book debt minus short-term borrowing to total assets |
|---|---|---|---|---|---|
| Size | 0.0118*** | 0.0025 | 0.0132*** | 0.0012*** | 0.0080*** |
| | (0.0007) | (0.0019) | (0.0006) | (0.0004) | (0.0022) |
| Exporter | 0.0158*** | -0.0043 | 0.0048** | 0.0026* | 0.0219*** |
| | (0.0022) | (0.0047) | (0.0018) | (0.0010) | (0.0054) |
| N | 74647 | 24842 | 74624 | 74625 | 24842 |
| $R^2$ | 0.0462 | 0.0113 | 0.0463 | 0.0085 | 0.0584 |

Standard errors in parentheses. *** indicates statistical significance at the 1% level, ** 5%, and * 10%.

Table 3: Panel Regressions with Interaction Term

| | (1)<br>Book Leverage ratio | (2)<br>Short-term borrowing to total assets | (3)<br>Long-term debt to total assets | (4)<br>Debt in current liabilities to total assets | (5)<br>Book debt minus short-term borrowing to total assets |
|---|---|---|---|---|---|
| Size | 0.0110*** | 0.0024 | 0.0126*** | 0.0011** | 0.0075*** |
| | (0.0007) | (0.0019) | (0.0006) | (0.0004) | (0.0022) |
| Exporter | -0.0462*** | -0.0145 | -0.0351*** | -0.0089** | -0.0412** |
| | (0.0059) | (0.0132) | (0.0049) | (0.0028) | (0.0154) |
| Exporter x size | 0.0101*** | 0.0017 | 0.0065*** | 0.0019*** | 0.0104*** |
| | (0.0009) | (0.0020) | (0.0007) | (0.0004) | (0.0024) |
| N | 74647 | 24842 | 74624 | 74625 | 24842 |
| $R^2$ | 0.0545 | 0.0112 | 0.0476 | 0.0087 | 0.0631 |

Standard errors in parentheses. *** indicates statistical significance at the 1% level, ** 5%, and * 10%.

Table 4: Benchmark Model Parameterization

| | From literature |
|---|---|
| Pareto distribution parameter | $\theta = 3.8$ |
| Substitution elasticity (domestic) | $\sigma = 3.8$ |
| Probability of death shock | $\lambda = 0.005$ |
| Iceberg trade cost | $\tau_X = 0.16$ |
| Tax benefit | $\tau = 0.35$ |
| household discount factor | $\beta = 0.96$ |
| household relative risk aversion | $\rho = 2$ |
| Weight of labor disutility in utility | $\kappa = 3.409$ |
| Inverse of labor supply elasticity | $\psi = 0.5$ |
| Rest-of-world income | $Y^* = 5Y$ |

| Moment matching | | Set of Targeted Moments |
|---|---|---|
| Domestic fixed cost | $f^d = 0.000327$ | Regression coefficient on firm size |
| Export fixed cost | $f^x = 0.00837$ | Regression coefficient for interaction |
| Export Entry cost | $K^{EX} = 0.667$ | Share of firms engaging in export |
| Rest-of-world export price | $P^* = 0.0988$ | Share of exports in firm sales |
| Substitution elasticity | $\sigma^* = 2.26$ | Avg. leverage ratio of exporters |
| Enforcement parameter | $\xi = 0.124$ | Avg. leverage ratio non-exporters |

Table 5: Moments from Model Simulations

| | (1) Data | (2) Model: benchmark | (3) No fixed cost or extra markup: $f^d = f^x = 0$ $\sigma^* - \sigma = 0$ | (4) Domestic fixed cost: $f^d > 0$, $f^x = 0$ $\sigma^* - \sigma = 0$ | (5) Domestic and export fixed costs: $f^d > 0$, $f^x > 0$ $\sigma^* - \sigma = 0$ | (6) Extra export markup: $\sigma^* - \sigma < 0$ $f^d = f^x = 0$ |
|---|---|---|---|---|---|---|
| <u>Average leverage ratios:</u> | | | | | | |
| exporters | 0.445 | 0.441 | 0.435 | 0.435 | 0.428 | 0.487 |
| non-exporters | 0.419 | 0.423 | 0.435 | 0.426 | 0.427 | 0.435 |
| <u>Regression coefficients:</u> | | | | | | |
| size | 0.0110 | 0.0130 | 0.0000 | 0.0092 | 0.0083 | 0.0000 |
| size* exporter | 0.0101 | 0.0089 | 0.0000 | -0.0084 | 0.0067 | -0.0288 |
| exporter | -0.0462 | -0.0096 | 0.0000 | -0.0041 | -0.0390 | 0.0512 |

Figure 1. Benchmark model
cross-sectional distributions across firms

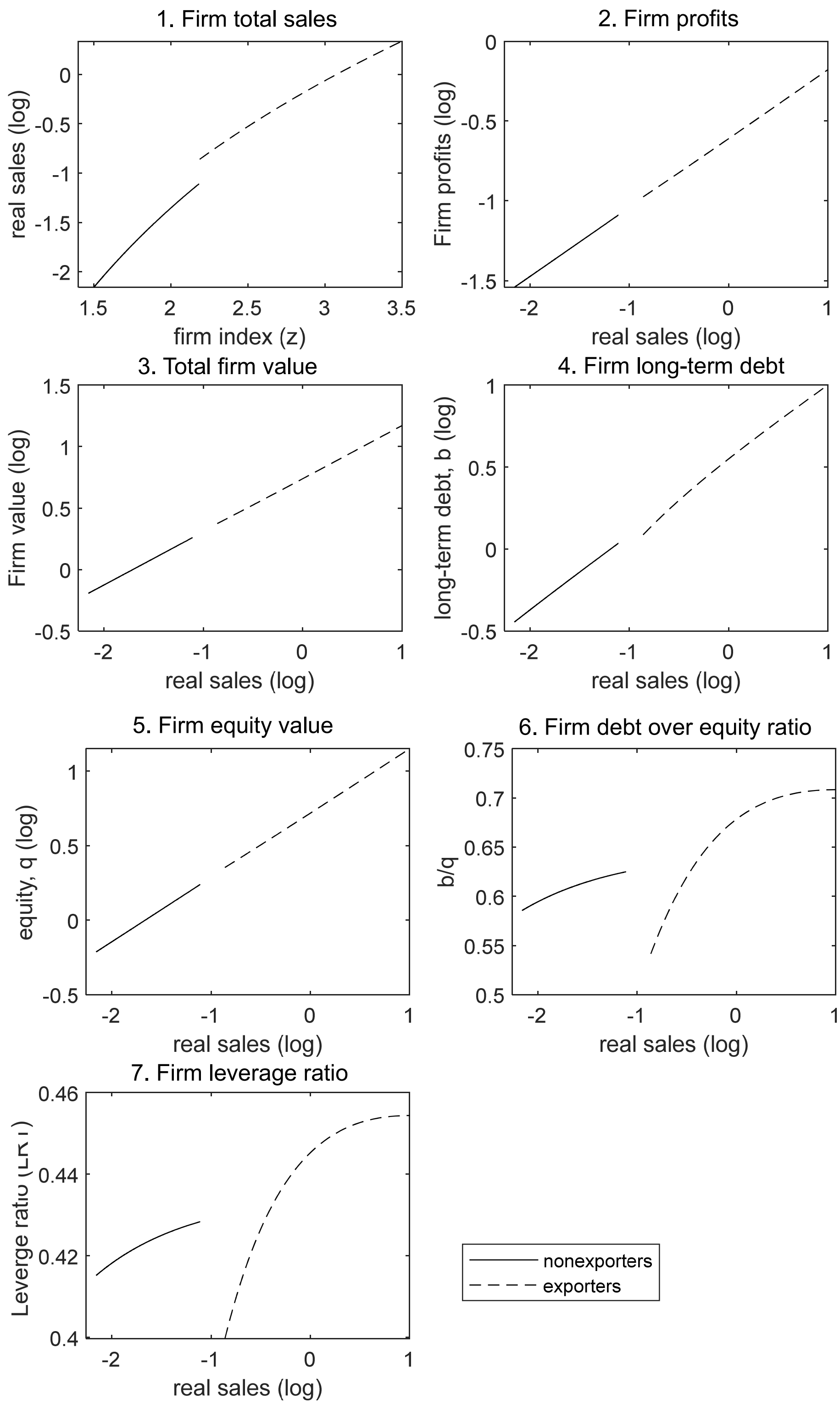

Figure 2: Sensitivity and Robustness:
Leverage ratio cross-sections for alternative model calibrations

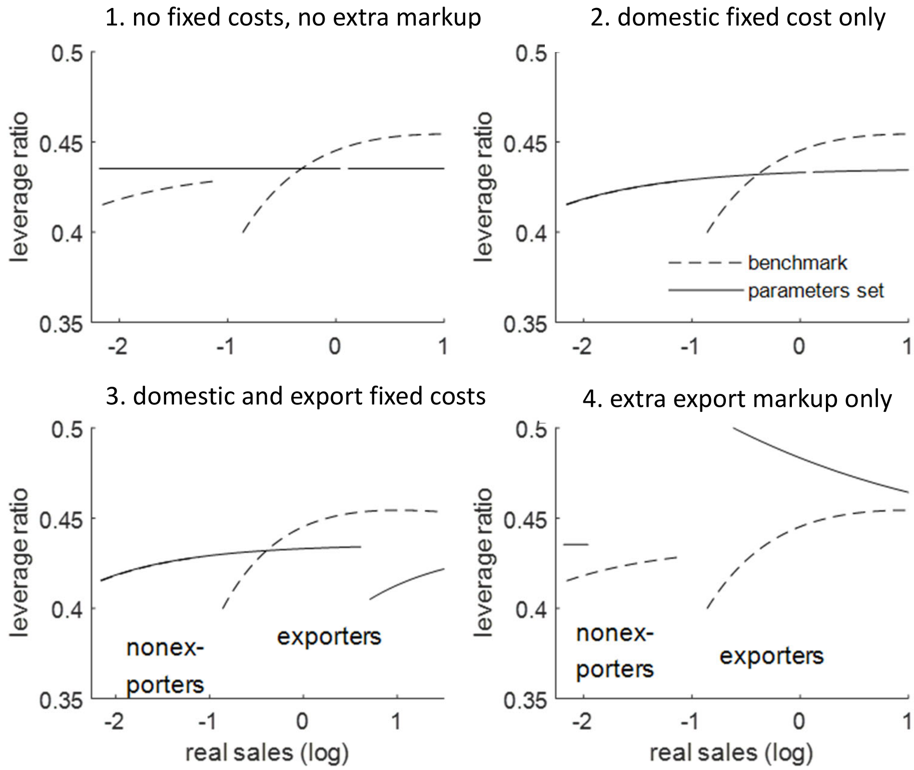


Figure 3: Alternative working capital requirements for exporters ($\phi^x$)