Local Credit and International Trade

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Abstract

Does local access to credit affect large-scale firm outcomes like exporting? I answer this question by modeling the relationship between finance-constrained exporters and bank entry decisions. Heterogeneous firms must finance fixed export costs via local banks that charge interest rates that are decreasing in bank branch presence. This generates bilateral trade equations where local access to banking increases the intensive and extensive margin of exporting. I estimate this model with a panel of Brazilian municipal-level trade and banking data and show that commercial bank presence per person increases bilateral exports. Literature in the financial development field has struggled to deal with the endogenous relationship between finance and economic outcomes. To untangle this reverse causality, I instrument bank presence by using geographic characteristics particular to the bank branching decision in the spirit of Frankel and Romer (1999). I build predictors of city branch levels with bank company characteristics including the geography of bank headquarter locations. I test the robustness of this instrument with measures of geographic financial remoteness. My results show that local bank access matters: a one standard deviation increase in bank branches per person raises city-level bilateral exports by at least 8.1%. The effect is even stronger for industries where the credit constraint binds: bilateral industry exports increase by a much as 46.0% in sectors that use less internal funds and have more difficulty producing collateral.

Keywords: International Trade; Financial Development; Banking; Brazil; Heterogenous Firms

JEL classification: F14; G21; O16

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1 Introduction

Imperfect credit markets are known to restrict growth and hamper development. Studies show that cross-country differences in financial access have significant effects on trade and production,[1] but less is known about variation in credit constraints *within* countries. Theoretical and empirical work has shown that bank-to-firm distance remains an important driver of credit constraints,[2] meaning that *local* financial development is an important determinant of firm-level outcomes, especially in developing countries.[3] This effect varies by firm size, particularly at the margins: smaller firms are more sensitive to distance-driven credit constraints.[4] However, just as firm behavior is driven by access to finance, banks expand into areas that are more likely to export and experience economic growth (Aviat and Coeurdacier 2007).

This paper investigates the impact of local access to credit on the intensive and extensive margin of aggregate and industry-level bilateral exports and works to untangle the endogenous relationship between finance and trade. To do this, I augment a heterogeneous firms trade model[5] to include a credit constraint determined by bank access. Less productive, smaller firms are excluded from the credit market, and therefore exporting, due to the costs of financing. To reflect the importance of local lending, I allow those costs to differ by region as a function of bank branching behavior. From this model, I show that bilateral trade, via the extensive margin, is decreasing in region-specific financing costs. I estimate the model with a panel of Brazilian municipality-level data, showing that access to banking services at the subnational level is a significant driver of export behavior.

This paper complements firm-level studies on finance and the extensive margin of exporting.[6] In particular, start-up costs and increasing returns to scale make exporting firms reliant on access

[1]See for example King and Levine [1993] , Rajan and Zingales [1998], Beck et al. [2000], and Beck [2002,2003].

[2]For a survey of this literature see Degryse and Ongena [2004].

[3]See work by Brown et al. [2016b,a]on Native American reservations in the U.S.; Guiso et al. [2004] on Italy; Bruhn and Love [2009] on Mexico; and Felkner and Townsend [2011] and Paulson and Townsend [2004] on Thailand.

[4]Using U.S. data, Petersen and Rajan [2002], Agarwal and Hauswald, and Berger et al. [2005] show that local lending relationships are most important for smaller businesses.

[5]See Melitz [2003] and for models of this type.

[6] Examples include Muûls [2008]on Belgium, Hasan [2013]on Peru, Greenaway et al. [2007]on the U.K., and Becker et al. [2012] on the U.S.

to credit. My modeling strategy reflects this: I include increasing returns and firm heterogeneity following Chaney [2008]'s approach. In my model, firms are liquidity constrained and reliant on external financing to expand their sales outside of their local region. This is similar to the setup by Manova [2013], whose model and cross-country empirical work shows that national indicators of financial development increase trade in finance-reliant sectors. The primary identification strategy in her paper relies on industry variation in financial dependence and asset tangibility.

In my model, I require that firms finance the fixed costs of exporting with funds from *local* banks. This allows me to avoid identification issues caused by cross-country variation in the laws and institutions that determine aggregate indicators of financial development. Instead, my identification strategy relies on the geographic distribution of bank branching behavior. Empirical work shows that bank headquarter location matters at the international level (Buch [2005]) and the subnational level (Felici and Pagnini [2008]) due to information costs that vary by distance (Dell'Ariccia and Marquez [2004]). In particular, Agarwal and Hauswald present evidence that soft information on borrowers, particularly smaller firms, is primarily a local characteristic. Alessandrini et al. 2009 and Hauswald and Marquez [2006] argue that the distance from a bank's headquarters to its branches makes the transmission of this information more difficult, and thus makes lending in a region more costly. As such, I model the choice of banks to build branches in a region as a function of bank company characteristics and the location of their headquarters. Additionally, I include a simple externality to bank branching: when banks build branches, the average bank branch-to-firm distance decreases, so total monitoring costs are lower.

This setup generates several simple estimation equations that show that the intensive and extensive margins of bilateral trade are increasing in access to banking services, proxied with commercial bank branches per person. Empirically, I treat "local" as a Brazilian municipality and use data on commercial bank branches, HS4-level product exports, and city-level economic indicators to estimate the model.

To deal with the endogeneity of the banking/trade relationship at the industry level, I follow Manova [2013] and use industry-specific measures that relate to the financing constraint. Firms that have less collateralizable assets and are less able to fund operations internally are perceived to be higher default risk by bank companies and thus face higher financing costs. However, as banks build branches, lending costs to all sectors are lower. This effect is largest in credit constrained industries: bilateral exports in financially dependent sectors and those with less tangible assets respond more to lower lending rates than less risky industries.

To identify the effect of bank access at the city level, I use an instrumental variables method inspired by Frankel and Romer [1999] and build a predictor of bank branches per person in a region using information on bank company characteristics that are exogenous to a city's export potential. My results show that a one standard deviation increase in bank branches per person raises city-level bilateral exports by at least 8.1%. This approach gives robust evidence that local financial development matters for the intensive and extensive margin of trade.

This paper is structured as follows. Section 2 presents a general equilibrium model of credit-constrained heterogeneous exporters and banking sector behavior. Section 3 includes model predictions and results that show how exports respond to increased access to banking services. In Section 4, I explain an empirical strategy to estimate the model with Brazilian data and present results showing the magnitude of the banking and trade relationship. Section 5 concludes.

2 Credit-constrained production and trade

In this section, I set up a demand and production model to motivate firm-level responses to the trade and finance variables. The model augments Chaney [2008] by adding a credit constraint and a banking sector. I focus on foreign demand, assuming that firms do not require external credit for domestic production. Instead, fixed exporting costs must be financed through the lending market.

The model generates an endogenous productivity cutoff for exporting to a given destination. Firms with productivity draws below this threshold do not export to that country. The productivity cutoff ultimately depends on the endogenous, region-specific financing cost. Regions with high finance costs will have less exporters and exports.

2.1 Consumer demand

Consumers in a destination country, d, derive utility from consuming agricultural goods, A, and goods from $k \in K$ manufacturing sectors, M, in the following way:

$$U = \prod_{k=1}^{K} M^{\mu_k} A^{1-\sum \mu_k} \qquad M = \left[\int_{Z_k} m(z)^{\frac{\sigma-1}{\sigma}} dz \right]^{\frac{\sigma}{\sigma-1}} \tag{1}$$

where μ_k is the share of sector k goods in utility, $z_k \in Z_k$ is the measure of available manufacturing varieties in sector k, and $\sigma > 1$ is the elasticity of demand for a given variety, assumed to be the same across sectors.

The geography of trade is as follows. I assume there are $D + 1$ countries in the world with exogenous populations N_d. One of those countries can be subdivided into o' sub-regions, which means there are $D + o'$ exporter and importer regions in the world.

From equation (1), consumers in region d demand variety z_k goods produced in origin region $o \in D + o'$ based on the following function

$$m_{kod}(z) = \mu_k Y_d p_{od}(z)^{-\sigma} P_{kd}^{\sigma-1} \tag{2}$$

where $p_{od}(z)$ is the F.O.B. price, and Y_d and $P_{kd}^{1-\sigma} = \int_{Z_k} p_{od}^{1-\sigma} dz$ are destination income and sector k ideal price index, respectively. Income in d comprises labor income $w_d N_d$ and aggregate profits made by producers in that region Π_d.

2.2 Production

I assume that the agricultural good is produced in a perfectly competitive market with a constant returns to scale technology in every region using $\frac{1}{w_o}$ units of labor and can be traded costlessly. I set the price of this good to 1 and allow it to function as the numéraire. Wages in region o equalize across sectors and are therefore pinned down by the agricultural wage w_o.

To export to a destination country d, a manufacturing firm in region o must pay a fixed cost f^x_{od} of the numéraire and a variable iceberg trade cost $\tau^x_{od} \geq 1$, where τ^x_{od} is the amount that must be shipped for one good to arrive in d. Without loss of generality, I assume $\tau^x_{oo} = 1$ and $f^x_{oo} < f^x_{od}$ for all $d \neq o$.

Following Melitz [2003], the manufacturing sector comprises firms that differ in a stochastic productivity parameter ϕ drawn from cumulative distribution function given by $G(\phi)$ that is identical across regions and sectors. This is modeled as marginal-cost reducing productivity parameter that appears in the following per-unit cost function for a firm of productivity ϕ in region o exporting to destination d. This cost function is the same across sectors, but differs by origin and destination pair:

$$\varsigma_{od}(\phi) = \frac{w_o \tau^x_{od}}{\phi} \tag{3}$$

Firms are monopolistically competitive in that I assume that Y_d and P_{kd} are exogenous to the firm. In this sense, the volume of trade from a single, atomistic firm does not affect aggregate variables. Due to increasing returns to scale and no economies of scope, a firm of type ϕ in sector k produces only one variety, so ϕ and k are sufficient to index a good.

Given demand in equation (2) and the structure of competition, firms charge a constant markup over marginal cost, incorporating variable trade costs:

$$p_{od}(\phi) = \frac{\sigma}{\sigma - 1} \frac{\tau^x_{od} w_o}{\phi} \tag{4}$$

The price charged by firms is increasing in wages and trade costs and decreasing in the efficiency parameter.

2.3 Credit constraints and the productivity cutoff

Firms are credit constrained in that they cannot finance all costs internally. As in Manova [2013], I assume that firms must finance fixed export costs[7] with external capital at the endogenous price $R_{ko} = 1+r_{ko}$. Without loss of generality, I assume that all fixed costs must be financed externally.[8] This means that a firm of type ϕ receives the following profits from exporting:

$$\pi_{kod}(\phi) = \mu_k \sigma^{-\sigma} Y_d \left[\frac{w_o \tau_{od}}{(\sigma - 1)\phi P_{kd}} \right]^{1-\sigma} - R_o f^x_{od} \tag{5}$$

The presence of the fixed cost means that firms will not sell goods to d if they cannot make positive profits. Thus, I define the lowest level of productivity a firm can have to make non negative profits as $\tilde{\phi}_{kod}$, which must satisfy $\pi_{kod}(\tilde{\phi}_{kod}) = 0$. Using the definition of profits given in equation (5), I can solve for the productivity cutoff for exporting:

$$\tilde{\phi}_{kod} = \left[(\frac{\sigma}{\mu})^{\frac{1}{\sigma-1}} \frac{\sigma}{\sigma - 1} \right] \left[\frac{w_o}{P_d Y_d^{\frac{1}{\sigma-1}}} \right] \left[\tau^x_{od} (f^x_{od})^{\frac{1}{\sigma-1}} \right] [R_{ko}]^{\frac{1}{\sigma-1}} \tag{6}$$

Firms from region o in sector k must have a productivity draw of $\phi_{kod} \geq \tilde{\phi}_{kod}$ export to d. An equation of this type is typical in the heterogeneous firms literature, but an important new result is that the sector threshold is increasing in $regionally - varying$ financing costs. This means the credit constraint is reducing the extensive and intensive margins of trade in a way that differs across regions.

Following Chaney [2008] and Arkolakis [2010], I do not impose free entry. Instead, I assume the potential number of entrants in each manufacturing sector is proportional to country size and equal to $w_o N_o$. This means that there will be profits earned by each firm with productivity higher than $\tilde{\phi}_{kod}$. I assume all consumers in region o own an equal fraction of domestic firms and

[7] Alternatively, I could model firms that finance some fraction of labor costs. However, as wages are pinned down in the agricultural sector, equilibrium aggregate loan demand would simply depend on exogenous region size and would be uninteresting.

[8] As long as firms must finance some positive fraction of their costs the qualitative results that follow are unchanged.

thus receive an equal fraction as income.

The amount of finance required by firms is equal to the total amount of fixed entry costs they must pay. In particular, aggregate loan demand from sector k firms in region o is given by the total fixed costs paid by exporters in that sector. It therefore depends on how many markets each firm is productive enough to enter:

$$L_{ko} = w_o N_o \sum_d f^x_{od} \left(1 - G(\tilde{\phi}_{kod})\right) \tag{7}$$

In the above equation financing costs only appear in the productivity cutoff. This means that the price-demand relationship for loans is exclusively channeled through the extensive margin of trade. The cutoff for exporting increases with financing costs, thus reducing the probability of exporting and therefore the number of exporters: $V^x_o = w_o N_o (1 - G(\tilde{\phi}_{kod}))$

Conditional on the productivity distribution of firms, the size of each country, bilateral trade costs, and the endogenous supply and cost of financing, the above setup generates a full model of production, income, and trade. Regions with higher financing costs will have less exporting firms and therefore less exports.

2.4 Banking and loans

The source of loans in this model is a monopolistically competitive banking sector. Banks take funds from the central banks at the exogenous lending rate r^d and supply them to firms. In order to match with firms in region o, banks must build bank branches in the region. Financing costs are affected by two things. First, there is a sector-specific probability of default $1 - \delta_k$. Additionally, I assume there is a simple information asymmetry: firms are able to shirk on paying back their loans unless banks pay a per loan monitoring cost, C_o.[9] This is a simple adaptation of the costly state verification model in Townsend [1979].

Banks are homogeneous and split the lending market equally among J^b_o (endogenous) active bank companies. Prices are set sector by sector to maximize the following variable profit function:

[9] Both variable and fixed costs are paid in units of the numéraire.

$$\pi_{ko}^{b} = \frac{L_{ko}}{J_o^b}(\delta_k R_{ko} - C_o(1 + r^d)) \tag{8}$$

For a given default rate δ_k and the (endogenous) elasticity of demand $\eta = -\frac{dL}{dR}\frac{R}{L}$, banks choose the optimal loan price as a markup[10] over the cost of funds and monitoring:

$$R_{ko} = \frac{1}{\delta_k}\frac{\eta}{\eta - 1}C_o(1 + r^d) \tag{9}$$

To generate an expression for loan demand, I assume that manufacturing firm-level productivity ϕ follows the Pareto distribution as is typical in the heterogeneous firm trade literature. Specifically, $G(\phi) = 1 - \phi^{-\gamma}$ where $\gamma > \sigma - 1 > 0$ is an inverse measure of the heterogeneity of firms in the manufacturing sector. This assumption is an approximation of the empirical size distribution of firms and allows for a closed form solution to the loan demand equation and its elasticity [11].

This assumption means that the probability of exporting is $1 - G(\tilde{\phi}_{kod}) = \tilde{\phi}_{kod}^{-\gamma}$ and the loan demand and elasticity are given by

$$L_{ko} = \left[(\frac{\sigma}{\mu})^{\frac{1}{\sigma-1}} \frac{\sigma}{\sigma - 1} \right]^{-\gamma} w_o^{1-\gamma} N_o \left[R_{ko}\right]^{\frac{-\gamma}{\sigma-1}} \sum_d \tau_{od}^{x-\gamma} f_{od}^{x1-\frac{\gamma}{\sigma-1}} \left[P_d Y_d^{\frac{1}{\sigma-1}} \right]^{-\gamma} \tag{10}$$

$$\eta = \frac{\gamma}{\sigma - 1} \tag{11}$$

$$R_{ko} = \frac{1}{\delta_k}\frac{\gamma}{\gamma - \sigma + 1}C_o(1 + r^d) \tag{12}$$

[12]

[10] Following Bremus et al. [2013] and De Blas and Russ [2013] we can also think of $\frac{\eta}{\eta-1}$ as an upper bound on the markup that banks would charge. For example, if there were a search cost or documentation cost to applying for loans, we would likely see interest rates lower than those implied by the monopoly markup, but higher than the perfect competition case. Pure price competition would lead banks to price at marginal cost.

[11] See Arkolakis and Muendler [2010] and Arkolakis [2013] for recent dynamic microfoundations for this assumption that are consistent with U.S. and Brazilian data on exporter firm size.

[12] See Appendix A.1 for this derivation.

This elasticity of loan demand is purely driven by the extensive margin of exporting. Intuitively, the markup is decreasing in γ because a more homogeneous manufacturing sector has average lower productivity, therefore more firms are sensitive to increases in the financing of fixed costs. The markup is increasing in σ, the elasticity of demand for manufactured goods, because a high level of σ indicates that the manufacturing sector is more competitive. Higher competition means only the most productive firms export, and, as they are further down their average cost curves, they are less sensitive to financing costs.

2.5 Endogenous access to finance

In this section, I augment the above financial sector to include multi-branch banking in a given region. First, I assume there is a convex cost to branch banking that varies based on a region-specific constant β_o. Second, I assume that banks can increase their share of the market by building bank branches in a simple way: market share is $\frac{b_o}{J_o^b}$ where b_o is branches per bank in region o[13]. Empirical work on bank branching decisions in the U.S. give evidence that increasing branch network size is a tool used by companies to increase market share[14].

Taking the above loan demand and pricing as given, I can express the banks aggregate profits as a function of branching as follows:

$$\Pi_o^b = b_o \pi_o^b - \beta_o b_o^2 = b_o \frac{L_o}{J_o^b} \frac{C_o(1+r^d)}{\sum_k \delta_k} \left(\frac{\sigma - 1}{\gamma - \sigma - 1}\right) - \beta_o b_o^2 \tag{13}$$

where L_o is total loan demand in region o.

Conditional on loan demand, banks choose the number of branches where the marginal benefit of branching is equal to the cost of branching: $\pi_o^b = \beta b_o$, generating the following expression for bank branching behavior:

[13]Recall that I am analyzing a symmetric equilibrium so b_o will be the same across bank companies.

[14]Dick [2007] and Cohen and Mazzeo [2010] show that bank branching can function as a means of quality-induced product differentiation and advertising, both towards the goal of increasing market share.

$$b_o = \frac{J_o^b}{2\beta_o L_o} \frac{\sum_k \delta_k}{(1+r_d)C_o} (\frac{\gamma}{\sigma - 1} - 1) \tag{14}$$

This says that branches are increasing proportionally with firm entry, but decreasing with firm level variable profits. This is due to the convexity of costs and the symmetry of the banking equilibrium: bank competitors cannibalize each others profits when they build branches.

To endogenize access to finance, I assume a simple externality in the banking sector: as bank branches relative to the population increase, monitoring costs go down:

$$C_o = C\left(\frac{B_o}{N_o}\right) \tag{15}$$

where B_o is the total number of bank branches in the region: $J_o^b b_o$. This function means financing costs are decreasing in bank branches, $C' < 0$, which is a simplification of results from the the theoretical and empirical literature on the relationship between banks and credit access. In effect, I am parameterizing C_o as a decreasing function of "operational distance" to banking services.

Assuming free entry in the banking sector, the total number of banks that enter is given by

$$J_o^b = \frac{L_o C_o (1 + r^d)}{\sum_k \delta_k} (\frac{\sigma - 1}{\gamma - \sigma - 1}) \tag{16}$$

First, note that in equilibrium total bank branches depend only on the branching cost parameter β_o, $b_o = \frac{1}{2\beta_o}$ This is due to the aforementioned cannibalization and symmetry. However, aggregate branching is affected by bank entry: $B_o = J_o^b \frac{1}{2\beta_o}$. The endogeneity of financial sector entry is revealed here: bank companies enter regions with more loan demand. As they enter they build bank branches and increase access to finance for firms.

To guarantee an equilibrium in the presence of this externality, I make the additional assumption that $\frac{\partial C(\cdot)^{1-\frac{\gamma}{\sigma-1}}}{\partial J_o^b} \frac{1}{J_o^b} < 1$. In essence, this means bank profits continue to decrease in bank entry even as marginal lending costs decrease.[15]

[15]This will hold true for most empirically relevant applications, because population size is large relative to bank

For the moment, I hold this endogeneity fixed and analyze the goods market equilibrium conditional on a given level of monitoring costs C_o.

2.6 Goods market equilibrium

Given the expression for loan costs and the explicit distribution of productivity, I can solve for the equilibrium level of trade in this economy. The sectoral price index is determined by firm-level pricing and the measure of active firms and can be expressed as follows:

$$P_{kd} = Y_d^{\frac{1}{\gamma}-\frac{1}{\sigma-1}} \Theta_d \sigma_p \delta_k^{\frac{\gamma(\sigma-1-\gamma)}{\sigma-1}} \tag{17}$$

$$\Theta_d^{-\gamma} = \sum_o w_o^{1-\gamma} N_o (\tau_{od}^x)^{-\gamma} (C_o(f_{od}^x))^{1-\frac{\gamma}{\sigma-1}} \tag{18}$$

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Aggregate prices are increasing in the probability of default $1-\delta_k$, decreasing in income, and increasing in the so-called "multilateral resistance" term: Θ_d. This variable is a measure of prices faced by county d weighted by their relative trade costs (Anderson and Van Wincoop [2003]). This term has the same form as in Chaney [2008], but now also reflects average financial costs. All else equal, region d faces higher prices if it is closer to regions with less bank presence.

Exports and income in this model depend on the volume of producing firms and their average revenues. Exports are given by $w_o N_o \tilde{\phi}_{kod}^{-\gamma} \sigma \bar{\pi}_{kod}$. Integrating over the productivity distribution gives me average exports per firm:

$$\bar{x}_{kod} = \sigma \bar{\pi}_{kod} = \sigma_{\bar{x}} \frac{C_o(1+r_d)}{\delta_k} f_{od}^x \tag{19}$$

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companies. At the limit, (imagine enough banks enter such that profits are now convex in costs), I assume an exogenous number of potential national bank companies to have a solution at this corner.

[16] $\sigma_p^{-\gamma} = \left[(\frac{\sigma}{\mu})^{\frac{1}{\sigma-1}} \frac{\sigma}{\sigma-1} \right]^{\sigma-1-\gamma} (\frac{\gamma}{\gamma+1-\sigma}(1+r_d))^{1-\frac{\gamma}{\sigma-1}}$

[17] $\sigma_{\bar{x}} = \sigma \frac{\sigma-1}{\gamma-\sigma-1} \frac{\gamma}{\gamma+1-\sigma}$

Per firm profits are increasing in financing costs and default risk. Intuitively, this is because as the credit constraint becomes more binding, less firms enter and thus the median producer is more productive and makes higher profits.

Using the price index, the productivity cutoff, and the aggregate export equation I can solve for equilibrium income. In Appendix A.2, I show that the profit share of aggregate regional income depends on a weighted average of expenditure shares, which I define as $\bar{\lambda}_d = \sum_l \frac{X_{dl}}{Y_l}$.[18]. Equilibrium income is then given by

$$Y_d = w_d L_d \frac{\sigma}{\sigma - \bar{\lambda}_d} \tag{21}$$

3 Model Predictions

This model is simple, but it generates important results for how finance effects city-level exports. In this section, I go over predictions from the model that show how the intensive and extensive margins of trade respond to local access to finance.

3.1 Bilateral exports

Combining the banking and goods sectors generates a gravity-style trade equation that captures typical bilateral trade features as well as financial sector variables:

$$X_{kod} = \frac{\sigma - \bar{\lambda}_o}{\sigma} Y_o Y_d \sigma_x (\frac{w_o}{\Theta_d})^{-\gamma} \left(\frac{1}{\delta_k} C\left(\frac{B_o}{N_o}\right)\right)^{1-\frac{\gamma}{\sigma-1}} \tau_{od}^{x-\gamma} f_{od}^{x^{1-\frac{\gamma}{\sigma-1}}} \tag{22}$$

$$X_{od} = \frac{\sigma - \bar{\lambda}_o}{\sigma} Y_o Y_d \sigma_x (\frac{w_o}{\Theta_d})^{-\gamma} \left(C\left(\frac{B_o}{N_o}\right)\right)^{1-\frac{\gamma}{\sigma-1}} \tau_{od}^{x-\gamma} f_{od}^{x^{1-\frac{\gamma}{\sigma-1}}} \sum_k \delta_k^{\frac{\gamma+1-\sigma}{\sigma-1}} \mu_k^{\frac{\gamma}{\sigma-1}} \tag{23}$$

[18]

$$\bar{\lambda}_d \equiv \sum_l \frac{X_{dl}}{Y_d} = w_d N_d \sum_l \left[(\frac{\sigma}{\mu})^{\frac{1}{\sigma-1}} \frac{\sigma}{\sigma-1}\right]^{-\gamma} \frac{\sigma-1}{\gamma-\sigma-1} (\frac{w_d \tau_{dl}^x}{\Theta_l \sigma_p})^{-\gamma} \left(\frac{\gamma}{\gamma-\sigma+1} C_d (1+r^d) f_{dl}^x\right)^{1-\frac{\gamma}{\sigma-1}} \sum_k \delta_k^{\frac{\gamma}{\sigma-1}-1} \tag{20}$$

[19].

The amount of bilateral exports can be decomposed into five parts. The results are the same for both sectoral and aggregate bilateral exports, as they are proportional conditional on the aggregate default risk

(1) It is increasing in the typical country size measures Y_o and Y_d. This result is typical in the literature and had been assumed in early applied trade research. In particular, it says that the elasticity of bilateral trade to importer or exporter size is one.

(2) Exports are decreasing in both variable and fixed bilateral costs to exporting. This result is identical to Chaney [2008], where the elasticity of trade to variable trade costs only depends on the productivity distribution of firms via γ, a supply-side parameter.

(3) Bilateral trade depends on the destination country's relative remoteness to the rest of the world. Recall that Θ_d is measure of how high prices are in region weighted by its distance to the countries with whom it trades. The elasticity of remoteness to trade is $\gamma > 0$ indicating that higher relative prices in d makes it easier for firms in o to compete in that market. As γ increases, productivity levels are more homogeneous and thus the aggregate market is more competitive and firms are more sensitive to aggregate price index changes.

(4) The level of wages and the share of profits in income also affect bilateral trade. First, note that $\frac{\sigma-\bar{\lambda}_o}{\sigma} Y_o w_o^{-\gamma} < Y_o$ which means that aggregate income over counts the effect of exporter size. I can write the term $\frac{\sigma-\bar{\lambda}_o}{\sigma} Y_o w_o^{-\gamma}$ as $w_o N_o w_o^{-\gamma}$, meaning the term captures origin region non-financial characteristics that increase the number of exporters. In effect, $\frac{\sigma-\bar{\lambda}_o}{\sigma} w_o^{-\gamma}$ is a downward adjustment to the effect of Y_o, reflecting that the term comprises characteristics of firm-level productivity and profits more than just labor income.

(5) Bilateral trade is decreasing in costs of financing. This component leads my first relevant empirical prediction:

[19] $\sigma_X = \left[(\frac{\sigma}{\mu})^{\frac{1}{\sigma-1}} \frac{\sigma}{\sigma-1} \right]^{-\gamma} \frac{\sigma-1}{\gamma-\sigma-1} (\frac{\gamma}{\gamma-\sigma+1}(1+r^d))^{1-\frac{\gamma}{\sigma-1}} \sigma_p^{-\gamma}$

Prediction 1: Regions with higher access to banking, $\frac{B_o}{N_o}$, will have higher bilateral exports. There are two channels at work here. First, higher financing costs mean less firms are productive enough to enter a given export market. The elasticity of exporting firms to bank costs is $-\frac{\gamma}{\sigma-1} < 0$. However, higher financing costs mean that the average productivity of exporting firms is higher and therefore their profits are higher. The elasticity of average-firm level revenues to financing costs is 1. In total, for a given trade pair, the elasticity of trade to exporter monitoring costs is $1 - \frac{\gamma}{\sigma-1} < 0$ given the assumption that $\gamma > \sigma - 1$.

(6) Industry-level bilateral trade is decreasing in default-risk, $1-\delta_k$. Looking at the combined expression $\frac{1}{\delta_k} C\left(\frac{B_o}{N_o}\right)$ gives me my second prediction:

Prediction 2: The relative effect of bank access on bilateral trade is higher in financially risky industries, $\frac{\partial X_{kod}}{\partial \delta_k \partial \frac{B_o}{N_o}} < 0$. [20] This says that for a financially risky sector ($1 - \delta_k$ high), the decrease in monitoring costs via $\frac{B_o}{N_o}$ will have a larger effect than on a sector with low default risk. In later sections, I will use indexes for asset tangibility and financial dependence to determine financial riskiness.

3.2 Extensive margin of trade

Combining the trade and goods sectors generates the following expression for number of bilateral exporters in a given sector:

$$V_{kod}^x = \sigma_J \frac{\sigma - \bar{\lambda}_o}{\sigma} Y_o Y_d \left(\frac{w_o \tau_{od}^x}{\Theta_d^{-\gamma} \sigma_p^{-\gamma}}\right)^{-\gamma} \left(\frac{1}{\delta_k} C_o\right)^{\frac{-\gamma}{\sigma-1}} f_{od}^{x^{-\frac{\gamma}{\sigma-1}}} \tag{24}$$

$$V_{od}^x = \sigma_J \frac{\sigma - \bar{\lambda}_o}{\sigma} Y_o Y_d \left(\frac{w_o \tau_{od}^x}{\Theta_d^{-\gamma} \sigma_p^{-\gamma}}\right)^{-\gamma} (C_o)^{\frac{-\gamma}{\sigma-1}} f_{od}^{x^{-\frac{\gamma}{\sigma-1}}} \sum_k (\mu_k \delta_k)^{\frac{\gamma}{\sigma-1}} \tag{25}$$

[21]

[20] $\frac{\partial X_{kod}}{\partial \delta_k \partial \frac{B_o}{N_o}} = (\frac{\gamma}{\sigma-1} - 1)\frac{X_{kod}}{C_o \delta_k} C'$. By assumption $C' < 0$ and $\frac{\gamma}{\sigma-1} > 1$ so $\frac{\partial X_{kod}}{\partial \delta_k \partial \frac{B_o}{N_o}} < 0$

[21] $\sigma_J \equiv \left[(\frac{\sigma}{\mu})^{\frac{1}{\sigma-1}} \frac{\sigma}{\sigma-1}\right]^{-\gamma} \left[\frac{\gamma}{\gamma-\sigma+1}(1+r^d)\right]^{\frac{-\gamma}{\sigma-1}}$

The interpretation of this equation is nearly identical to that intensive margin equation above. The number of bilateral exporters is a function of country sizes, exporter firm characteristics, bilateral trade costs, and the costs of export financing.

Prediction 3: Number of exporting firms is increasing in access to banking. The elasticity of exporters to finance costs is $\frac{-\gamma}{\sigma-1} < 0$. The effect here is larger than the aggregate effect, as per firm exports are increasing in bank costs. However, empirically firm-level export counts are often unobserved. So I consider the following prediction related to number of products as a function of the financial sector

Prediction 4: The number of bilateral varieties shipped is increasing in access to banking. This follows directly from above, as varieties are equivalent to firms in this model.

4 Empirical Specification and Results

In this section, I outline an approach to estimate the model predictions and show the effects of local bank access on city-level export behavior. While this model has a global equilibrium, I will be focusing on the o' subregions of one country exporting to D destinations.

4.1 Brazilian Data

I test these predictions looking at a panel of Brazilian banking and trade data from 2007-2012. Empirically, I treat "local", or the o' subregions, as Brazilian municipalities, the most geographically disaggregated administrative level in the country. This allows for a relatively precise measure of nearby banking services.

I use data on bilateral exports of HS4-level commodities aggregated to either the ISIC 3 digit industry level or the aggregate city level. Table 1 summarizes the data. The median Brazilian exporting city exports $8.2 million in goods to 12 foreign export partners. I use two different distance measures. The first is the greatest circle distance from the city to the capital of the destination country. However, Brazilian municipal trade data is based on the location of the Brazilian company that exports, not necessary the location where the good was produced. To account for this, I run specifications with a measure of export port to destination distance. I first the calculate the port's share in a city's exports to a destination country $\tilde{p}_{odp} = \frac{X_{odp}}{X_{od}}$. Then, I use this as a weight on the distance from those port cities to the destination capital: $\sum_p \tilde{p}_{odp}(1+d_{pd})$.[22]

The banking data that I use is primarily count data on Agências registered by the Central Bank of Brazil. Agências are full-service bank branches with legally set hours of operation, the most likely category of bank institution to engage in direct firm lending. State-owned banks still play a large role in credit access in Brazil. However, their branching behavior and contribution to firm-level exports at the local level is difficult to identify given the potential endogeneity of their location choices. For example, a portion of employee payroll taxes are automatically deposited at the federal government owned Caixa Econômica Federal. Brazil's largest state bank, Banco do Brasil, has a special role in distributing subsidized rural and housing credit. It is highly plausible that these institutions may move into areas with high levels of economic activity that are correlated with export behavior.

To abstract from the role of state banks, I focus on a smaller indicator of bank access: the quantity of commercial bank branches in a municipality. I define this as branches that are part of bank companies where the government does not hold majority ownership. The median Brazilian export city has approximately one commercial branch per 20,000 people.

[22]This measure is similar to Chen [2004]'s weighting scheme for calculating internal distance.

Table 1: Summary Statistics

	Mean	Median	SD
General			
GDP (1000 US Dollars)	1044252.60	187634.86	6916732.63
GDP/pop (US Dollars)	9821.14	7685.94	9612.03
Population	86091.14	25800.50	370665.43
Population Density	281.05	46.91	1033.72
Establishments	2506.75	669.50	14942.70
Banking			
Commercial Bank Branches	6.80	2.00	55.30
Commercial Branches per 10k people	0.63	0.55	0.58
Branch remoteness (KM)	872.55	644.33	691.36
Brank Branches in 1995	8.08	3.00	48.74
Exports			
Aggregate Exports (1000 US Dollars)	124370.25	8247.56	545606.54
Export Destinations	21.86	12.00	26.37
Exported Products (HS4Digit)	28.18	4.00	73.29
Distance: City to Destination(KM)	7810.39	7660.13	3217.95
Distance: Port to Destination (KM)	4846.09	4168.59	3252.18
Observations	9552		

Notes: Observations: Brazilian cities with positive trade from 2007 - 2012. Sources: IBGE, Central Bank of Brazil, Ministry of Development, Industry and Foreign Trade. Data notes: Port to Destination distance is a weighted average of distance from most used ports. Branch remoteness is a weighted average of distance to bank company headquarter cities.

4.2 Endogeneity and commercial bank branching

In this section, I formally define the bank-branch externality and discuss show how to deal with potential endogeneity.

First, I give an explicit functional form to the marginal cost function: $C(\frac{B_0}{N_0}) = \exp(-\frac{B_0}{N_0})$. This says that the marginal cost reducing externality is highly convex on its own. However, note that $\frac{\partial C(\cdot)^{1-\frac{\gamma}{\sigma-1}}}{\partial J_o^b}\frac{1}{J_o^b} = (\frac{1}{2\beta_o})(\frac{\gamma}{\sigma-1}-1)\exp\left(\frac{J_o^b}{N_o}(\frac{1}{2\beta_o})(\frac{\gamma}{\sigma-1}-1)\right)/J_o^b N_o$. As the number of bank companies in a region is generally much smaller than the population, this expression will be less than one, avoiding a corner solution.

Once this functional form has been established, there are still potential endogeneity issues in any attempt to estimate the effect of bank access on export behavior. $\frac{B_o}{N_o}$ can be correlated with the error term due to reverse causality: exporters drive loan demand and loan demand drives bank entry. To control for this, I need a predictor for $\frac{B_o}{N_o}$ that is uncorrelated with the error term.

To do this, I use a three stage estimation approach. Stage zero is a reduced-form extension of the structural banking model. First, note the symmetric, simultaneous equilibrium in the banking sector says the number of bank branches per person reduces to $\frac{B_o}{N_o} = h\left(\frac{1}{\sum_k \delta_k}(1+r^d)\frac{1}{2}\beta_o\frac{1}{N_o}\sum_d J_{od}^x f_{od}^x \frac{1}{\sum_k \delta_k}(1+r^d)\frac{1}{2}\beta_o^{-1}\right)$[23]. The primary exogenous, region-varying parameter here is the β_o the branching cost parameter.

To estimate this equation, I start from the bank company level and assume β_{ob} varies by banking company, b. In particular, I treat this variable as in information-based entry cost. Building branches is effectively expanding market reach and thus involves gathering new clients. These costs can thought of as the adverse selection issues encountered on expanding into a market as available clients may be the worst (Dell'Ariccia et al. [1999], Dell'Ariccia [2001]). In the context of relationship lending this parameter could measure the "time, effort, and resources that it takes to build lending relationships and for the losses that a bank might incur" upon entry (Hauswald and Marquez [2006]).

[23] $h(\cdot)$ is the product log function

To have a plausibly exogenous measure of branching costs, I deal with bank-company-specific geography. In particular, I focus on city to bank headquarter distance, as empirical work has shown that bank branching is decreasing in regions that are remote to the company.[24] In addition to the geographic characteristics of the bank branching decision, aggregate company-specific characteristics are exogenous to a given city's level of exports. For example, the size of a bank in terms of assets or credit operations is a national bank-company variable that determines whether a bank branches into difference regions.

As such, I express company-specific branching costs as a a function of headquarter distance, company effects, and city-level variables. Using the company-level branch equation, $b_{ob} = \frac{1}{2\beta_{ob}}$, I can then transform this into a regression of company-level branches per person on bilateral (headquarter city to export city) distance and company and export city fixed effects.

$$\frac{b_{ob}}{N_o} = \psi_o + \psi_b + \zeta_B \ln(1 + d_{ob_h}) + \epsilon_{ob} \tag{26}$$

where ψ_o is a city-level fixed effect capturing city characteristics, ψ_b captures bank company size, and d_{ob_h} is the distance to the bank headquarter region. After this estimation, I can instrument $\frac{B_o}{N_0}$ with

$$\widehat{\left(\frac{B_o}{N_o}\right)} = \sum_b \widehat{\left(\frac{b_{ob}}{N_o}\right)} \tag{27}$$

This procedure is reminiscent of the the Frankel and Romer [1999] work that uses predicted trade shares as an instrument for observed trade shares using the exogeneity of bilateral distance to identify effects.[25]

Table 2 shows the results of the bank company-level regression of estimation equation (26) . Columns (1) and (2) exclusively contain the dyadic headquarter distance term and the bank company specific fixed effect and credit operations variable. The company-specific terms are

[24] See Felici and Pagnini [2008] Buch [2005], Degryse and Ongena [2004, 2005] for this work. If we think of bank branching as bank-holding company investment, Goetz et al. [2013, 2016] show that distance is negatively correlated with bank expansion. A classic example of this process is the retail sector is the expansion of Wal-Mart in the United States (Holmes [2011])

[25] See Goetz et al. [2013] and Goetz et al. [2016] for examples of using this strategy in the banking literature. See Neumark et al. [2008] for using Wal-Mart expansion in this way.

Table 2: Company-level determinants of commercial bank branch presence

Dep. Var.: $\frac{branches}{N}$	(1) Dist	(2) FE	(3) City 1	(4) City 2	(5) City 3
Ln HQ Distance	-0.00392***	-0.00392***	-0.00408***	-0.00358***	-0.00408***
	(0.000121)	(0.000121)	(0.000180)	(0.000130)	(0.000180)
Ln Bank Credit		0.000148***	0.000148***	0.000148***	0.000148***
		(0.0000107)	(0.0000107)	(0.0000107)	(0.0000107)
Ln GDP per capita				0.00110***	0.000648**
				(0.000169)	(0.000267)
Gov't Branches				-0.0000228***	-0.000147***
				(0.00000541)	(0.0000232)
Company FE	Yes	Yes	Yes	Yes	Yes
City FE	No	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
R^2	0.110	0.110	0.115	0.110	0.115
Observations	2588608	2588608	2588608	2588608	2588608

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Notes: Standard errors clustered at the city-bank headquarter level. HQ distance is the greatest circle distance from the branching city to the bank headquarter city. Bank credit is the total bank credit operations over all branches. Government owned branches are those where the government owns a majority of the company's shares.

significant determinants of company-level branching behavior with the expected signs: larger and closer banks are more likely to enter a given region.

Columns 3-5 add various city-level characteristics including the presence of government branches, per capita income, and a city-level fixed effect. However, as noted by Ortega and Peri [2014], the city-level characteristics include variables that affect trade and are therefore part of the endogeneity that I am trying to purge from my model. What those results do show, however, is that the coefficient on company-size and headquarter distance are significant and similar across models. This indicates that estimates of the bank-company specific variables are not biased by the exclusion of city-level fixed effects and controls. Though it appears that commercial banks are less likely to branch into regions with government banks, their presence doesn't substantially change the results from columns 1 and 2.

As an additional robustness check, instead of building from the bank-level up, I can think of a weighted-average of headquarter distance as an indicator of potential branching behavior. I define a financial remoteness term that measures how far the largest bank companies are from a given city:

$$REMOTE_o = \sum_{b_h} \left(\frac{SIZE_b}{\sum_b SIZE_b} d_{ob_h} \right) \tag{28}$$

where size can stand in for various bank company characteristics such as assets, credit operations, or branch network.[26]

I consider $(\widehat{B_o/N_o})$ as constructed from estimates in column 2 of Table 2 and $REMOTE_o$ using credit operations as the size measure separately and use each in the first stage regression. The second stage of this estimation procedure will be any of the below tests of the effects of bank access on city-level export outcomes.[27]

4.3 City-level trade

4.3.1 Intensive margin

I use the functional form of the externality assumption and the instruments from above to test Prediction 1 (bank access increases bilateral trade). I take logs of the bilateral gravity equation (23), plug in $C(\frac{B_0}{N_0}) = \exp(-\frac{B_0}{N_0})$, and estimate the following :

$$\ln X_{od} = \zeta_{x1} \ln \tilde{J}_o + \zeta_{x2} \ln Y_o + \zeta_{x3} \ln Y_d + \zeta_{x4} \tilde{\tau_{od}} + \zeta_{x4} \frac{B_o}{N_o} + \psi_d + \zeta_{x5} \ln \tilde{\delta}_o + \epsilon_{od} \tag{29}$$

where $\ln \tilde{\tau_{od}} = -\gamma \ln \tau^x_{od} - (1 - \frac{\gamma}{\sigma - 1}) \ln f^x_{od}$, $\psi_d = \Theta_d^{-\gamma}$, and ϵ_{od} as the error term. The indicator for bank access appears in level form and it's coefficient is $\zeta_{x4} = \frac{\gamma}{\sigma-1} - 1 > 0$, as increased access to banking lowers effective fixed export costs and thus increases bilateral trade. ψ_d is a importer

[26] Rose and Spiegel [2009] also use financial remoteness as a plausibly exogenous way to measure financial market effects.Their indicator is the distance of a country from the one of three major global financial centers. This term is also comparable to "functional distance" in Alessandrini et al. [2009] . Their measure, however, is explicitly related to the headquarter location of *active* branches in a region and is therefore not appropriate to use for estimating *potential* bank branch presence.

[27] The results below are qualitatively robust to instruments constructed from each model in Table 2. Additionally, the results are robust to calculating $REMOTE_o$ with bank branches or bank assets.

fixed effect that is a function of multilateral resistance.

There are two other terms in this equation I need to deal with more carefully. The first is $\ln\tilde{\delta}_o = \sum_k \delta_k^{\frac{\gamma+1-\sigma}{\sigma-1}} \mu_k^{\frac{\gamma}{\sigma-1}}$, which is generated by aggregating up from the sector level. Effectively, this term is an indicator of city-level default risk that varies based on the sectoral composition of a given city. To control for this, I calculate industry shares of trade for each city and generate a new variable that is a linear combination of financial riskiness indicators that I call $xdelta_o$. The second term is $\ln\tilde{J}_o = \ln\frac{\sigma-\bar{\lambda}_o}{\sigma} - \gamma\ln w_o$. Traditionally in the gravity literature, you can absorb $\ln\tilde{J}_o$ into an exporter fixed effect. The issue is that the coefficient of interest $\frac{B_o}{N_o}$ generally varies at the city level over. To control for this, I follow a strategy laid out in Head and Mayer [2015] to generate a monadic variable that functions as an exporter fixed effect. I define $\bar{D}_o$ as the average characteristics of each exporter and calculate is as $\bar{D}_o = \frac{\sum_d \tilde{\tau}_{od}}{D}$.

Table 3 presents the results from this regression. All regressions include time fixed effects to control for aggregate time trends and time-varying destination fixed effects to control for changes in destination multilateral resistance and market size. For exporters, I include population density, firm count data, $\bar{D}_o$, and $xdelta_o$ as controls, and city-level GDP as the traditional measure of exporter size.

The first two columns are different OLS specifications of equation (29) with alternate measures for distance. The first is the traditional measure of greatest circle distance used in the trade literature. In the second, I use the weighted distance from the port city to destination country, which I carry through for the rest of my regressions. In all cases, the distance coefficients have the expected signs. The level of exports are decreasing in bilateral distance.

The most relevant coefficient in my analysis is the effect of Bank Access, measured by commercial bank branches per 10,000 people. Across the distance specifications, the result is the same: bank branch access increases the level of bilateral exports in a statistically significant way.

Columns 4-5 are alternative ways of dealing with the endogeneity of bank presence and exports, with each presenting the second stage results with different instruments for bank presence

Table 3: The effect of bank access on bilateral exports

Dep. Var.: LnXod	OLS			2SLS Predicted Branch share	2SLS Credit Remoteness	2SLS Predicted Branch share
Bank Access	0.141***	0.159***	0.167***	0.354***	0.346***	0.233***
	(0.0285)	(0.0300)	(0.0310)	(0.0893)	(0.0882)	(0.0880)
LnDist	-0.606***	-1.034***	-1.011***	-1.038***	-1.038***	-1.013***
	(0.0553)	(0.0215)	(0.0219)	(0.0217)	(0.0217)	(0.0221)
LnExporter GDP	0.552***	0.385***	0.381***	0.377***	0.377***	0.379***
	(0.0159)	(0.0159)	(0.0166)	(0.0168)	(0.0167)	(0.0169)
LnPop Density	-0.222***	-0.250***	-0.259***	-0.253***	-0.253***	-0.260***
	(0.0122)	(0.0120)	(0.0126)	(0.0121)	(0.0121)	(0.0127)
Exporter Delta	0.0273***	0.0332***	0.0332***	0.0320***	0.0321***	0.0328***
	(0.00184)	(0.00196)	(0.00198)	(0.00196)	(0.00195)	(0.00197)
Exporter Control	1.632***	1.298***	1.229***	1.286***	1.287***	1.225***
	(0.0559)	(0.0545)	(0.0541)	(0.0544)	(0.0544)	(0.0544)
Distance Measure	City	Port	Port	Port	Port	Port
CountryYearFE	Yes	Yes	Yes	Yes	Yes	Yes
YearFE	Yes	Yes	Yes	Yes	Yes	Yes
HQ regions	Yes	Yes	No	Yes	Yes	No
First Stage F				205.4	240.0	220.0
R^2	0.237	0.287	0.277	0.285	0.285	0.276
Observations	188301	188301	179390	188301	188301	179390

* p < 0.1, ** p < 0.05, *** p < 0.01.

Notes: Standard errors clustered at the exporter-year level. Bank access is comercial bank branches per 10,000 people. City distance is the greatest circle distance from the city to the destination country capital. Port distance is the weighted greatest circle distance from a city's most used ports to the destination country capital. Columns 3-6 are second stage regressions with the column title as the instrument used. Predicted branch share is estimated in column 2 of Table 2. Credit remoteness is the distance from a city to headquarter regions weighted by the credit operations of banks in that region.

as defined in Section 4.2. Column 4 uses predicted bank presence from the stage 0 regression and column 5 uses a bank-size-weighted measure of headquarter distance. Both instruments pass the weak instrument test and the coefficients on bank access remain positive and significant. For additional robustness of my results, in columns 3 and 6, I exclude regions with major bank headquarters.

Conditional on distance, foreign demand, and exporter controls, a one standard increase in bank access increases bilateral exports from 8.1% up to 20.0%.

4.3.2 Extensive margin

In place of firm-level data, I can analyze the bilateral number of varieties exported which corresponds to the number of exporters in my model. Taking logs of (25) and including the financial access externality I have a firm-level flavored bilateral gravity equation:

$$\ln V_{od} = \zeta_{v1} \ln \tilde{J}_o + \zeta_{v2} \ln Y_o + \zeta_{v3} \ln Y_d + \zeta_{v4} \tilde{\tau_{od}} + \zeta_{v4} \frac{B_o}{N_o} + \psi_d + \zeta_{x5} \ln \tilde{\delta}_o + \epsilon_{od} \tag{30}$$

This is almost identical to the aggregate bilateral equation, however $\tilde{\tau_{od}}$ is now given as $\ln \tilde{\tau_{od}} = -\gamma \ln \tau_{od}^x - \frac{\gamma}{\sigma-1} \ln f_{od}^x$ and $\zeta_{v4} = \frac{-\gamma}{\sigma-1}$.

The estimation procedure here replicates the discussion of the intensive margin above. The estimates here are presented in Table 4 and the coefficient on bank access remains positive and significant. The estimated increase in exported varieties due to a one standard deviation increase in bank access ranges from 11.7% to 43.8%.

4.4 Industry-level trade

In this section, I use industry-level trade data to allow for additional controls and to emphasize the credit mechanism at work. First, I replicate the exercise above to show the aggregate industry-level bank access effect. Second, I use measures of sector-specific default rates to show that bank access has a relatively larger effect in financially vulnerable industries.

Table 4: The effect of bank access on number of exported bilateral varieties

	OLS			2SLS		
Dep. Var.: LnVod				Predicted Branch share	Credit Remoteness	Predicted Branch share
Bank Access	0.202***	0.213***	0.208***	0.728***	0.753***	0.639***
	(0.0175)	(0.0160)	(0.0163)	(0.0448)	(0.0439)	(0.0423)
LnDist	-0.376***	-0.649***	-0.630***	-0.659***	-0.660***	-0.640***
	(0.0250)	(0.00969)	(0.00971)	(0.00977)	(0.00985)	(0.00983)
LnExporter GDP	0.248***	0.144***	0.132***	0.121***	0.120***	0.119***
	(0.00877)	(0.00658)	(0.00653)	(0.00702)	(0.00702)	(0.00687)
LnPop Density	0.0853***	0.0677***	0.0649***	0.0606***	0.0602***	0.0592***
	(0.00570)	(0.00496)	(0.00528)	(0.00572)	(0.00582)	(0.00571)
Exporter Delta	-0.0101***	-0.00631***	-0.00643***	-0.00930***	-0.00945***	-0.00884***
	(0.000797)	(0.000650)	(0.000645)	(0.000755)	(0.000757)	(0.000725)
Exporter Control	0.630***	0.419***	0.391***	0.386***	0.385***	0.361***
	(0.0272)	(0.0217)	(0.0217)	(0.0262)	(0.0265)	(0.0251)
Distance Measure	City	Port	Port	Port	Port	Port
CountryYearFE	Yes	Yes	Yes	Yes	Yes	Yes
YearFE	Yes	Yes	Yes	Yes	Yes	Yes
HQ regions	Yes	Yes	No	Yes	Yes	No
First Stage F				205.4	240.0	220.0
R^2	0.380	0.484	0.459	0.436	0.431	0.424
Observations	188634	188634	179720	188634	188634	179720

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Notes: Dependent variable is the log of total number of HS4 level varieties exported from a given city to a destination country in a given year. Standard errors clustered at the exporter-year level.Bank access is comercial bank branches per 10,000 people. City distance is the greatest circle distance from the city to the destination country capital. Port distance is the weighted greatest circle distance from a city's most used ports to the destination country capital. Columns 3-6 are second stage regressions with the column title as the instrument used. Predicted branch share is estimated in column 2 of Table 2. Credit remoteness is the distance from a city to headquarter regions weighted by the credit operations of banks in that region. 1995branches is total number of bank branches in the city in 1995. First Stage F stat is the Kleibergen-Paap rk Wald F statistic from the first stage regressions.

4.4.1 Sector-level regressions

For this specification I take logs of (22) and (24) generate estimation equations for sectoral exports and varieties:

$$\ln X_{kod} = \psi_k + \psi_d + \psi_{ok} + \zeta_1 \frac{B_o}{N_o} + \zeta_2 \ln Y_o + \zeta_3 \ln d_{od} + \bar{D}_o + \varepsilon_{od} \tag{31}$$

$$\ln V_{kod} = \psi_k + \psi_d + \psi_{ok} + \zeta_1 \frac{B_o}{N_o} + \zeta_2 \ln Y_o + \zeta_3 \ln d_{od} + \bar{D}_o + \varepsilon_{od} \tag{32}$$

where ψ_k is a sector-level fixed effect that controls for variation in default risk; ψ_d is a importer fixed effect that controls for foreign income and price indexes, and ψ_{ok} is a exporter-sector fixed effect that captures sector-specific outward multilateral resistance. As in the previous specification, I include exporter income, population density, and $\bar{D}_o$ as exporter controls, and I use the weighted port distance measure to control for bilateral trade costs.

The results in Tables 5 and 6 demonstrate that this result is robust to the further controls provided by using industry-level data. Under this setup, increasing bank access increases industry-level bilateral trade with an effect ranging from 10.0% to 58.7% and industry-level bilateral varieties from 5.0% to 20.8%.

4.4.2 Identifying the credit channel

To demonstrate that it is the credit channel at work in these results, my empirical strategy relies on the relationship between sector-specific default rates and bank access. Following Manova [2013], I define two industry-specific measures: asset tangibility and financial dependence using indexes calculated by Braun [2005]. I apply these to Brazilian city-level data at the ISIC 3-digit level.

Financial dependence is a measure of how reliant firms are on external funds. This measure is based on the percentage of capital expenditures financed internally. In particular, it is capital expenditures less cash flows from operations divided by total capital expenditure. This value is

Table 5: The effect of bank access on industry-level bilateral exports

	OLS			2SLS		
Dep. Var.: LnXkod						
Bank Access	0.195***	0.172***	0.238***	0.925***	1.012**	0.509**
	(0.0480)	(0.0489)	(0.0457)	(0.183)	(0.454)	(0.204)
LnDist	-0.829***	-0.770***	-0.760***	-0.821***	-0.761***	-0.758***
	(0.0176)	(0.0171)	(0.0174)	(0.0176)	(0.0175)	(0.0174)
LnExporter GDP	0.224***	0.300***	0.234***	0.117***	0.177**	0.197***
	(0.0182)	(0.0183)	(0.0202)	(0.0368)	(0.0722)	(0.0306)
LnPop Density	-0.169***	-0.178***	-0.127***	-0.147***	-0.152***	-0.119***
	(0.0225)	(0.0225)	(0.0278)	(0.0266)	(0.0296)	(0.0269)
Exporter Control	0.346***	0.214***	0.224***	0.394***	0.273***	0.225***
	(0.0591)	(0.0579)	(0.0589)	(0.0649)	(0.0716)	(0.0595)
Importer+YearFE	Yes	Yes	Yes	Yes	Yes	Yes
YearFE	Yes	Yes	Yes	Yes	Yes	Yes
SectorFE	Yes	Yes	Yes	Yes	Yes	Yes
ExporterRegion+SectorFE	Yes	Yes	Yes	Yes	Yes	Yes
Sector+CountryFE	No	Yes	Yes	No	Yes	Yes
HQ regions	Yes	Yes	No	Yes	Yes	No
First Stage F				69.94	57.81	75.57
R^2	0.498	0.537	0.544	0.495	0.531	0.544
Observations	498012	497607	443043	498012	497607	443043

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Notes: Standard errors clustered at the exporter-year level. Bank access is comercial bank branches per 10,000 people. Columns 3-6 are second stage regressions. Colums 4 and 6 used the bank prediction measure. Column 5 uses bank remoteness. Colums 3 and 6 exclude headquarter regions from the estimation.

Table 6: The effect of bank access on number of industry-level exported bilateral varieties

	OLS			2SLS		
Dep. Var.: LnVkod						
Bank Access	0.0921***	0.0967***	0.0874***	0.354***	0.360***	0.222***
	(0.0108)	(0.0114)	(0.0113)	(0.0354)	(0.0366)	(0.0310)
LnDist	-0.203***	-0.199***	-0.193***	-0.206***	-0.202***	-0.195***
	(0.00629)	(0.00642)	(0.00652)	(0.00641)	(0.00658)	(0.00649)
LnExporter GDP	0.0772***	0.0847***	0.0698***	0.0506***	0.0583***	0.0598***
	(0.00459)	(0.00504)	(0.00424)	(0.00523)	(0.00545)	(0.00454)
LnPop Density	-0.0133***	-0.0108***	-0.0132***	-0.0104**	-0.00802*	-0.0119***
	(0.00390)	(0.00412)	(0.00444)	(0.00450)	(0.00472)	(0.00459)
Exporter Control	0.135***	0.130***	0.121***	0.115***	0.111***	0.103***
	(0.0203)	(0.0210)	(0.0200)	(0.0213)	(0.0218)	(0.0202)
Importer+YearFE	Yes	Yes	Yes	Yes	Yes	Yes
YearFE	Yes	Yes	Yes	Yes	Yes	Yes
SectorFE	Yes	Yes	Yes	Yes	Yes	Yes
Sector+CountryFE	No	Yes	Yes	No	Yes	Yes
HQ regions	Yes	Yes	No	Yes	Yes	No
First Stage F				171.6	105.7	107
R^2	0.763	0.774	0.782	0.755	0.766	0.780
Observations	498856	498451	443888	498856	498451	443888

* p < 0.1, ** p < 0.05, *** p < 0.01.

Notes: Standard errors clustered at the exporter-year level. Bank access is comercial bank branches per 10,000 people. Columns 3-6 are second stage regressions. Colums 4 and 6 used the bank prediction measure. Column 5 uses bank remoteness. Colums 3 and 6 exclude headquarter regions from the estimation.

negative if cash flows are higher than capital expenditure, i.e. there are enough internal funds to finance operations. This has been used in many studies of financial development to tease out causal effects: Rajan and Zingales [1998] show that better financial markets increase growth in sectors dependent on external finance. Here, I argue that perceived default risk, $1-\delta_k$ is increasing in financial dependence. While my model requires that firms finance the entirety of their foreign fixed costs, banks realize that firms will be better able to pay back if they have cash on hand. In this index, for example, professional and scientific equipment is highly dependent on finance, while the tobacco sector relies on internal funds.

Asset tangibility is a way to capture whether or not firms have collateral for banks to take in the event of default. It is defined as the ratio of physical asset value to total value of a firm. Physical assets include property, buildings, and equipment, things that a bank could seize in the case of bankruptcy. A sector with a larger proportion of physical assets has high asset tangibility and is a lower default risk for banks, as they are able to recoup a portion of the firms assets in the case of default. An example of a highly tangible sector is the iron and steel industry, while footwear producers have less physical assets as a proportion of their total value.

I express the interaction of C_o with δ_k as a function of bank access, bank access interacted with asset tangibility and financial dependence, and various fixed effects to estimate prediction 2: the relative effect of bank access on bilateral trade is higher in financially risky industries. The estimation equations for city-level industry exports and city level industry varieties are:

$$\ln X_{od}^k = \psi_k + \psi_d + \zeta_1 \frac{B_o}{N_o} + \zeta_2 \frac{B_o}{N_o} \cdot FinDep_k + \zeta_3 \frac{B_o}{N_o} \cdot AssetTan_k + \zeta_3 \ln Y_o + \zeta_4 \ln d_{od} + \zeta_5 \bar{D}_o + \varepsilon_{od} \quad (33)$$

$$\ln V_{od}^k = \psi_k + \psi_d + \zeta_1 \frac{B_o}{N_o} + \zeta_2 \frac{B_o}{N_o} \cdot FinDep_k + \zeta_3 \frac{B_o}{N_o} \cdot AssetTan_k + \zeta_3 \ln Y_o + \zeta_4 \ln d_{od} + \zeta_5 \bar{D}_o + \varepsilon_{od} \quad (34)$$

I expect the total effect of bank access to be positive, $\zeta_1 > 0$, but for that effect to be larger in sectors with high financial dependence $\zeta_2 > 0$ and low asset tangibility $\zeta_3 < 0$.

Table 7 presents the results from this estimation. Columns 1-3 replicate equation 33 above and the results are significant with the coefficients matching my predicted signs. The extensive margin results in columns 4-6 have the correct signs but are not consistently significant. It appears that the extensive margin of industry-level exports is driven primarily by the capital structure of firms via the financial dependence measure.

Across all specifications the estimates match the predicted relationship between bank access and financial vulnerability. More tangible sectors respond less to increased bank branches and financially dependent sectors respond more. For example, we would expect to see large effects in the professional and scientific industry with asset tangibility in the 10th percentile and external financial dependence in the 99th. A one standard deviation increase in bank access raises bilateral exports in this sector by 46.0% and bilateral varieties exported by 10.5%. Whereas in the industrial chemical sector with asset tangibility in the 80th percentile and financial dependence in the 15th percentile, we would only see exports increase by 3.0% and varieties decrease by .7%.[28].

5 Conclusion

In this paper, I approach the "black box" of financial development at the national level and show that it is theoretically and empirically relevant at the city-level in Brazil. In particular, I augment a heterogeneous firms model with a banking sector and a geographically varying financial constraint. The model is tractable and allows me to estimate bilateral gravity equations at the city and industry level. The inclusion of the banking sector is a micro-foundational approach to the geographic spread of financial development: banks expand outward from their headquarters a rate that is decreasing in distance, increasing in bank size, and increasing in the level of development of the markets they enter. I focus on the distance and bank size characteristics to deal with this underlying endogeneity. This allows me to identify a causal relationship between city-level financial development, proxied by bank branches per person, and a large scale firm

[28]Results here are based on coefficients from the models with the full set of controls in columns 3 and 6.

Table 7: Industry-level exports, bank access, and financial vulnerability

	Log Industry Exports			Log Industry Varieties		
	(1)	(2)	(3)	(4)	(5)	(6)
Branches per 10k people	0.303**	0.279**	0.464***	0.0109	0.0378	0.0270
	(0.0991)	(0.0989)	(0.112)	(0.0225)	(0.0202)	(0.0220)
Branches x FinDep	0.263**	0.378***	0.539***	0.286***	0.284***	0.295***
	(0.0865)	(0.0871)	(0.102)	(0.0317)	(0.0264)	(0.0314)
Branches x AssetTan	-0.625*	-0.744**	-1.251***	-0.0419	-0.0905*	-0.0823
	(0.281)	(0.276)	(0.322)	(0.0488)	(0.0424)	(0.0481)
LnDist	-0.830***	-0.771***	-0.761***	-0.196***	-0.200***	-0.193***
	(0.0176)	(0.0171)	(0.0174)	(0.00621)	(0.00647)	(0.00654)
LnExporter GDP	0.220***	0.295***	0.224***	0.0617***	0.0828***	0.0675***
	(0.0184)	(0.0187)	(0.0205)	(0.00391)	(0.00504)	(0.00419)
Exporter Control	0.351***	0.220***	0.232***	0.124***	0.129***	0.119***
	(0.0592)	(0.0581)	(0.0590)	(0.0193)	(0.0210)	(0.0199)
LnPop Density	-0.169***	-0.178***	-0.126***	-0.0148***	-0.00994*	-0.0120**
	(0.0226)	(0.0226)	(0.0278)	(0.00416)	(0.00412)	(0.00443)
SectorFE	Yes	Yes	Yes	Yes	Yes	Yes
Importer+YearFE	Yes	Yes	Yes	Yes	Yes	Yes
YearFE	Yes	Yes	Yes	Yes	Yes	Yes
ExporterRegion+SectorFE	Yes	Yes	Yes	No	No	No
Sector+CountryFE	No	Yes	Yes	No	Yes	Yes
HQ region	Yes	Yes	No	Yes	Yes	No
R^2	0.499	0.537	0.545	0.772	0.774	0.783
Observations	498012	497607	443043	444294	498451	443888

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Notes: Standard errors clustered at the city-year level. Log distance is the (weighted) distance in KM from the origin port to the destination country capital. Branches x FinDep is Branches per 10k people interacted with the industry-level financial dependence level. Branches x AssetTang is Branches per 10k people interacted with the industry-level asset tangibility level.

outcome: exports.

At the industry-level, I show the mechanisms by which bank access effects trade: financially vulnerable sectors export more in the presence of bank branches. My results here show that the effects captured by Manova [2013] at the country level are not equally distributed.

My use of Brazilian data is evidence that my results are part of an economic development story. Brazil is a middle income country that has experienced relatively high levels of financial development. This has important implications for regional development policy: poorer regions might lag behind the rest of the country if they do not have access to the same levels of financing. Any welfare gains may be concentrated in wealthy cities close to bank headquarters. Future research can work to untangle the role of bank regulation policy and the role of state banks in either exacerbating or ameliorating these trends toward unequal within-country financial development.

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A Model Derivations

A.1 Expression for Loan Demand Elasticity and Markup

Loan demand is given by: $L_{ko} = \left[(\frac{\sigma}{\mu})^{\frac{1}{\sigma-1}} \frac{\sigma}{\sigma-1} \right]^{-\gamma} w_o^{1-\gamma} N_o \left[R_{ko}\right]^{\frac{-\gamma}{\sigma-1}} \sum_d \tau_{od}^{x-\gamma} f_{od}^{x1-\frac{\gamma}{\sigma-1}} \left[P_d Y_d^{\frac{1}{\sigma-1}}\right]^{-\gamma}$.

Bank companies take aggregate prices indexes as given, so I absorb all variables not varying directly with the price of loans into the term Γ_1,[29] allowing me to write $L_{ko} = \Gamma_1 \left[R_{ko}\right]^{\frac{-\gamma}{\sigma-1}}$

Differentiating with respect to R_o finally gives us this result: $\eta = -\frac{dL}{dR} / \frac{L}{R} = \frac{\gamma}{\sigma-1}$. Plugging this into $R_o = \frac{\eta}{\eta-1} \frac{C_o}{1-\delta_o}$ gives us $R_o = \frac{\gamma}{\gamma+1-\sigma} \frac{C_o}{1-\delta_o}$

A.2 Equilibrium Income

In this section, I show that the profit share of aggregate regional income depends on a weighted average of foreign import (home export) trade shares, that I define as $\bar{\lambda}_o = \sum_d \frac{X_{od}}{Y_d}$ resulting in an equilibrium income of $Y_o = w_o N_o \frac{\sigma}{\sigma - \bar{\lambda}_o}$.

First, recall that $Y_d = w_d N_d + \Pi_d$. Define $\pi_d = \frac{\Pi_d}{w_d N_d}$, then $Y_d = w_d N_d (1 + \pi_d)$. Next, note that I can write $\frac{X_{od}}{Y_d}$ as a function of exporting firms and per firm export trade shares. $\frac{X_{od}}{Y_d} = w_o N_o \lambda_{od}$ where $\lambda_{od} = \left[(\frac{\sigma}{\mu})^{\frac{1}{\sigma-1}} \frac{\sigma}{\sigma-1} \right]^{-\gamma} \frac{\sigma-1}{\gamma-\sigma-1} (\frac{w_o \tau_{od}^x}{\Theta_d \sigma_p})^{-\gamma} \left(\frac{\gamma}{\gamma-\sigma+1} C_o (1 + r^d) f_{od}^x \right)^{1-\frac{\gamma}{\sigma-1}} \sum_k \delta_k^{\frac{\gamma}{\sigma-1}-1}$, a function of parameters and trade costs.

$\bar{\lambda}_d = \sum_o \frac{X_{do}}{Y_d} = w_d N_d \sum_o \left[(\frac{\sigma}{\mu})^{\frac{1}{\sigma-1}} \frac{\sigma}{\sigma-1} \right]^{-\gamma} \frac{\sigma-1}{\gamma-\sigma-1} (\frac{w_d \tau_{do}^x}{\Theta_o \sigma_p})^{-\gamma} \left(\frac{\gamma}{\gamma-\sigma+1} C_d (1 + r^d) f_{do}^x \right)^{1-\frac{\gamma}{\sigma-1}} \sum_k \delta_k^{\frac{\gamma}{\sigma-1}-1}$

(1) Balanced Trade

Balanced trade says that aggregate exports equal aggregate imports. For country o: $\sum_d X_{od} = \sum_d X_{do}$.

$\sum_d w_o N_o \lambda_{od} Y_d = \sum_d w_d N_d \lambda_{do} Y_o \iff w_o N_o \sum_d \lambda_{od} Y_d = Y_o \sum_d w_d N_d \lambda_{do} \iff$

$w_o N_o \sum_d \lambda_{od} Y_d = Y_o \sum_d w_d N_d \lambda_{do} \iff \frac{Y_o}{w_o N_o} = \frac{\sum_d \lambda_{od} Y_d}{\sum_d w_d N_d \lambda_{do}} \iff 1 + \pi_o = \frac{\sum_d \lambda_{od} Y_d}{\sum_d w_d N_d \lambda_{do}}$

(2) Aggregate profits

$\Pi_o = \sum_d \frac{1}{\sigma} X_{od} = \sum_d \frac{1}{\sigma} n_o L_o \lambda_{od} Y_d$, so $\pi_o = \sum_d \frac{1}{\sigma} \lambda_{od} Y_d$

Combining the results from (1) and (2):

[29] $\Gamma_1 \equiv \left[(\frac{\sigma}{\mu})^{\frac{1}{\sigma-1}} \frac{\sigma}{\sigma-1} \right]^{-\gamma} w_o^{1-\gamma} N_o \sum_d \tau_{od}^{x-\gamma} f_{od}^{x1-\frac{\gamma}{\sigma-1}} \left[P_d Y_d^{\frac{1}{\sigma-1}}\right]^{-\gamma}$

$\frac{1+\pi_o}{\pi_o} = \frac{\sum_d \lambda_{od} Y_d}{\sum_d w_d N_d \lambda_{do}} \frac{\sigma}{\sum_d \lambda_{od} Y_d}$

$1 + \pi_o = \frac{\sigma}{\sigma - \sum_d w_d N_d \lambda_{do}}$, where $w_d N_d \lambda_{do} = \frac{X_{do}}{Y_o}$, or the share of o income spent on d.

With $\sum_d w_d N_d \lambda_{do} = \bar{\lambda}_o$

Thus $1 + \pi_o = \frac{\sigma}{\sigma - \bar{\lambda}_o}$ and $Y_o = w_o N_o \frac{\sigma}{\sigma - \bar{\lambda}_o}$