Dissecting the Effect of Credit Supply on Trade: Evidence from Matched Credit-Export Data *

Daniel Paravisini
Columbia GSB, NBER, BREAD

Veronica Rappoport
Columbia GSB

Philipp Schnabl
NYU Stern, CEPR

Daniel Wolfenzon
Columbia GSB, NBER

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Abstract

We estimate the elasticity of exports to credit using matched customs and firm-level bank credit data from Peru. To account for non-credit determinants of exports, we compare changes in exports of the *same* product and to the *same* destination by firms borrowing from banks differentially affected by capital flow reversals during the 2008 financial crisis. We obtain elasticity estimates for the intensive and extensive margins of exports, size and frequency of shipments, and the method of freight and payment. Our results suggest that the credit shortage reduces exports through raising the cost of working capital for general production, rather than the cost of financing export-specific cash cycles or sunk entry investments.

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1 Introduction

The role of banks in the amplification of real economic fluctuations has been debated by policymakers and academics since the Great Depression (Friedman and Schwarz (1963), Bernanke (1983)). The basic premise is that funding shocks to banks during economic downturns increase the real cost of financial intermediation and reduce borrowers access to credit and output. Through this channel, international commercial banks have been shown to represent an important source of contagion during periods of international capital reversals.[1] Although there is now a large body of evidence suggesting that negative bank credit shocks may affect economic activity, the magnitude of the sensitivity of output to credit shortages is unknown, and the underlying economic mechanisms behind this sensitivity are less understood.[2]

In this paper we study empirically the impact of bank credit shortages on economic activity using disaggregated firm export data. Measuring firm output with disaggregated export data allows us to dissect the effect of credit on economic activity along three novel dimensions. First, we can empirically decompose the effect of credit on output into the credit supply shock and the sensitivity of exports to credit fluctuations. In doing so, we provide the first estimates of a firm's elasticity of output to credit, a key input for parameterizing quantitative analysis. Second, customs data at the shipment level allows us to decompose the export elasticity to credit in its intensive and extensive margins, as well as measuring the elasticity of other dimensions of the export activity (shipment size and frequency, freight and payment method). Third, we can analyze how the export elasticity to credit varies across firms, product and export flow characteristics. These decompositions provide insights into the channel through which credit fluctuations affect exports and output.[3]

[1] See Schnabl (2010), Cetorelli and Goldberg (2010), Puri, Rocholl and Steffen (2011), and IMF (2009).

[2] For early evidence see, for example, Bernanke and Blinder (1992), Kashyap, Lamont and Stein (1994), Kashyap and Stein (2000), Peek and Rosengren (2000), and Ashcraft (2005).

[3] Progress along these dimensions in the literature that studies the effect of financial shocks on trade

We study the export behavior of Peruvian firms during the 2008 financial crisis. The funding of banks operating in Peru was negatively affected by the reversal of capital flows during the crisis. We use this funding shortage, which was particularly pronounced among banks with a high share of foreign liabilities, as a source of variation for the supply of credit to their related firms. To overcome concerns that unobserved demand and input market shocks might be correlated with the credit supply shock, we rely on the disaggregated nature of our data to account for these non-credit shocks: We compare the export growth of the *same* product and to the *same* destination of firms that borrow from banks that were subject to these heterogeneous funding shocks.

To illustrate the intuition behind this approach consider, for example, two firms that export *Men's Cotton Overcoats* to the *U.S.*[4] Suppose that one of the firms obtains all its credit from Bank A, which had a large funding shock, while the other firm obtains its credit from Bank B, which did not. Changes in the demand for overcoats in the U.S., or changes in the financial condition of coat importers in the U.S. should, in expectation, affect exports by both firms in a similar way. Also, any real shock to the production of overcoats in Peru, e.g. changes in the price of cotton or wage fluctuation in the garment industry, should affect both firms' exports the same way. Thus, the change in export performance in a product-destination of a firm that borrows from Bank A relative to a firm that borrows from Bank B isolates the effect of credit on exports. We use an instrumental variable approach based on this intuition to estimate the credit elasticity of exports.

We start by showing that banks that rely heavily on foreign funding before the financial crisis reduced significantly the supply of credit when capital flows reversed during 2008.

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has been limited by the use of export data aggregated at the sector-destination level or the firm level, and/or the unavailability of bank credit information. See, for example, Amiti and Weinstein (2009), Bricongne, Fontagne, Gaulier, Taglioni and Vicard (2009), Iacovone and Zavacka (2009), and Chor and Manova (2010).

[4]The example coincides with the 6-digit product aggregation in the Harmonized System, used in the paper.

We demonstrate, using the within-firm estimator from recent work on the lending channel, that the supply of credit by banks with above average share of foreign liabilities declined by 17% after July 2008.[5] Consistent with the hypothesis that the credit supply decline was caused by the foreign funding shortage, the entire credit supply decline occurs through foreign currency denominated loans.

Our results on the credit elasticity of exports are as follows. On the intensive margin, we find that a 10% reduction in the supply of credit results in a contraction of 2.3% in the (one year) volume of export flows for those firm-product-destination flows active before and after the crisis. This elasticity does not vary with the size of the export flow. On the extensive margin, a negative credit supply shock reduces the number of firms that continue exporting to a given market, with an elasticity of 0.36. This effect is particularly important for small export flows: a 10% decline in the supply of credit reduces the number of firms exporting to a product-destination by 5.4%, if the initial export flow volume was below the median. However, the credit shock does not significantly affect the number of firms entering an export market.

The estimated intensive and extensive margin elasticities provide new insights on the relationship between exporters' production function and their use of credit. Consider, for example, the benchmark model of trade with sunk entry costs.[6] In such a framework, a negative credit shock affects the entry margin, but once the initial investment is paid, credit fluctuations do not affect the intensive margin of trade or the probability of exiting an export market. Yet, we find positive elasticities both in the intensive and continuation margins, suggesting that credit shocks affect the *variable* cost of exporting. This would

[5]For applications of within-firm estimators in banking see, for example, Gan (2007), Khwaja and Mian (2008), Paravisini (2008), Iyer, Lopes, Peydro and Schoar (2010), Iyer and Peydro (2010), Schnabl (2010), Jimenez, Mian, Peydro and Saurina (2011a) and Jimenez, Ongena, Peydro and Saurina (2011b).

[6]See, among others, Baldwin and Krugman (1989), Roberts and Tybout (1999), and Melitz (2003). Motivated by the important fixed costs involved in entering a new market—i.e. setting up distribution networks, marketing– Chaney (2005) develops a model where firms are liquidity constrained and must pay an export entry cost. Participation in the export market is, as a result, suboptimal.

be the case, for example, if banks financed exporters' working capital, as in Feenstra, Li and Yu (2011). By increasing the unit cost of production, adverse credit conditions reduce the equilibrium size and profitability of exports. In combination with fixed costs, the profitability decline induces firms to discontinue small export flows, which are close to the break-even point.

We further characterize the nature of the fixed cost of exporting by analyzing how credit supply alters firms' freight practices. After a credit shock, firms adjust the intensive margin of exports by changing the frequency of shipments of a given product to a given destination (with elasticity 0.14), while keeping the volume size of the shipment constant. This suggests the existence of a fixed cost of exporting at the shipment level. The transportation method chosen by the exporter is also elastic to credit: firms are less likely to ship by air after a negative credit shock. On the other hand, a credit shock to the exporter is not found to alter the credit conditions agreed in the trade contract (i.e., the fraction of the contract paid in advanced by the importer).

To explore whether our results are specific to the role of credit in export activities, we measure the heterogeneity of the estimated elasticity across destinations, transport means, and the importer's method of payment. These dimensions have been suggested to increase the sensitivity of exports to credit beyond that of domestic sales: distance to markets, longer freight times, and delay in international payments imply longer cash cycles and higher working capital needs.[7] If export-related working capital needs represent a large fraction of the overall working capital of the firm, these factors would result in a higher export sensitivity to a credit shortage. We find, however, that the elasticity of exports to credit does not vary in the cross section with distance to the destination market, freight speed (ground and sea versus air), or the payment method (cash versus

[7]See Hummels (2001), Auboin (2009), Amiti and Weinstein (2009), Antras and Foley (2011), and *Doing Business* by the World Bank for suggestive evidence and Ahn (2010), Feenstra et al. (2011), and Schmidt-Eisenlohr (2010) for related theory.

credit). This suggests that the observed sensitivities do not result from changes in the cost of funding working capital that is specific to the exporting activity. Instead, the results suggest that the computed elasticity of exports to finance results from the cost of funding the firm's requirements of working capital for production, irrespectively of the market of destination.

Our estimates correspond to the elasticity of exports to short-run credit fluctuations. We explore whether factors assumed in prior research to affect the sensitivity of exports to long-term financial conditions can predict the effect of short-term credit shocks. Among other dimensions, we look at the heterogeneity of the elasticity across sectors that differ in terms of their external finance dependence, as measured in Rajan and Zingales (1998).[8] We find that the elasticity of exports to credit shocks is constant across sectors with different measure of external finance dependence. This result suggests that the elasticity to long-term and short-term changes in financial conditions reflect different aspects of the firm's use of credit. The former varies with the firm's technological requirements of capital in sectors characterized by important entry costs or fixed investments. The latter is related to the funding of working capital. They are complementary parameters that characterize the link between exports and credit.

We find that accounting for the determinants of exports at the product-destination level is necessary for obtaining an unbiased estimate of the magnitude of the credit shock on output. The elasticities and overall impact of the credit shock on exports are overestimated by 65% to 95% when export demand and input price variations are unaccounted for. This implies that firms and banks are not matched at random, but instead, banks with a high share of foreign liabilities specialize in products and destination markets disproportionately hit by non-credit factors during the 2008 international crisis.[9]

[8]For examples of research using the Rajan and Zingales (1998) measure as a proxy for credit constraints in trade see, for example, Beck (2003), Manova (2008), and Manova, Wei and Zhang (2009).

[9]Bank specialization is consistent with Olsen (2011), which proposes a model in which banks build reputation in export markets through repeated interactions.

The sizable magnitude of the bias emphasizes the importance of non-credit factors during the great trade collapse.[10] Indeed, in the case of Peru, our estimates suggest that while bank credit appears to have a first order effect on trade, the bulk of the decline in the volume of exports during the analysis period is explained by the drop in international demand for Peruvian goods. Peruvian exports volume growth was -9.6% during the year following July 2008, almost 13 percentage points lower than the previous year. Assuming that only banks with above average foreign liabilities to assets reduced their supply of credit, the estimated elasticities imply that the credit supply decline accounts for about 15% of the missing volume of exports.

The rest of the paper proceeds as follows. Section 2 describes the data. Section 3 describes the empirical strategy. Section 4 shows the estimates of the export elasticity to credit supply. Section 5 analyzes how the sensitivity of exports to credit shocks varies according to observable characteristics of the export flow. Section 6 estimates the importance of credit and non-credit factors in the estimation of the Peruvian exports drop during the 2008 crisis. Section 7 performs identification and robustness tests on our baseline estimation strategy. Finally, section 8 concludes.

2 Data Description

We use four data sets: bank level data on Peruvian banks, loan level data on credit in the domestic banking sector, customs data for Peruvian firms, and information on firms' country of ownership from *Top Peru*, a private data provider.

We collect the customs data from the website of the Peruvian tax agency (Superintendence of Tax Administration, or SUNAT). Collecting the export data involves using a web crawler to download each individual export document. To validate the consistency

[10] For evidence of non-financial determinants of the 2008 trade collapse, see Alessandria, Kaboski and Midrigan (2010), Bems, Johnson and Yi (2010), Eaton, Kortum, Neiman and Romalis (2010), and Levchenko, Lewis and Tesar (2010).

of the data collection process, we compare the sum of the monthly total exports from our data, with the total monthly exports reported by the tax authority. On average, exports from the collected data add up to 99.98% of the exports reported by SUNAT. We match the loan data to export data using a unique firm identifier assigned by SUNAT for tax collection purposes.

The bank and credit data are from the Peruvian bank regulator, Superintendence of Banking, Insurance, and Pension Funds (SBS). All data are public information. The bank data consist of monthly financial statements for all of Peru's commercial banks from January 2007 to December 2009. Columns 1 to 3 in Table 1 provide descriptive statistics for the 13 commercial banks operating in Peru during this period.[11] The credit data are a monthly panel of the outstanding debt of every firm with each bank operating in Peru.

Peruvian exports in 2009 totaled almost $27bn, approximately 20% of Peru's GDP. North America and Asia are the main destinations of Peruvian exports; in particular United States and China jointly account for approximately 30% of total flows. The main exports are extractive activities: goods derived from gold and copper account for approximately 40% of Peruvian exports. Other important sectors are food products (coffee, asparagus, and fish) and textiles.

In the time series, Peruvian exports grew steadily over the last decade until the 2008 financial crisis and suffered a sharp drop after 2008. Figure 1 shows the monthly (log) export flows between 2007 and 2009. Peak to trough, monthly exports dropped around 60% in value (40% in volume) during the 2008 financial crisis. The timing and magnitude of this decline aligns closely with the sharp collapse of world trade during the last quarter of 2008.

Panel 1 in Table 2 provides descriptive statistics of Peruvian exporters. Our data cover the universe of exporters, which are all firms with at least one export shipment registered

[11] Although included in the regressions, the statistics in Table 1 do not describe the Savings and Loans institutions because their participation in lending to exporters is negligible.

between July 2007 and June 2009. The descriptive statistics correspond to the period July 2007-June 2008, prior to the capital flow reversal caused by the 2008 crisis (next section explains this timing choice in more detail). The average bank debt outstanding of the universe of exporters as of December 2007 is $1.01 million and the average level of exports is $3.3 million FOB (Free On Board). The average firm exports to 2.7 destinations, out of a total of 198. The average firm exports 5.3 four-digit products (out of a total of 1,103 products with positive export flows in the data). Our empirical analysis in Section 4 is based on exporting firms with positive debt in the domestic banking sector, both, before and after the negative credit supply shock. As shown in Table 2, firms in this subsample are larger than in the full sample. For example, average exports in the analysis sample is $4.0 million, and average debt outstanding is $1.25 million.

The unit of observation in our baseline regressions is a firm-product-destination annual export flow. Panel 2 in Table 2 provides the descriptive statistics for the universe of 53,690 export flows and for the 47,810 observations that correspond to our sample of exporters. The average annual export flow in our sample is US$184,800 FOB (446,400 kg), and is distributed into 2.17 shipments. Approximately a third of these export flows are paid in advanced by the importer. A similar proportion is shipped by air, the rest is transported by sea or ground. To estimate the effect of credit on the intensive margin of trade, the sample is restricted to around 16,500 firm-product-destination export flows that are positive (at least one shipment), both, in the period July 2007-June 2008 and July 2008-June 2009, the years before and after the beginning of the capital flow reversal. The effect on the extensive margin is estimated using all positive firm-product-destination export flows.

In order to analyze how the sensitivity of exports to credit varies across multinational and domestic, we combine the credit and export data with information from *Top Peru*, a private data provider that publishes annual information on the 10,000 largest companies

in Peru. For the largest 500 firms, Top Peru provides information on equity held by foreign companies. We use the unique tax identifier to merge our data to the 2004 Top Peru data set and classify firm as multinational if at least 50% of the firm are foreign-owned. With this classification, 4% of the firms in the analysis sample are foreign-owned affiliates of a multinational firm, which account for 9.2% of product-destination export flow (see Table 2).

3 Empirical Strategy

This section describes our approach to identifying the causal effect of finance on exports. Consider the following general characterization of the level of exports by firm i of product p to destination country d at time t, X_{ipdt}.

$$X_{ipdt} = X_{ipdt}(H_{ipdt}, C_{it}). \tag{1}$$

The first argument, H_{ipdt}, represents determinants of exports other than finance, i.e. demand for product p in country d, financial conditions in country d, the cost of inputs for producing product p, the productivity of firm i, etc. The second argument, C_{it}, represents the amount of credit taken by the firm.

We are interested in estimating the elasticity of trade to credit: $\eta = \frac{\partial X}{\partial C}\frac{C}{X}$. The identification problem is that the amount of credit, C_{it}, is an equilibrium outcome that depends on the supply of credit faced by the firm, S_{it}, and the firm's demand for credit, which may be given by the same factors, H_{ipdt}, affecting the level of exports:

$$C_{it} = C_{it}(H_{ipdt}, ..., S_{it}). \tag{2}$$

Our empirical strategy to address this problem is based on two pillars. First, we instru-

ment for the supply of credit, using shocks to the balance sheet of the banks lending to firm i. This empirical approach obtains unbiased parameters if banks and firms are randomly matched. However, if banks specialize by firms' product or destination markets, the instrument may be correlated to factors that affect exports though channels other than the supply of credit. For example, suppose that banks suffering a negative balance sheet shock specialize in firms that export *Men's Cotton Overcoats* to the U.S. If the demand for Men's Cotton Overcoats in the U.S. drops disproportionately during the crisis, we would erroneously attribute this decline in exports to the credit supply shock.

To avoid potential bias due to non-random matching of firms and banks, a second pillar of our empirical strategy involves controlling for all heterogeneity in the cross section with firm-product-destination fixed effects, and for shocks to the productivity and demand of exports with product-country-time dummies.[12] Instead of comparing total exports across firms, our estimation compares exports within product-destinations. In the example above, our estimation procedure compares the change in Men's Cotton Overcoat exports to the U.S. by a firm that is linked to a negatively affected bank, relative to the change in Men's Cotton Overcoat exports to the U.S. of a firm whose lender is not affected.

The identification assumption is that factors other than bank credit that may affect the exports of mens' cotton overcoats to the U.S. differentially across these two firms during the crisis are not related to the banks the firms borrow from. This identification assumption is much weaker than the parallel assumption at the firm-level. A violation of this identification assumption would require, for example, that production stoppages due to equipment breakdowns become more frequent during the crisis for firms that borrow from banks with a high fraction of foreign liabilities.[13] Such a correlation between bank

[12]Subsection 6.2 shows that the impact of the credit shock on export is severely overestimated if the model does not control for heterogeneity of non-credit factors across product and destinations.

[13]Note that a negative credit supply shock may cause production stoppages, for example, due to financial distress. This does not invalidate our identifying assumptions; on the contrary, this type of effect is precisely the one we are measuring.

affiliation and idiosyncratic shocks to exports of the same product and to the same destination is unlikely. To corroborate this, we show in Section 7 that our point estimates are unchanged when we allow the effect of credit to exports to vary across firms that export products of different quality, firms that have different currency composition of their liabilities, single and multi-product firms, and small and large firms measured both by volume of exports and by number of destinations.

Summarizing, we estimate η, the elasticity of exports to credit, using the following empirical model of exports:

$$\ln(X_{ipdt}) = \eta \cdot \ln(C_{it}) + \delta_{ipd} + \alpha_{pdt} + \varepsilon_{ipdt}, \tag{3}$$

where, as in equation (1) above, X_{ipdt} represents the exports by firm i of product p to destination country d at time t and C_{it} is the the sum of all outstanding credit from the banking sector to firm i at time t. The right-hand side includes two sets of dummy variables that account for the cross sectional unobserved heterogeneity of product p exported to destination d by firm i, δ_{ipd}, and the product-destination-time shocks, α_{pdt}. The first component captures, for example, the managerial ability of firm i, or the firm knowledge of the market for product p in destination d. The second component captures changes in the cost of production of good p, variations in the transport cost for product p to destination d, or any fluctuation in the demand for product p at destination d.

We estimate equation (3) using shocks to the financial condition of the banks lending to firm i as an instrument for the amount of credit received by firm i at time t, C_{it}. We next explain the economic rationale behind the instrument, and further discuss the identification hypothesis behind the instrumental variable (IV) estimation.

3.1 Capital Flow Reversals, Bank Foreign Liabilities and Credit Supply

Portfolio capital inflows to Peru, which were growing prior to the crisis, stopped suddenly in mid 2008. Foreign funding to Peruvian banks exhibits the same evolution (see Figure 2). Although this reversal of the foreign funding trend characterizes all Peruvian financial institutions, there were differences in the foreign funding dependence across banks before the crisis.[14] For example, the foreign liabilities of HSBC and Banco Santander, two large foreign owned banks operating in Peru, were 17.7% and 2.2% of assets in 2006. The hypothesis behind the instrumental variable approach is that banks with a larger fraction of their funding from foreign sources reduce the supply of credit relative to other banks after the capital flow reversal. In this section we test this identification assumption formally using a *within-firm* estimation procedure to disentangle credit supply from changes in the demand for credit.[15]

To do this, we first rank banks according to their dependence on foreign liabilities in 2006, a year before the crisis. A bank b is considered to be *exposed* if the share of foreign liabilities in its balance sheet is above the mean (9.5%). Of the thirteen commercial bank in the sample, four are classified as exposed.[16] Both groups of commercial banks include local and foreign owned institutions. For example, in the example above, HSBC is classified as exposed and Santander as not-exposed. The fraction of loans to exporting firms by exposed and non-exposed commercial banks is 53.9% and 60.5% respectively. All Savings and Loans Institutions are classified as not-exposed and lend almost exclusively to individuals and non exporting small firms.

[14]See Banco Central de Reserva del Peru (2009) for an analysis of the performance of the domestic financial market during the 2008 crisis.

[15]This procedure has been used in Gan (2007), Khwaja and Mian (2008), Paravisini (2008), Iyer et al. (2010), Iyer and Peydro (2010), Schnabl (2010), Jimenez et al. (2011a) and Jimenez et al. (2011b).

[16]The exposed banks are Citibank, Continental, HSBC, and MiBanco. Not exposed banks are Credito, Comercio, Financiero, Interamericano, Interbank, Santander, Trabajo, and Wiese-Scotiabank.

Table 1 provides the descriptive statistics of the two groups of commercial banks: Banks with above-mean exposure to foreign borrowing and banks with below-mean exposure to foreign borrowing as of December 2007. High foreign exposure banks are slightly smaller than low foreign exposure banks with total assets of $2.5 billion relative to $2.8 billion. Both high and low foreign exposure banks have loans worth more than 60% of assets and finance more than 50% of assets with retail deposits. By construction, the main difference between the two types of banks is that foreign finance represents 19.6% of total liabilities for high exposure banks relative to 5% for low exposure banks.

The *within-firm* estimator entails comparing the change in the amount of lending by banks with different dependence on foreign capital to the *same firm*, before and after the capital flow reversal. Based on the evolution of total foreign lending to Peruvian banks in Figure 2, we set July 2008 as the starting date for the capital reversals.[17] This leads to the following empirical model:

$$\ln\left(C_{ibt}\right) = \theta_{ib} + \gamma_{it} + \beta \cdot FD_b \cdot Post_t + \nu_{ibt} \tag{4}$$

C_{ibt} refers to average outstanding debt of firm i with bank b during the intervals $t = \{Pre, Post\}$, where the Pre and $Post$ periods correspond to the 12 months before and after July 2008. FD_b is a dummy that takes value one for *exposed* banks and zero otherwise, and $Post_t$ is a dummy equal to one when $t = Post$. The regression includes firm-bank fixed effects, θ_{ib}, which control for all (time-invariant) unobserved heterogeneity in the demand and supply of credit. It also includes a full set of firm-time dummies, γ_{it}, that control for the firm-specific evolution in overall credit demand during the period under analysis. As long as changes in a firm's demand for credit are equally spread across different lenders in expectation, the coefficient β measures the change in credit supply by

[17] Section 7 shows that results are robust to setting the turning point in April 2008, after the collapse of Bearn Stearns.

banks with higher dependence on foreign funding.

We present in Table 3, column 1, the estimated parameters of specification (4), obtained by first-differencing to eliminate the firm-bank fixed effects, and allowing correlation of the error term at the bank level in the standard error estimation. We find that, indeed, banks transmitted the international funding shock to firms. Banks with an above-average share of foreign liabilities reduced lending by 17% relative to other banks, after controlling for credit demand. Consistent with the hypothesis that the credit supply decline was driven by shortage in dollar funding, the decline is entirely explained by the evolution of dollar denominated loans, which drop by more than 24% relative to non-exposed banks (column 2). Local currency denominated loans, on the other hand, increased by 16% relative to non-exposed banks (column 3) and partially offset the reduction in the supply of dollar denominated credit.

This implies that a bank's share of liabilities funded with foreign capital is a good predictor of the supply of bank credit after the capital flow reversals and confirms the main identification assumption behind our instrumental variable approach. It is important to emphasize that the identification assumption tested here, that the instrument be correlated with the *supply* of credit, is much stronger than the typical necessary condition for the IV estimation of equation (3), i.e. that the instrument be correlated with the *amount* of credit. We present the first stage regression of the instrument on credit in Section 4, and show that this weaker necessary condition also holds.

Following the above discussion, in the baseline estimation of specification (3) we use the following functional form for the instrumental variable

$$F_{it} = F_i \cdot Post_t, \tag{5}$$

where the indicator function F_i is one if firm i borrows more than 50% from exposed banks in 2006, and zero otherwise; $Post_t$ is an indicator variable that turns to one after

July 2008, when the decline in foreign funding started. The cross sectional variation in F_{it} comes from the amount of credit that firm i receives from exposed banks in 2006. The classification of banks and firms in 2006 reduces the likelihood that bank foreign dependence and firm-bank matching were endogenously chosen in anticipation of the crisis. The time series variation in F_{it} is given by the aggregate decline of foreign liquidity in the Peruvian economy. In robustness checks reported in Section 7, we also define F_i as the fraction of the firm's total debt that came from exposed banks in 2006.

4 Effect of Credit Supply Shock on Exports

In this section we use the methodology described above to estimate the elasticity of exports to credit. We estimate separately the elasticity on the intensive and extensive margins. Since our empirical strategy relies crucially on accounting for shocks to export productivity and demand, we define the margins of trade at the product-destination level. The intensive margin corresponds to firm export flows of a given product to a given destination, that were active, both, in the *Pre* and *Post* periods. The extensive margin corresponds to the number of firms that enter or exit a product-destination market. In the baseline specifications, we define products at the 4-digit level according to the Harmonized System (HS). As a result, our estimations are obtained from exports variation within close to 6,000 product-destinations.

Table 4 presents the decomposition of export growth during the *Pre* and *Post* periods along these margins. Export growth declined over 33 percentage points between the *Pre* and *Post* periods. Most of this decline is due to the change in the price of Peruvian exports. The decline in the growth of export volume was 12.8 percentage points. One third of this decline is explained by the drop in the intensive margin, and two thirds are explained by the reduction in the number of exporting firms within a product-destination market. In Subsection 6.1, we use the elasticities estimated next to calculate the fraction

of this variation that can be attributed to the decline in credit supply.

4.1 Intensive Margin of Exports

This subsection analyzes the effect of a credit supply shock on the *volume* of exports of firm-product-destination flows that are active in the two periods, $t = \{Pre, Post\}$. Export data are highly seasonal, so we collapse the panel into the two periods to avoid estimation bias due to serial correlation and seasonality. Thus, X_{ipdt} corresponds to the sum of the volume of exports (in kilograms) of product p to destination d by firm i in the period t, and C_{it} corresponds to the average outstanding debt balance (in local currency) of firm i in period t.

We estimate equation (3) by first-differencing to eliminate the firm-product-destination fixed effects. The resulting estimation equation is:

$$\ln\left(X_{ipdPost}\right) - \ln\left(X_{ipdPre}\right) = \alpha'_{pd} + \eta \cdot \left[\ln\left(C_{iPost}\right) - \ln\left(C_{iPre}\right)\right] + \varepsilon'_{ipd} \tag{6}$$

The product-destination dummies, $\alpha'_{pd} = \alpha_{pdPost} - \alpha_{pdPre}$ in equation (3), absorb all demand fluctuations of product p in destination d.

The first stage coefficient —i.e., a linear regression of credit of firms i at time t (C_{it}) on the instrument (F_{it})– is shown in column 1, Panel 1 of Table 5. The coefficient is negative and significant at the 1% level, which confirms that the instrument is correlated with the amount of credit ($t = 8.6$ and $F = 74.4$).

The results of the Instrumental Variable (IV) estimation of the export elasticity to credit supply in specification (6) are presented in Table 5, column 3. The IV estimate implies that a 10% reduction in the stock of credit results in a decline of 2.3% in the volume of yearly export flows (Panel 1). We obtain elasticity estimates of the same magnitude if we define export markets at the 6-digit level, according to the Harmonized

System (see Panel 2 in Table 5). Following the example above, this further disaggregation implies comparing firms' exports of *Men's Cotton Overcoats*, instead of *Men's Overcoats*. This robustness suggests that the estimated magnitude of the elasticity is not driven by measurement error or unaccounted for variation in export shocks at narrower product markets.

This finding provides a novel insight regarding the usage of credit by exporting firms. Existing theoretical models of finance and trade, in which firms use credit to finance sunk cost of entry in new exports markets, cannot account for a positive intensive margin elasticity. In such frameworks, a credit shock should not affect the volume of exports for those firms already exporting a given product to a recurrent destination. Our findings suggest that credit frictions affect the *variable* cost of the firm –i.e., the financial cost of working capital. Then, adverse credit supply shocks increase the marginal cost and result in a reduction in the equilibrium size of the export flow.

The IV estimate of the export elasticity to finance is considerably larger than the OLS estimate. The downward bias of the OLS estimate implies that (non-credit) shocks to exports are negatively correlated with changes in the demand for credit. This can occur, for example, because a collapse in the prices and demand for a firm's exports reduces substantially the cash flows generated by the firm internally through revenues. To substitute for this decline in internally generated cash, the firm's demand for external finance increases.[18]

4.2 Extensive Margin of Exports

We analyze the effect of a credit supply shock on the *number* of exporting firms within given product-destination market. We separately estimate the number of firms entering and continuing exporting to a given market. To count the number of entering and con-

[18]The OLS estimate is also likely affected by attenuation bias, given that the regression is in differences and it includes a large number of fixed effects (see Arellano (2003))

tinuing firms, we aggregate the data at the group-product-destination level, where group refers to a classification of firms into two groups ($G = \{1, 0\}$) according to their exposure to credit shocks: those with at least 50% of their debt with exposed banks (group $G = 1$) and those with most of their debt with non exposed banks (group $G = 0$). Then we estimate the following equation:

$$\ln N_{Gpdt} = \delta_{Gpd} + \alpha_{pdt} + \nu \cdot \ln \left(\sum_{i \in G} C_{it} \right) + \xi_{Gpdt} \tag{7}$$

To study the entry margin, we use as the left-hand side variable the number of firms in group G that start exporting product p to destination d at time t, for $t = \{Pre, Post\}$ (N^E_{Gpdt}). To study the continuation margin, we use the number of firms in group G that were exporting product p to destination d at time $t-1$ and continue doing so in time t, for $t = \{Pre, Post\}$ (N^C_{Gpdt}).

As in the previous subsection, we collapse the time series into two periods, Pre and $Post$, which correspond to the 12 months before and after July 2008. There is a large number of intermittent export flows in the sample; thus, we consider a firm-product-destination flow to be active at time t if it registered positive exports at any time during those 12 months. The right-hand side variable of interest, credit, is now also defined at the group-product-destination level: it is the log sum of (average) debts outstanding for all firms in group G at time t, $\ln(\sum_{i \in G} C_{it})$. Similar to the instrument definition in equation (5), we instrument debt of firms in group G with a function F_{Gt} that predicts the credit supply to the firms in group G based on the external dependence of its related banks: $F_{Gt} = 1$ if $F_{it} = 1$ for $i \in G$ (firms with at least 50% of their debt in exposed banks) and zero otherwise.

We include product-destination-time dummies, α_{pdt}, that control for changes in demand and productivity. This specification differs from the one in (6) in that the unit of observation is defined at the group-product-destination level. The fixed effects δ_{Gpd} con-

trol for any time-invariant heterogeneity of exports of product p to destination d by firms in group G, instead of controlling at the firm-product-destination level as in specification (6).

We estimate the parameter ν after first differencing equation (7) to eliminate the group-product-destination fixed effects. The dependent variables are therefore $(\ln N^E_{GpdPost} - \ln N^E_{GpdPre})$ and $(\ln N^C_{GpdPost} - \ln N^C_{GpdPre})$, respectively.

The entry margin results are presented in Table 5, column 6, for product definition at the 4 and 6 digit level, according to the Harmonized System. The elasticity of the entry margin to credit is positive but not statistically significant. Column 8 shows the continuation margin results. According to our preferred specification, using product definition aggregated at 4-digit level (Panel 1), a 10% increase in the stock of credit increases the number of firms continuing exporting a given product-destination flow in 3.6%. The estimate of the continuation elasticity drops from 0.36 to 0.275 when export markets are defined at the 6-digit HS level (Panel 2). This potentially reflects that the misclassification of exports into categories is more likely with highly disaggregated product data. Such misclassification can have a first order effect on measurement error of the extensive margin of trade (see Armenter and Koren (2010) for a discussion). Therefore, the continuation elasticity using 6-digit product categorizations is potentially biased downwards due to classical attenuation bias.

These results allow us to infer the existence of fixed costs of exporting. We established in the previous subsection that credit shocks affect the intensive margin of exports: a negative credit shock reduces the size of export flows. If exports are also characterized by a fixed cost, this contraction induces firms to abandon markets when sales drop below the minimum level required for the activity to be profitable. Consistent with this interpretation, we find in unreported regressions that the continuation elasticity is larger for firm-product-destination flows below the median volume size, which are more likely to

drop the break even point. The point estimates for the continuation elasticity is are 0.54 and 0.15 for small and large export flows respectively, and the difference is significant at the 10% level.

4.3 Effect on Freight Characteristics and Trade Credit

Firms may adjust other dimensions of the trade activity when subject to a negative credit shock. In this subsection we explore the effect of a decline in the availability of bank funding on freight policies and the trade credit conditions with the importer. We estimate specifications parallel to (6) using the following left-hand side variables: (i) frequency of shipments for a firm-product-destination export flow during period t ($ShipFreq_{ipdt}$); (ii) average size of shipments (in volume) for a given export flow during the period t ($ShipVol_{ipdt}$); (iii) the fraction of the annual flow (value FOB) transported by air, as opposed to sea and ground, ($FracAir_{ipdt}$); and (iv) the fraction of the annual flow (value FOB) paid in advance by the importer ($FracCash_{ipdt}$).

The results are presented in Table 6. A negative shock to credit supply is found to reduce the frequency of shipments, with elasticity 0.14, significant at the 1% level (column 1). The elasticity of average shipment size is also positive but not statistically significant (column 2). These estimates suggest the existence of fixed costs of exporting at the shipment level. A large per-shipment cost together with a low variable cost imply that the frequency of shipments will be more elastic to a credit shock than their size, consistent with our results.

Credit supply is also found to influence the choice of transportation mode. The preference for aerial transportation increases with the availability of credit: a 1% increase in credit supply rises the fraction of exports shipped by air in 0.02% (column 3). This indicates that, holding the product and the destination constant, firms endogenously choose the transportation mode and that negative credit shocks induce firms to shift from using

expensive (and fast) transportation modes to slower (and cheaper) ones.

Finally, the fraction of the transaction value paid in advance by the importer is not sensitive to the decline in credit supply (column 4). That is, the credit arrangements between the exporter and the importer do not appear to react to funding shocks to the exporting firm. This result relates to Antras and Foley (2011), who document the stickiness of the terms of trade credit contracts between established trade partners during the 2008 financial crisis.

5 Characterization of the Effect of Credit on Exports

In this section we analyze how the elasticity of exports to credit shocks varies according to observable characteristics of the export flow, the exporting firms, and the product. This analysis allows us to make inferences regarding the role of external financing in the activities of the firm.

5.1 Role of Credit in Export Activities

The results in the previous section provide strong evidence for the existence of fixed cost of exporting. Substantial fixed exporting costs can make exports more sensitive to credit than domestic sales, as changes in the exporter's availability of credit may trigger discontinuous changes in exports. Furthermore, international trade is characterized by longer freight times and, thus, longer cash cycles than domestic sales. If export-related working capital represents a large fraction of the overall working capital of the firm, it is possible that the elasticity of export activities to credit is larger than that of domestic sales.

We explore the importance of the export-related working capital of the firm by analyzing how the sensitivity of exports to credit varies with the cash-cycle length of the export

flow and with the trade credit arrangements between the importer and the exporter; i.e., whether the importer or the exporter finances the transaction.[19] We measure the length of the cash-cycle in two alternative ways: distance to destination market and freight speed (ground and sea versus air); the results are presented in Table 7. The elasticities of, both, the intensive and extensive margins of exports do not vary for export flows destined to markets located beyond the median distance (column 1, 4, and 5), or whether the export flow was shipped by air (as oppose to by sea or ground) in the *Pre* period (column 2 and 6). Furthermore, columns 3 and 7 show that the elasticities of the intensive and continuation margins do not differ for those export flows paid in advance by the importer ($Cash$) in the *Pre* period. Overall, our results do not support the hypothesis that export-specific financing requirements have a first order effect on the magnitude of the elasticity. Instead, the sensitivity to credit appears to emerge from the general working capital requirements by the firm, which becomes costlier after a negative credit shock.

5.2 Firm Heterogeneity in Access to Credit

Changes in a bank's supply of credit affect the outcomes of related firms to the the extent that these firms cannot find alternative sources of funding. Then, differences across firms in their access to finance translate into heterogeneous elasticity to bank credit. We analyze how the elasticity of exports to bank credit varies across two firm dimensions: membership of a multinational enterprise, which potentially provides the firm with access to funding from internal capital markets, and the number of banking relationships, which potentially allows the firm to substitute among bank funding sources at a lower cost.

In Table 8 we report the results of estimating equations (6) and (7) augmented with an interaction between all the right-hand side variables with a dummy that equals one whenever the exporting firm is an affiliate of a foreign owned multinational (Panel 1) and

[19] We do not have data on total production or the domestic sales of the firm.

a dummy that equals one when the exporter obtains credit from more than one bank on the *Pre* period (Panel 2). The point estimates of the elasticities on the intensive and extensive margin indicate that exports by foreign affiliates are not sensitive to local bank credit (the intensive margin estimate is not statistically significant, however). Having multiple banking relationships, on the other hand, is not found to affect the elasticity of the intensive or extensive margin of exports to a credit shock.

5.3 Sectorial Heterogeneity in Credit Intensity

Since the seminal work by Rajan and Zingales (1998), heterogeneity in the degree of external finance dependence across sectors has been widely used to identify the effect of credit constraints on long-term growth and the cross country pattern of international trade. It remains to be shown whether the same factors that affect the sensitivity of exports to long-term finance can also predict the effect of short-term credit shocks. This subsection explores this question.

We analyze how our estimates of the export elasticities to credit shocks vary across sectors with different external finance dependence. Our measure of external finance dependence follows Chor and Manova (2010); it corresponds to the fraction of total capital expenditure not financed by internal cash flows based on cross sectoral data of U.S. firms. This measure is considered to represent technological characteristics of the sector the firm belongs to. For example, according to this measure, *textile mills* that transform basic fibers into fabric, intensively require external finance, while *apparel manufacturing* firms that process that fabric into the final piece of clothing, are considered to be less dependent.

We report in Table 9, Panel 1, the result of estimating equations (6) and (7) augmented with an interaction between all the right-hand side variables with a dummy that equals one if the product belongs to an industry with above median external financial dependence. The point estimates on the interaction term are negative in all specifica-

tions, and significantly different than zero in the continuation margin. This indicates that the elasticity of the intensive margin of exports to credit shocks does not vary across sectors with different levels of external finance dependence. The continuation margin is *less* elastic for sectors with a high external finance dependence.

Our results suggest that the elasticities to short-term and long-term changes in financial conditions capture different aspects of the firm's use of credit. The measure of external finance dependence may indicate the sensitivity of the firm to long term credit conditions, which is potentially related to the presence of important fixed investments or entry costs. The elasticity of exports to credit shocks, on the other hand, appears to be related to the short term needs of working capital.

Cross sectoral analysis on the impact of credit shocks on exports often uses, as indicator of the sector reliance to short term credit, the average usage of trade credit —i.e. the sector average ratio of the change in accounts payable over the change in total assets– (Chor and Manova (2010)). Panel 2 of Table 9 shows how the elasticities estimated in the previous section vary for sectors with high share of trade credit. The point estimates are not statistically significant.

Finally, we analyze how the sensitivity to credit varies for commodities and differentiated goods. World exports of these types of goods behave differently during the 2008 crisis. Although quantities exported drop for all products and countries, their unit values present interesting differences: world commodity prices collapse while prices of differentiated goods do not (see Haddad, Harrison and Hausman (2010)). Credit constraints in the differentiated sector, by negatively affecting supply of exports, can rationalize this pattern. We explore this hypothesis by comparing the elasticity for homogeneous and differentiated goods, following the product classification in Rauch (1999). The point estimates in Panel 3 of Table 9 are consistent with this hypothesis. For homogenous goods, the continuation margin is significantly less sensitive to credit. In the case of the intensive

margin, however, the estimation is too noisy to be conclusive.[20]

6 Credit and Non-Credit Determinants of Exports

In this section we use the estimated elasticities to perform a *back of the envelope* calculation of the contribution of finance to the overall export decline during the the 2008 crisis and perform analysis of the potential biases that arise when estimating the contribution of finance shock to output fluctuations when non-credit factors (i.e., demand and price shocks) are ignored in the econometric specification.

6.1 Contribution of Credit Shock on Overall Export Decline

Our estimates are obtained from relative changes in credit by exposed versus non-exposed banks. Thus, to obtain a back of the envelope calculation of the overall effect of the credit shock to firms on the total exports decline we must make an assumption about the change in credit supply of non-exposed banks —i.e. banks with a share of foreign liabilities below 9.5%–. We make the simplifying assumption that credit supply of non-exposed banks is constant throughout the analysis period. This assumption produces conservative estimates of the overall effect of credit if non-exposed banks also reduced credit supply during the crisis. The contrary occurs if non-exposed banks expanded credit supply to substitute for the unfulfilled demand by exposed banks.

The estimates in Table 3 imply that exposed banks reduced credit supply by 16.8% relative to not-exposed banks. Exposed banks account for 30.5% of total credit to exporters in the *Pre* period (12 months before July 2008). Given the above assumption, these estimates imply that total credit supply dropped by 5.1%. For the intensive margin elasticity we use the estimate of 0.23 from Table 5, and for the continuation margin we

[20]Since less than 10% of Peruvian export flows involves differentiated products, this estimation is particularly noisy.

use the estimate of 0.15, which characterizes the elasticity of large export flows (small export flows account only for 2% of total exports). The elasticity of the entry margin is not statistically significant in most specifications, so we set it to zero for the calculation. These assumptions imply that the drop in credit supply to Peruvian firms can explain a 1.9% reduction in the volume of exports during the 12 months following July 2008 (*Post* period). We note that this estimate captures the effect of a negative credit supply shock on the supply of exports by Peruvian firms; they do not reflect the effect of financial frictions outside Peru and their potential effect on the foreign demand for Peruvian exports.

Compared to the total drop in the annual growth rate of the volume of exports between the *Pre* and *Post* periods, 12.8 percentage points (see Table 4), this estimate implies that the credit shock can account for approximately 15% of the missing volume of trade. When we look separately at the intensive, entry and exit margins, the credit shock can account for 27%, 0% and 9% of each margin, respectively. This suggests that the bulk of the export decline during the 12 months following July 2008 was triggered by the contraction in international demand for Peruvian exports, and this was particularly true regarding firms' decisions to enter or to continue supplying product-destination markets.

6.2 Estimation Bias

Recent work studying real effects of the bank transmission channel during crises has been constrained by data limitations to studying firm level outcomes, such as total sales, total exports, or investment (see for example Amiti and Weinstein (2009), Carvalho, Ferreira and Matos (2010), Iyer et al. (2010), Jimenez et al. (2011a), Kalemli-Ozcan, Kamil and Villegas-Sanchez (2010)). The typical empirical strategy compares outcomes of firms related to banks that are differentially affected by the crisis. In this subsection we compute the bias that arises when we aggregate the data at the firm level and use it to obtain a difference-in-differences estimate that compares the change in average exports by

firms borrowing from exposed banks relative to firms borrowing from non-exposed banks (parallel to the reduced form estimates in the above mentioned studies). This approach provides an unbiased reduced form estimate of the bank transmission channel if banks and firms are randomly matched. If, on the contrary, firms related to exposed banks specialize in certain products or destinations, then estimates based on comparing the outcomes of firms related to exposed and non exposed banks confound the effect of the lending channel with the heterogeneous impact of the crisis across products and destinations.

In Table 11, column 1, we present the naive difference-in-differences reduced form estimate (with firm fixed effects), and in column 2, the reduced form version of equation (6), which controls for shocks at the product-destination level.[21] The naive difference-in-differences estimator overestimates the reduced form effect of the credit shock on exports during the 2008 crisis by 95%. This overestimation of the overall effect on credit on exports combines two amplifying effects. First, not accounting for non-credit related factors affecting the product and destination markets introduces a bias in the estimation of the elasticity of exports of 66% (columns 3 and 4). And second, the magnitude of the credit supply shock is overestimated when not controlling for the firm's change in credit demand (as we do in the within-firm estimation in equation 4).

This finding implies that firms and banks are not randomly matched. In particular, exposed banks specialize in destinations that are disproportionately affected by the financial crisis.[22] It also implies that when non-finance shocks at the product-destination level are unaccounted for, the overall importance of credit shocks in explaining output fluctuations can be severely overestimated. In the present case, the bias would lead to conclude erroneously that credit shocks explained twice as much of the Peruvian export

[21]The reduced form is the regression of exports on the instrument. Intuitively, the difference in export growth to a product-destination market by firms related by exposed and non-exposed banks, controlling for shocks at the product-destination level.

[22]The bias is largest when there are no controls for changes in export demand across destination markets.

decline during the Great Trade Collapse than they actually did.

These results also call for caution when deriving conclusions regarding the importance of credit in explaining output fluctuations based on comparisons across sectors or destinations. For example, conclusions regarding the specific usage of credit by export activities often rely on comparing the effect of a credit shock on the firm's sales across destinations; i.e., domestic versus foreign sales, or across foreign destinations with different freight time. These comparisons may confound the effect of the credit shock on exports with the heterogeneous impact of the crisis across markets.

7 Identification and Robustness Tests

As mentioned in Section 3, the elasticity estimates will be biased if firms associated with banks with high foreign liabilities experience a disproportionate negative shock to exports relative to other firms exporting to the same product-destination for reasons other than bank credit. This could occur, for example, if firms that borrow from exposed banks export products of a higher quality (within the same 4 or 6 digit HS code), and the demand for higher quality products dropped more during the crisis. It would also occur if firms with high foreign currency denominated liabilities borrow from banks with high foreign liabilities, and the capital flow reversals affect the balance sheet of firms directly and not through bank lending. In this section we perform identification tests to account for potential shocks correlated with bank affiliation. We also test the robustness of the results to the definition of the instrument.

In the first identification test we estimate the export elasticity in the intensive margin measuring exports in dollar FOB values. If price changes faced by firms exporting to the same market are orthogonal to their bank affiliation, then the product-destination dummies should absorb these effects resulting in the same estimates of export elasticities if measured in volume or value. The result in Panel 1 in Table 10 confirms that the volume

and value elasticities are of the same order of magnitude and statistically indistinguishable.

An alternative way to test for unaccounted shocks correlated with bank affiliation is to explicitly control for them. In the second identification test we augment equation (6) with a set of observable firm characteristics in the Pre period as control variables: average unit price of exports at the firm-product-destination level, average fraction of debt denominated in foreign currency, total exports, number of products, and number of destinations at the firm level. Including these pre-determined variables in the first differenced specification is equivalent to including them interacted with time dummies in the panel specification of equation (3). Thus, this augmented specification controls for heterogeneity in the evolution of exports after the crisis along the product quality, firm external exposure, and firm size dimensions. The elasticities of, both, the intensive and extensive margins of exports (in Panel 2, Table 10) are virtually identical to those computed without controls.

In the third identification test we explore the possibility that firms associated with exposed banks were simply on a different export and borrowing growth path before the crisis. If this were the case, our estimates could be capturing such pre-existing differences across the two groups of firms and not the effect of the credit shock. We perform the following placebo test: we estimate equation (6) lagging the debt and export measures one year, as if the capital flow reversals had occurred in 2007 instead of 2008. That is, for $t = \{Pre - 1, Pre\}$, where Pre is, as above, the period July 2007-July 2008, and $Pre - 1$ corresponds to the previous 12 months. The elasticities of both the intensive and extensive margin of exports, reported in Panel 3 of Table 10, are not statistically different from zero. This confirms that firms borrowing from banks with a high share of foreign liabilities as of December 2007 did not face any differential credit supply prior to the crisis. And, correspondingly, their exports performance was not different from those of firms linked to banks with a low share of foreign liabilities.

Finally, we test the robustness of the results to the definition of the instrument. First, we vary the cross-sectional definition of the instrument by substituting the indicator variable F_i with a continuous function, defined as the maximum fraction of total funding that firm i obtained from exposed banks during 2006. The results, qualitatively and quantitatively similar to those described above, are presented in Panel 4 of Table 10.[23] Second, we verify that the results are not sensitive to the exact definition of the *Pre* and *Post* periods. In our baseline regressions, we define the initial month of the *Post* period, July 2008, based on the evolution of foreign capital inflows in Peru. But the 2008 financial crisis does not have an objective start date and domestic banks may have anticipated the capital flow reversals after the collapse of Bearn Stearns and the increase in international financial volatility in March 2008. We therefore set April 2008 as an alternative start of the *Post* period. We obtain point estimates of 0.25 for the intensive margin elasticity and 0.65 for the continuation elasticity. This last estimate, although larger than the one reported in Table 5, is noisily estimated (s.d. 0.33) and the difference is not statistically significant. Again, the elasticity of the entry margin is not statistically different from zero.

Overall, the results in in this section suggest that our empirical approach obtains unbiased estimated of the elasticity of exports to credit. In other words, after conditioning on product-destination shocks to exports, a firm's affiliation to a bank with a high share of foreign liabilities is orthogonal to other non-credit determinants of exports.

8 Conclusions

It has long been argued that funding shocks to the banking sector are transmitted to the credit availability of non-financial firms. Existing evidence on whether these shocks

[23]The first stage (non-reported) for this continuum function is stronger than the baseline instrument, with t=10.8 and F=115.5.

have consequences on real outcomes in inconclusive, however. In this paper, we provide evidence of this link in the context of international trade. The main advantage of exploring the real consequences of bank credit supply shocks under the lens of international trade is that detailed customs data allows accounting for price and demand shocks at a highly disaggregated product markets. Another advantage of disaggregated data is that they allow characterizing the channel through which credit supply fluctuations impact output.

Our results stem from analyzing Peruvian exports during the 2008 international crisis. Although Peru was not directly affected by the collapse in the value of U.S. real estate, the capital flow reversal during the international financial crisis affected the lending capacity of domestic commercial banks. We use this drop in the supply of credit to Peruvian firms to estimate the sensitivity of exports to credit.

We find that a 10% reduction in the supply of credit results in a contraction of 2.3% in the (one year) volume of export flows for those firm-product-destination flows active before and after the crisis. This result indicates that credit shocks affect the variable cost of exporting. On the extensive margin, a negative credit supply shock reduces the number of firms that continue exporting to a given market. This extensive margin sensitivity is consistent with a fixed cost of exporting: firms that suffer a negative credit shock stop exporting to markets that drop below the minimum size to cover it. Credit shocks are also found to affect the frequency and freight method (air versus ground and sea) of shipments, but not the shipment size. These findings suggest the existence of a fixed cost of exporting at the shipment level.

The existence of fixed cost of exporting makes international trade more sensitive to credit than domestic sales, as changes in the exporter's availability of credit may trigger discontinuous changes in exports due to fluctuations in the number of active export flows. However, our results suggest that export-related working capital does not represent a substantial fraction of the total working capital of the firm: the sensitivity of exports to

credit does not change with the determinants of export cash-cycle length (i.e., distance to destination market, mode of transportation, and existence of trade credit by the importer). This suggests that the intensive margin of exports is not more sensitive to credit than domestic sales through the working capital channel.

Overall, the results in this paper show that credit has a first order effect on the volume of exports. However, the largest determinant of the Peruvian exports collapse during the 2008 crisis is related to non-credit factors (e.g., international demand and prices). In our context, failure to control for determinants of exports other than bank credit at the product-destination level leads to severely biased estimates when studying the effect of a contraction in credit on trade. Our results suggest that estimates that rely on more aggregated data (e.g., outcomes at the firm or sector levels) should be interpreted with caution during crisis episodes, which have potentially large and heterogeneous real effects across sectors and countries.

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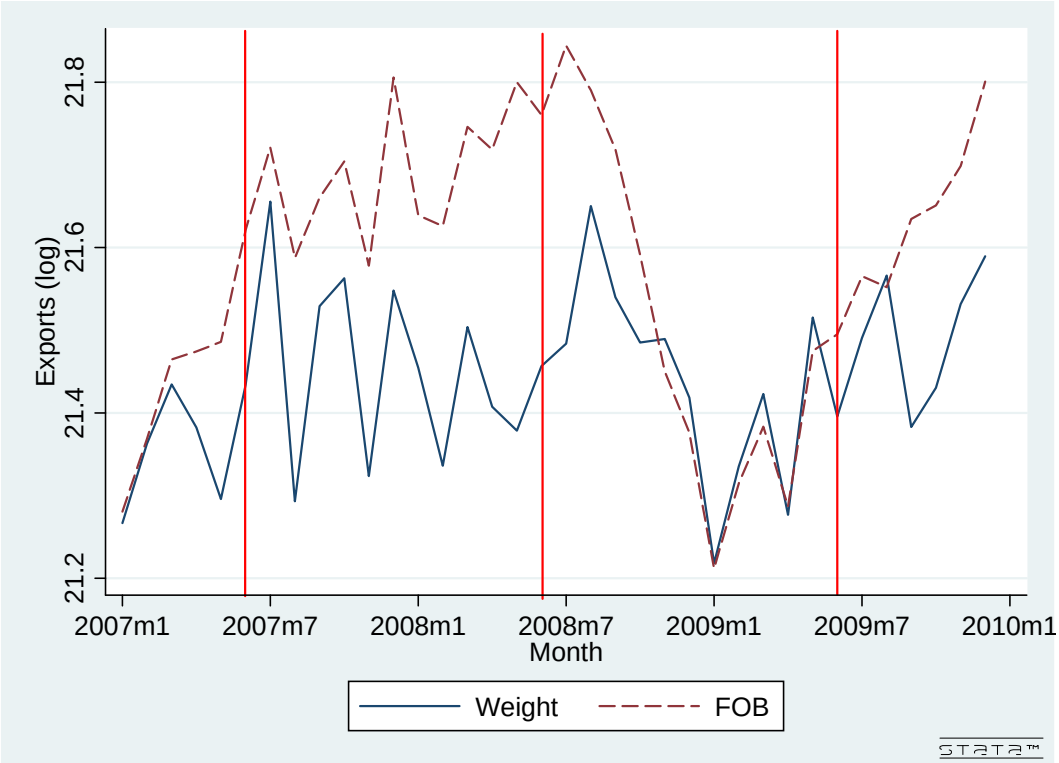
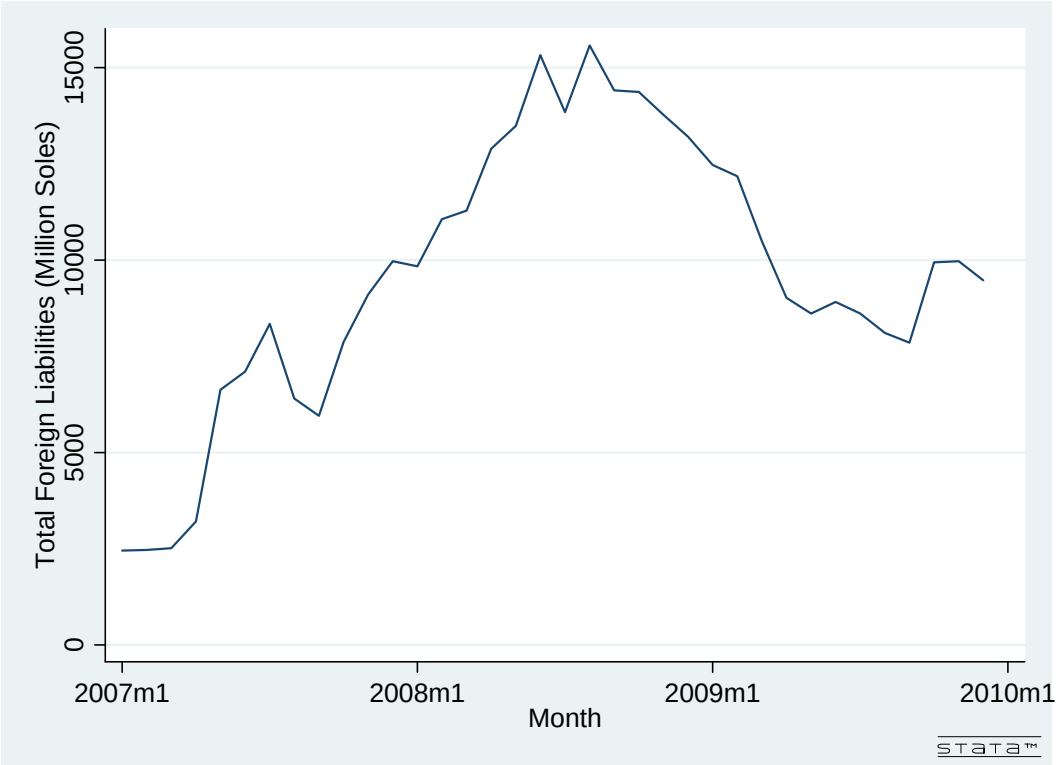


Source: SUNAT. Volume of exports in kg, and value in dollars FOB.

Figure 1: Total Peruvian Exports



Source: Bank financial statements, Superintendencia de Bancos y Seguros de Peru. Foreign financing: bank liabilities with institutions outside Peru.

Figure 2: Total Banking Sector Foreign Financing

	All Commercial Banks (N = 13)			High Foreign Exposure (N = 4)			Low Foreign Exposure (N = 9)		
	mean	sd	p50	mean	sd	p50	mean	sd	p50
Assets (M US$)	2,778	4,175	753	2,533	3,817	794	2,887	4,543	753
Loans (M US$)	1,668	2,379	507	1,709	2,575	562	1,650	2,451	507
Deposits (M US$)	1,979	3,060	465	1,681	2,682	436	2,112	3,359	465
Foreign Financing (M US$)	256	400	71	353	507	121	212	370	52
Loans/Assets	0.661	0.105	0.673	0.659	0.126	0.660	0.661	0.103	0.673
Deposits/Assets	0.637	0.142	0.691	0.573	0.082	0.543	0.665	0.158	0.733
Foreign Financing/Assets	0.095	0.101	0.068	0.196	0.135	0.175	0.050	0.034	0.065

Source: Bank financial statements as of December 2007, Superintendencia de Bancos y Seguros de Peru.

Table 1: Commercial Bank Descriptive Statistics

	All Exporters			Analysis Sample: Positive Debt after June 2008								
				Full Subsample			Borrows > 50% from Affected Banks					
							Yes			No		
	mean	sd	p50	mean	sd	p50	mean	sd	p50	mean	sd	p50
Panel 1: Firms Statistics	(N = 6,169)			(N=4,974)			(N = 1,471)			(N=3,503)		
Debt (1,000 US$)	1,013	6,903	1.45	1,253	7,668	9.58	2,076	11,794	118.30	907	4970	0.37
# Lenders	1.70	1.10	1.10	1.75	1.12	1.19	2.03	1.10	1.76	1.57	1.10	1.00
Fraction Dollar Debt	0.708	0.385	0.951	0.713	0.381	0.953	0.780	0.333	0.982	0.659	0.408	0.918
Exports - FOB (1,000 US$)	3,348	52,721	28	4,005	58,478	31	4,487	41,066	101	3,802	64,405	20
Exports (1,000 Kg)	8,466	230,071	11	10,371	256,182	12	6,004	43,503	39	12,204	303,959	8
# destinations	2.7	4.3	1.0	2.9	4.5	1.0	3.6	5.3	2.0	2.5	4.1	1.0
# products (4-digit)	5.3	9.4	2.0	4.7	8.2	2.0	4.6	7.2	2.0	4.7	8.6	2.0
> 50% debt in exposed bank	0.248	0.432	0.000	0.296	0.456	0.000	1.000	0.000	1.000	0.000	0.000	0.000
Dummy=1 if multinational	0.036			0.040			0.065			0.030		
Fraction debt in exposed bank	0.247	0.398	0.000	0.295	0.417	0.000	0.910	0.149	1.000	0.036	0.109	0.000
Panel 2: Firms-Product-Destination Statistics	(N = 53,690)			(N=47,810)			(N = 13,339)			(N=34,471)		
Value - FOB (1,000 US$)	169.3	3,675.6	0.7	184.8	3,875.5	0.8	208.1	4,198.9	2.7	175.7	3,743.0	0.4
Volume (1,000 Kg)	401.7	22,112.8	0.1	446.4	23,432.3	0.1	280.8	3,143.1	0.5	510.4	27,526.6	0.1
Distance (km)	6,521	7,986	5,587	6,518	8,005	5,587	6,497	8,727	4,725	6,526	7,708	5,587
Paid in advance - FOB (1,000 US$)	42.2	1,764.5	0.0	46.3	1,869.6	0.0	34.6	432.4	0.0	50.8	2,185.3	0.0
Transported by Air - FOB (1,000 US§)	37.2	2,181.9	0.0	40.8	2,311.6	0.0	84.4	4,027.6	0.0	24.0	1,064.7	0.0
Shipment Value - FOB (1,000 US§)	32.8	470.2	0.5	36.0	497.1	0.5	39.7	488.6	1.6	34.6	508.4	0.3
Shipment Volume (1,000 kg)	77.5	2,203.1	0.1	86.1	2,334.4	0.1	64.2	529.2	0.3	94.5	2,729.4	0.1
# Shipments per year	2.23	2.19	1.00	2.17	2.15	1.00	2.51	2.43	1.00	2.04	2.02	1.0
Dummy=1 if multinational	0.085			0.092			0.143			0.072		

Source: Customs data from SUNAT, credit registry data from the Superintendencia de Bancos y Seguros de Peru. Sample: firms with at least one export registered between July 2007 and June 2009. The statistics are estimated over the calendar year July 2007-June 2008.

Table 2: Firm Descriptive Statistics

Dependent Variable	$\Delta \ln C_{ib}$		
	All Debt	US Dollar Denominated	Local Currency Denominated
	(1)	(2)	(3)
FD_b	-0.168***	-0.241***	0.161**
	(0.046)	(0.047)	(0.076)
Firm FE	yes	yes	yes
Observations	10,334	8,433	6,515
R^2	0.630	0.634	0.650
R^2 adj	0.261	0.250	0.102
# banks	41	33	39
# firms	5,154	4,320	3,977

Estimation of equation (4). FD_b is a dummy that signals whether foreign liabilities of bank b is above the median. Robust standard errors, clustered at the bank level, in parenthesis. $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Table 3: Transmission of Credit Shocks by Banks with High Foreign Dependence

	Value (FOB)		Volume (kg)	
	t=Pre	t=Post	t=Pre	t=Post
Total	10.9%	-22.4%	3.2%	-9.6%
Intensive	10.6%	-15.7%	2.1%	-2.2%
Extensive	0.3%	-6.6%	1.2%	-7.4%
Entry	8.4%	8.2%	8.6%	8.3%
Exit	-8.1%	-14.8%	-7.4%	-15.7%

Source: SUNAT. Extensive and intensive margins defined at the level of product destination flows. For each $t = \{Pre, Post\}$, it corresponds to the growth rate $X_t/X_{t-1} - 1$. Each time t is a 12 months period and Pre and $Post$ periods correspond to the 12 months before and after July 2008. A flow firm-product-destination is considered active at time t if exports were positive at any time during the period. Product definition aggregated at 4-digit level according to the Harmonized System.

Table 4: Descriptive Statistics of Export Growth

Dependent Variable:	Intensive Margin			Extensive Margin				
	$\Delta \ln C_i$	$\Delta \ln X_{ipd}$		$\Delta \ln(\sum_{i \in G} C_i)$	$\Delta \ln N^E_{Gpd}$		$\Delta \ln N^C_{Gpd}$	
	FS	OLS	IV	FS	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel 1:	Products defined at 4-digit HS							
Dummy Affected: $> 50\%$	-0.561***			-0.394**				
	(0.192)			(0.190)				
$\Delta \ln C_i$		0.025	0.227***					
		(0.018)	(0.068)					
$\Delta \ln(\sum_{i \in G} C_i)$					0.031**	0.232	0.015	0.363***
					(0.015)	(0.185)	(0.013)	(0.095)
Product-Destination FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,208	14,209	14,210	9,153	4,495	3,916	6,114	5,827
# Product-Destination	5,997	5,997	5,997	6,995	3,564	3,088	4,866	4,658
R^2	0.360	0.438		0.797	0.770		0.788	
Panel 2:	Products defined at 6-digit HS							
Dummy Affected: $> 50\%$	-0.636**			-0.439**				
	(0.250)			(0.204)				
$\Delta \ln C_i$		0.029	0.209***					
		(0.019)	(0.060)					
$\Delta \ln(\sum_{i \in G} C_i)$					0.046**	0.594	0.018	0.275***
					(0.019)	(0.435)	(0.015)	(0.065)
Product-Destination FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16,472	16,472	16,472	12,285	5,212	4,512	7,668	7,302
# Product-Destination	8,567	8,567	8,567	10,004	4,330	3,739	6,421	6,143
R^2	0.447	0.528		0.845	0.801		0.806	

Estimation of equations (6) and (7). In the IV regression, the change in (log of) credit, $\Delta \ln C_i$ ($\Delta \ln(\sum_{i \in G} C_i)$), is instrumented with F_i (F_G), a dummy that takes value 1 if the firm (firms in group G) borrows more than 50% from an exposed bank. Standard errors clustered at the product-destination level in parenthesis. $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Table 5: Export Elasticity to Credit Shocks

Dependent Variable:	$\Delta \ln(ShipFreq_{ipd})$ (1)	$\Delta \ln(ShipVol_{ipd})$ (2)	$\Delta FracAir_{ipd}$ (3)	$\Delta FracCash_{ipd}$ (4)
$\Delta \ln(C_i)$	0.140***	0.087	0.018*	0.004
	(0.030)	(0.054)	(0.010)	(0.016)
Product-Destination FE	Yes	Yes	Yes	Yes
Observations	14,208	14,208	14,208	14,208

IV estimation of equation (6). Dependent variable in column 1 is the (log of) frequency of shipments; in column 2 is the (log of) average size of shipments (in volume); in columns 3 and 4, it is the change in the fraction of annual export flows (FOB) transported by air and paid in advanced by the importer, respectively. Change in (log of) credit, $\Delta \ln C_i$ ($\Delta \ln(\sum_{i \in G} C_i)$), is instrumented with F_i (F_G), a dummy that takes value 1 if the firm (firms in group G) borrows more than 50% from an exposed bank. Standard errors clustered at the product-destination level in parenthesis. $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Table 6: Effect of Credit on Export Arrangements

Dependent Variable:	Intensive Margin			Extensive Margin			
	$\Delta \ln X_{ipd}$			$\Delta \ln N^E_{Gpd}$	$\Delta \ln N^C_{Gpd}$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\Delta \ln C_i$	0.283***	0.220**	0.234***				
	(0.063)	(0.109)	(0.080)				
$\Delta \ln C_i \cdot (dist_d > \overline{dist})$	-0.226						
	(0.194)						
$\Delta \ln C_i \cdot Air_{ipd}$		0.054					
		(0.132)					
$\Delta \ln C_i \cdot Cash_{ipd}$			0.052				
			(0.171)				
$\Delta \ln(\sum_{i \in G} C_i)$				0.358	0.394**	0.206**	0.589*
				(0.301)	(0.163)	(0.080)	(0.312)
$\Delta \ln(\sum_{i \in G} C_i) \cdot (dist_d > \overline{dist})$				-0.660	-0.199		
				(0.458)	(0.186)		
$\Delta \ln(\sum_{i \in G} C_i) \cdot Air_{ipd}$						0.023	
						(0.119)	
$\Delta \ln(\sum_{i \in G} C_i) \cdot Cash_{ipd}$							-0.313
							(0.327)
Product-Destination FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,146	14,208	14,208	2,788	6,281	6,259	6,601

IV estimations of equations (6) and (7). Change in (log of) credit, $\Delta \ln C_i$ ($\Delta \ln(\sum_{i \in G} C_i)$), instrumented with F_i (F_G), a dummy that takes value 1 if the firm (firms in group G) borrows more than 50% from an exposed bank. Credit is interacted with the following dummies: $(dist_d > \overline{dist}) = 1$ if distance to market of destination is above the median, $Air_{ipd} = 1$ if shipment was by air, and $Cash_{ipd} = 1$ if a fraction of the transaction was payed in advanced by the importer. Standard errors clustered at the product-destination level in parenthesis. $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Table 7: Elasticities by Export Flow Characteristics

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Dependent Variable:	Intensive Margin	Extensive Margin	
	$\Delta \ln X_{ipd}$	$\Delta \ln N^E_{Gpd}$	$\Delta \ln N^C_{Gpd}$
	(1)	(2)	(3)
Panel 1:	Foreign Ownership		
$\Delta \ln C_i$	0.263**		
	(0.069)		
$\Delta \ln C_i \cdot Foreign_i$	-0.290		
	(0.255)		
$\Delta \ln(\sum_{i \in G} C_i)$		0.447	0.519***
		(0.520)	(0.128)
$\Delta \ln(\sum_{i \in G} C_i) \cdot Foreign_{i \in G}$		-0.466	-0.538***
		(0.630)	(0.194)
#Banks-Product-Destination FE	Yes	Yes	Yes
Observations	14,208	3,640	6,240
Panel 2:	Multiple Banking Relationships		
$\Delta \ln C_i$	0.145**		
	(0.067)		
$\Delta \ln C_i \cdot ManyBanks_i$	0.809		
	(0.732)		
$\Delta \ln(\sum_{i \in G} C_i)$		0.450***	0.234
		(0.143)	(0.343)
$\Delta \ln(\sum_{i \in G} C_i) \cdot ManyBanks_{i \in G}$		-0.303	3.253
		(0.271)	(6.958)
#Banks-Product-Destination FE	Yes	Yes	Yes
Observations	14,208	2,444	5,618

IV estimations of equations (6) and (7). Change in (log of) credit, $\Delta \ln C_i$ ($\Delta \ln(\sum_{i \in G} C_i)$), instrumented with F_i (F_G), a dummy that takes value 1 if the firm (firms in group G) borrows more than 50% from an exposed bank. Credit is interacted with dummy $Foreign_i$ that takes value 1 if the firm is a subsidiary of a foreign firm, and $ManyBanks_i$ that takes value 1 if the number of banks that lend to the firm is larger than the median. Panel Standard errors clustered at the product-destination level in parenthesis. $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Table 8: Elasticity by Firm Characteristics

Dependent Variable	Intensive Margin	Extensive Margin	
	ΔX_{ipd}	$\Delta \ln N^E_{Gpd}$	$\Delta \ln N^C_{Gpd}$
	(1)	(2)	(3)
Panel 1:	External Finance Dependence		
$\Delta \ln(C_i)$	0.211**		
	(0.083)		
$\Delta \ln(C_i) \cdot HighFinDep_p$	-0.004		
	(0.169)		
$\Delta \ln(\sum_{i \in G} C_i)$		1.859	0.645***
		(6.579)	(0.222)
$\Delta \ln(\sum_{i \in G} C_i) \cdot HighFinDep_p$		-1.842	-0.469*
		(6.615)	(0.257)
Observations	12,652	3,561	5,246
Product-Destination FE	Yes	Yes	Yes
Panel 2:	Trade Credit		
$\Delta \ln(C_i)$	0.200***		
	(0.075)		
$\Delta \ln(C_i) \cdot HighTradeCredit_p$	0.104		
	(0.190)		
$\Delta \ln(\sum_{i \in G} C_i)$		1.478	0.338***
		(6.926)	(0.124)
$\Delta \ln(\sum_{i \in G} C_i) \cdot HighTradeCredit_p$		-1.378	0.030
		(6.950)	(0.213)
Observations	14,208	3,561	5,246
Product-Destination FE	Yes	Yes	Yes
Panel 3:	Product Differentiation		
$\Delta \ln(C_i)$	0.208***		
	(0.069)		
$\Delta \ln(C_i) \cdot Homogeneous_p$	-0.116		
	(0.186)		
$\Delta \ln(\sum_{i \in G} C_i)$		0.249	0.499***
		(0.197)	(0.152)
$\Delta \ln(\sum_{i \in G} C_i) \cdot Homogeneous_p$		-0.091	-0.432**
		(0.237)	(0.181)
Observations	13,537	3,667	5,517
Product-Destination FE	Yes	Yes	Yes

IV estimation of equations (6) and (7). The change in (log of) credit, $\Delta \ln C_i$ ($\Delta \ln(\sum_{i \in G} C_i)$), is instrumented with F_i (F_G), a dummy that takes value 1 if the firm (firms in group G) borrows more than 50% from an exposed bank. The classification of sectors according to their dependence of external finance and share of tangible assets follows Chor and Manova (2010). Definition of homogeneous products is from Rauch (1999). Standard errors clustered at the product-destination level in parenthesis. $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Table 9: Elasticity by Product Characteristic

Dependent Variable:	Intensive Margin	Extensive Margin	
	$\Delta \ln X_{ipd}$	$\Delta \ln N^E_{Gpd}$	$\Delta \ln N^C_{Gpd}$
	(1)	(2)	(3)
Panel 1:	X_{ipd} is Value (FOB) of Exports		
$\Delta \ln C_i$	0.257***		
	(0.060)		
Observations	14,210		
Panel 2:	Controlling for Observable Firm Characteristics		
$\Delta \ln C_i$	0.227***		
	(0.070)		
$\Delta \ln(\sum_{i \in G} C_i)$		0.473	0.394***
		(0.337)	(0.122)
$\ln X$	-0.041**	0.153	-0.004
	(0.017)	(0.156)	(0.012)
ln dollar debt	0.135*	-0.061	-0.019
	(0.069)	(0.119)	(0.031)
unit price	0.000	0.390*	-0.017
	(0.000)	(0.213)	(0.039)
ln # products	0.002	1.096	-0.023
	(0.020)	(1.030)	(0.125)
ln # destinations	0.057*	0.000	-0.000
	(0.034)	(0.001)	(0.000)
Observations	14,024	3,088	5,827
Panel 3:	Placebo Test		
$\Delta \ln C_i$	0.059		
	(0.352)		
$\Delta \ln(\sum_{i \in G} C_i)$		0.476	-0.180
		(0.299)	(0.318)
Observations	15,265	4,003	5,990
Panel 4:	Alternative Instrument Functional Form		
$\Delta \ln C_i$	0.195***		
	(0.048)		
$\Delta \ln(\sum_{i \in G} C_i)$		0.232	0.327***
		(0.185)	(0.079)
Observations	14,210	3,916	5,827
Product-Destination FE	Yes	Yes	Yes

IV estimations of (6) and (7). In Panel 1, exports measured in US$ FOB. Panel 2 adds the following controls: overall volume of export, fraction of dollar debt, unit price of exports, # products exported, and # destinations. For intensive margin, controls are at firm level; for extensive margin they correspond to group average. In Panel 3, $t = \{Pre-1, Pre\}$, where Pre = June 2007-July 2008 and $Pre-1$ = June 2006-July 2007. In Panel 4, $\Delta \ln C_i$ instrumented with F_i: (max) proportion of firm debt in exposed banks. Standard errors clustered at the product-destination level in parenthesis. $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Table 10: Identification Tests

	Reduced Form		IV estimation	
Dependent Variable:	$\Delta \ln X_i$	$\Delta \ln X_{ipd}$	$\Delta \ln X_i$	$\Delta \ln X_{ipd}$
	(1)	(2)	(3)	(4)
Dummy Affected: $> 50\%$	-0.247***	-0.127**		
	(0.070)	(0.058)		
$\Delta \ln C_i$			0.376***	0.227***
			(0.116)	(0.068)
Product-Destination FE	No	Yes	No	Yes
Observations	2,438	14,208	2,438	14,210
R^2	0.005	0.438		

Reduced form and IV estimations of equation (6). The instrument F_i is a dummy that takes value 1 if the firm borrows more than 50% from an exposed bank. X_i and X_{ipd} are volume of exports at the firm and firm-product-destination levels, respectively. In column 2 and 4 standard errors are clustered at the product-destination level, in parenthesis. $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$

Table 11: Estimation Bias