Estimating the Direct Impact of Bank Liquidity Shocks on the Real Economy: Evidence from Letter-of-Credit Import Transactions in Colombia*

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Abstract

This study identifies and provides a precise estimate of the direct impact of bank liquidity shocks on real economic activity by exploring letter-of-credit import transactions in Colombia during the 2008-09 global financial crisis. The detailed dataset on letter-of-credit transactions allows for exploiting within-importer-exporter variations across issuing banks. The study finds substantial effects of bank liquidity shocks on letter-of-credit import transactions: a 1 percentage point decline in bank deposit growth led to a 4.5 percentage point decline in imports in intensive margins, and to a 5 percent increase in the exit probability in extensive margins. Further, the estimate suggests that adverse bank liquidity shocks can explain at least 38 to 47 percent of the collapse in import transactions via letters of credit in Colombia.

JEL classification: F1, F4, G2, G3

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1. Introduction

Money is fungible. So are most types of loans. There is no guarantee that a borrower will always abide by the purpose of a loan as stated on the loan request. This makes it an almost elusive quest to fully identify the direct link between loans and economic activity. A rare exception is a letter of credit. Its sole purpose–to pay for an import transaction specified therein–connects the financial sector with the real sector, and thus provides a unique prism through which to view the direct impact of financial shocks on real economic activity. The analysis in this paper draws on that information.

Since the global financial crisis, academic research has centered on two main transmission channels through which the financial crisis led to what has been called the Great Recession. One channel is the global transmission of financial shocks across countries, and the other is the subsequent transmission of financial shocks to the real economy. This paper aims to identify the second transmission channel, taking bank liquidity shocks transmitted by the first channel as a given.[1]

Specifically, this study identifies and provides a precise estimate of the *direct* impact of bank liquidity shocks on real economic activity by exploring letter-of-credit import transactions in Colombia during the 2008-09 global financial crisis.[2] It finds a substantial impact of bank liquidity shocks on the supply of letters of credit: a 1 percentage point decline in bank deposit growth led to a 4.5 percentage point decline in letter-of-credit supply in intensive margins, and to a 5 percent increase in the discontinuation probability in extensive margins. The non-fungibility of letters of credit ensures that the estimated impact of bank liquidity shocks on the supply of letters of credit is directly translated into the impact on import transactions.[3] The estimate further suggests that adverse bank liquidity shocks can explain at least 38 to 47 percent of the collapse in import transactions via letters of credit in Colombia.

The identification strategy exploits the extremely detailed nature of Colombian import transaction data, which provide the name of importers, exporters, and banks for each letter-of-credit transaction. Together with the fact that there are many importer-exporter pairs that use multiple issuing banks for letter-of-credit transactions, the data allow for controlling for importer-exporter specific shocks, and for exploring within-importer-exporter variations

[1] Growing evidence confirms that global banks played a significant role in propagating financial shocks via cross-border lending and/or local lending by subsidiaries/branches during the global financial crisis (e.g., Allen, Hryckiewicz, Kowalewski, and Tümer-Alkan, 2010; Cetorelli and Goldberg, 2011, 2012; De Haas and Van Horenf, 2013, forthcoming; Giannetti and Laeven, 2012). Earlier studies include, among others, Peek and Rosengren (1997) on the Japanese banking crisis in early 1990's and Schnabl (2012) on the 1998 Russian default.

[2] The term "direct" is stressed in order to distinguish the lending supply channel from other indirect effects that occur through, for example, asset value deterioration. See Shleifer and Vishny (2011) for details.

[3] This is a stark contrast to other general loans that are not always entirely used for designated real activities and thus are expected to deliver a noisier interpretation.

in letter-of-credit transactions across issuing banks.

One potential concern about this estimation strategy is that it reflects only *relative* changes in the supply of letters of credit across banks for a given importer-exporter pair. It is plausible that the results were mainly driven by switching across issuing banks within an importer-exporter pair, without any significant effect on total imports via letters of credit. Similarly, it is conceivable that importer-exporter pairs switched to alternative payment methods in response to a reduced supply in letters of credit, without resulting in overall reductions in import transactions. The study undertakes further analysis to check these possibilities by investigating within-importer variations across exporters for both letter-of-credit and total-import transactions. It confirms that there is no evidence of such switching across banks or payment methods, and that the estimated impact of bank liquidity shocks on the supply of letters of credit is indeed entirely passed on to the aggregate reductions in import transactions.

The study also addresses another concern that the estimation results are likely to reflect the impact on bigger importers only. This is because smaller importers tend to import from a single exporter with a single issuing bank, and thus are excluded in the analysis with importer or importer-exporter fixed effects. The study investigates potential implications of such inadvertent sample selection problems by incorporating all importers into the analysis at the expense of fixed effects. The results show that smaller importers were much more vulnerable to adverse bank liquidity shocks than bigger importers. This strongly suggests that the baseline estimation results provide lower bounds for the estimate.[4]

This paper contributes to two strands of literature. First, it builds on the literature that studies the bank lending channel through which financial shocks affect the real economy.[5] Identifying the real transmission of financial shocks has often been quite challenging not least because of the difficulty in separating out demand shocks from supply shocks. The problem is tackled by employing and improving on the novel methodology developed in Khwaja and Mian (2008) that uses extensive sets of fixed effects to control for demand shocks. The detailed dataset in the present study provides a much finer level of disaggregation compared to those in previous studies that examined borrower-level variations across lenders for aggregate loans (e.g., Iyer, Lopes, Peydró, Schoar, 2010; Khwaja and Mian, 2008;

[4] This finding also has important implications on the distributive aspect of trade collapses during financial crises. To the extent that imported intermediate inputs are important factors in determining firm productivity, financially vulnerable smaller firms are likely to suffer from additional adverse productivity shocks (e.g., Gopinath and Neiman, 2012).

[5] The subsequent impact of the recent global financial crisis on loan supply has been studied extensively in Iyer, Lopes, Peydró, Schoar (2010) for Portuguese non-financial firms; Popov and Udell (2012) for SMEs in emerging Europe; Puri, Rocholl, and Steffen (2011) for individual borrowers from German saving banks. Ashcraft (2005), Khwaja and Mian (2008), Paravisini (2008), Peek and Rosengren (2000) and Schnabl (2012) study earlier episodes. Bernanke and Blinder (1992) and Kashyap and Stein (2000), among others, address the bank lending channel through which monetary policy affects the real economy, and Peek, Rosengren, and Tootell (2003) examine the importance of loan supply shocks in general.

Paravisini, Rappoport, Schnabl, and Wolfenzon, 2011; Schnabl, 2012).[6] The disaggregation level in the estimation process used here corrects potential biases and demonstrates that the failure to control for finer-level shocks would have underestimated the impact of bank liquidity shocks on loan supply substantially.

Beyond identifying loan supply shock, this study goes a step further than the previous literature and estimates the real consequences of the shocks (i.e., the impact of a reduced supply of letters of credit on import transactions). In this regard, this paper is most closely related to Paravisini, Rappoport, Schnabl, and Wolfenzon (2011), who examine the impact of financial shocks on international trade using bank-firm matched data as well as customs export data in Peru.[7] Unlike that study, however, this paper focuses on letters of credit, which are trade-specific financings, and thus provide direct evidence of the role of trade finance in the great trade collapse. The non-fungible nature of letters of credit guarantees the validity of estimated effects, another advantage over other studies.

This represents an important contribution to the trade finance literature.[8] Despite the substantial research on the issue, the lack of direct trade finance data at the micro level has made it hard to evaluate the independent role of trade finance in the great trade collapse.[9] The unique dataset in the present study enables such an evaluation by exploring one particular trade finance product, and by separating out its demand shocks from its supply shocks effectively at the importer-exporter level. Simple calculation using predicted values from a regression suggests a substantial role of the trade finance channel in explaining the collapse in import transactions via letters of credit in Colombia.

This paper proceeds as follows. Section 2 provides background information on a letter of credit as well as Colombian economy during the recent global financial crisis, and the data is introduced in section 3. Section 4 discusses our identification strategy, and empirical findings are presented in section 5. Section 6 concludes.

[6] Instead, this study examines borrower-project (importer-exporter) level variations across lenders (issuing banks) for a particular type of loan (letters of credit).

[7] Few other exceptions that study the real effects of adverse loan supply shocks include Amiti and Weinstein (2013), Kalemli-Ozcan, Kamil, and Villegas-Sanchez (2011), and Chodorow-Reich (2013). Claessens, Tong, and Wei (2012) study differential impacts of financial shocks on firms' performance across various dimensions.

[8] Empirical evidence suggesting the important role of trade finance in the great trade collapse is provided in Ahn, Amiti, and Weinstein (2011), Amiti and Weinstein (2011), Berman, de Sousa, Martin, Mayer (2012), Berman and Martin (2012), Bricongne, Fontagné, Gaulier, Taglioni, Vicard (2012), Chor and Manova (2012), Feenstra, Li, and Yu (2011) among others. A theoretical framework is provided in Ahn (2011), Antràs and Foley (2011), Olsen (2010) and Schmidt-Eisenlohr (2010). On the other hand, Levchenko, Lewis, and Tesar (2011) do not find supporting evidence, and Eaton, Kortum, Neiman, and Romalis (2011) attribute a minor role to the trade finance channel.

[9] There is a newly emerging literature employing various types of trade finance data. This includes Auboin and Engemann (2012) and Van der Veer (2010) for export credit insurance, and Felbermayr and Yalcin (forthcoming) for export guarantees.

2. Background

2.1. A Letter of Credit

Although it is hard to come up with an exact number without any representative data, there are several sources of data from which an approximate share of international transactions covered by letters of credit in world trade can be inferred. Despite differing estimates across data sources, data sources mostly confirm that a letter of credit is one of the major payment methods used in international transactions.

The data include a bank survey conducted by the IMF and the Bankers' Association for Finance and Trade (BAFT). The survey asked participating banks to provide an estimate of the share of each payment method. According to the survey, letters of credit are estimated to account for, on average, around 40 percent of international transactions worldwide (Asmundson, Dorsey, Khachatryan, Niculcea, and Saito, 2011). Another survey report by the International Chamber of Commerce (ICC) found that a letter of credit accounts for about half of traditional trade finance, which is used for approximately 20 percent of total international transactions.

Besides survey data, information can be obtained from countries' customs data that provide payment method information for the universe of export and/or import transactions. Albeit specific to the source country, customs data are believed to deliver the most accurate figure. There are at least three countries that require importers and exporters to report the payment method used for each cross-border transaction: Chile, Colombia, and South Korea. A calculation based on Chilean National Customs Service data finds that letters of credit financed around 10 percent of total imports and exports during 2008-09.[10] Colombian data, the main data introduced in the next section in more detail, show that letters of credit were responsible for around 4 percent of total imports in 2008 and 2009.

South Korean customs data offer a useful time-series picture of the changing role of letters of credit in total trade during the period from 1991–2012 (<Figure 1>).[11] It is rather striking to observe the rapidly declining role of letters of credit in South Korean trade. For both imports and exports, a letter of credit was used for most international transactions in the early 1990s, but its share started falling in the mid 1990s, and its rapid decline appears to have occurred during the Asian financial crisis. By 2012, the letter of credit accounted for around 20 percent of total trade.[12]

[10] Chilean export and import data at the transaction level do not provide information on the identity of trading partners (at the firm level) or banks for each transaction. Given the crucial role of this information in the estimation strategy used in this study (as discussed in section 4), it was preferable to use Colombian import transaction data.

[11] This is publicly available on the Korea International Trade Association website (http://www.kita.net/statistic/index_eng.jsp).

[12] Although it is tempting to investigate reasons behind the declining share of letters of credit, it is beyond the scope of this paper. A more thorough discussion on the choice of payment methods is provided in Ahn

<Figure 2> describes how international transactions are conducted using a letter of credit.[13] Instead of a direct transaction between an importer and an exporter, a letter of credit involves banks intermediating the transaction on their behalf. An importer's bank (i.e., issuing bank) promises to pay an exporter's bank (i.e., confirming bank) on behalf of an importer, and the exporter's bank guarantees the payment to an exporter whether the importer's bank actually pays or not. The entire transaction concludes with the payment from the importer to the importer's bank. This implies that, from the exporter's viewpoint, the nonpayment risk from the importer is replaced by the nonpayment risk from the importer's bank, and the exporter's bank assumes the nonpayment risk that would have been borne otherwise by the exporter. For this reason, it is critical for the importer's bank to assess the importer's credit risk correctly, while the exporter's bank needs to conduct a proper evaluation of the importer's bank's creditworthiness.

The way banks are involved in letter-of-credit transactions makes it quite interesting to study how such transactions can be disturbed during financial crises. The inherent nature of inter-bank transactions in letters of credit resembles that of inter-bank lending markets. As evidence suggests, inter-bank lending markets almost collapsed during the recent global financial crisis (e.g., Afonso, Kovner, and Schoar, 2011), from which it can be inferred that the same could have happened for letter-of-credit transactions. Regulatory rules on capital requirements (e.g., Basel II), which assign a letter of credit into one of the highest risk-weight categories, must have exacerbated the reluctance of confirming banks to be exposed to heightened default risk of issuing banks. At the same time, the unsecured nature of letters of credit must have led importer's banks to reduce issuance of them, as they reduced other types of loans, in response to adverse liquidity shocks. These mechanisms provide the foundation on which the main analysis of this paper is based.

2.2. Colombia during the Global Financial Crisis

Financial shocks from the epicenter of the crisis rapidly diffused to emerging countries. It is by now well known that in the aftermath of the Lehman bankruptcy, banks stopped lending to one another and started pulling out their deposits from other institutions both within and across borders, and from both subsidiaries and arm's length institutions. The international spillover from the financial crisis was not limited to the banking sector. The impact on the real economy was almost immediate. The most notable of the real consequences was an unprecedented collapse in trade, which far exceeded GDP declines worldwide (Baldwin, 2009).

Colombia was neither immune from nor an exception to the international transmission

(2011, 2013), Antràs and Foley (2011), Engemann, Eck, and Schnitzer (2011a, 2011b), Hoefele, Schmidt-Eisenlohr, and Yu (2012), Olsen (2010) and Schmidt-Eisenlohr (2010).

[13] The figure describes irrevocable confirmed letters of credit, which is the most commonly used among many other different types of letters credit.

of shocks and the great trade collapse. As shown in <Figure 3>, after several years of rapid growth, total deposits in Colombia decelerated substantially in 2009 (solid line, left axis). This was in part precipitated by huge reductions in foreign banks' claims on Colombian banks (dashed line, right axis), which constitute a large portion of bank-to-bank deposits in Colombia.

<Figure 4> plots quarterly imports in Colombia (solid line, left axis), which dropped by more than 30 percent during the subsequent three quarters after the onset of the financial crisis. Colombian imports financed by letters of credit (dashed line, right axis) showed similar and even more severe patterns. The remainder of this paper will explore these letter-of-credit import transactions in Colombia to identify and estimate the economic size of the direct transmission channel through which bank liquidity shocks affected the collapse in trade.

3. Data

The primary data for this study come from the import transaction database of the Colombian National Customs and Taxes Authority (DIAN). The value of import transactions in the data adds up to 99.99 percent of the official import value reported by the Central Bank of Colombia.[14] The unique feature of the data, even when compared to other countries' micro-level customs data, is that every observation is recorded at the transaction level with extremely detailed information. This includes the name of importers and foreign exporters *both* at the firm level, payment methods, and the banks involved, in addition to other routine items such as cif value, quantity, 10-digit product codes, country of exports, dates, etc.

Regarding the payment methods item, there are three major payment methods (i.e., open account, cash-in-advance, and letter of credit) covering nearly all of the transactions. Given the focus of the paper, only letter-of-credit transactions are explored.[15] <Table 1> shows the total value and number of transactions paid by letters of credit in 2008 and 2009, and their share in total import transactions. In 2008, letter-of-credit transactions accounted for about 4.4 percent of total import transactions in value, and about 2.4 percent in number. In 2009, the share of letter-of-credit transactions declined to 3.4 percent and 2.1 percent in value and number, respectively. Although their share in Colombia is remarkably low relative to other countries or sources, these letter-of-credit transactions are nonetheless expected to most clearly identify the transmission of shocks from the financial sector to the real sector because the loans made by each bank (i.e., the letter of credit) have a direct one-to-one

[14] Small transactions of which the cost, insurance, and freight (cif) value is below US $100 are not included in the main analysis so as to remove noisy transactions. The resulting observations cover 99.2 percent of the official import value.

[15] A more detailed discussion of other types of payment methods in the dataset is provided in Ahn (2013).

relationship with the real activity by each borrower (i.e., the import transaction supported by the letter of credit).

Detailed information on importers, exporters, and banks allows for identifying each importer-exporter with an issuing bank for every letter-of-credit transaction. Noting that imports started collapsing in the fourth quarter of 2008 through the second quarter of 2009 in <Figure 4>, the first three quarters of 2008 are classified as the pre-crisis period, and the subsequent three quarters as the post-crisis period, and the observations at the importer-exporter-bank level are aggregated in each period. The main strategy here is to track each letter-of-credit transaction by an importer-exporter-bank triplet that was present in the pre-crisis period. Restricting the focus to such observations, panel A in <Table 2> provides mean and median values of pre-crisis letter-of-credit transactions in the sample. There are a total of 4,706 unique importer-exporter-bank triplets that conducted import transactions using letters of credit in the pre-crisis period. Of those, 1,189 importer-exporter-bank triplets continued letter-of-credit transactions in the post-crisis period, while 3,517 of them stopped such transactions. Those that continued tend to have had larger transaction values on average compared to those that stopped. The most interesting feature of letter-of-credit transactions is that there are many importer-exporter pairs that used letters of credit issued by multiple banks in a given period. These importer-exporter pairs with multiple issuing banks in the pre-crisis period constitute 1,823 observations. They form the baseline sample with the idea that demand shocks can be effectively controlled by looking at variations across banks within an importer-exporter pair. Again, among those 1,823 observations, 670 observations survived in the post-crisis period, while 1,153 observations were dropped.

Panel B in <Table 2> breaks down the sample at three different levels: by importer, by importer-country pairs, and by importer-exporter pairs. In the sample, there are 1,197 unique importers, of which 351 used multiple issuing banks and 436 imported from multiple exporters in the pre-crisis period. Similarly, there are 2,125 unique importer-country pairs, and 542 of them used multiple issuing banks. That there are more importer-country pairs than importers reflects the fact that some importers import from multiple countries. One potential strength of the current data on exporter information at the firm level is highlighted in the third column of the importer-country-level section. There are 496 importer-country pairs that have multiple exporters within the country. Unlike other existing datasets that would aggregate such transactions to the importer-country level, the dataset here records the transaction at the actual importer-exporter level. To the extent that import demand varies at each importer-exporter level, it will help correctly control for import demand shocks. Consequently, there are 3,629 unique importer-exporters, far exceeding the number of importer-country pairs due to the presence of multiple exporters per importer within a country. Among them, 746 importer-exporter pairs used multiple issuing banks, which constitute the baseline sample of 1,823 observations.

Given that this study is going to explore those importer-exporter pairs with multiple issuing banks, it is imperative to ask why they want to use multiple issuing banks in a given period. <Table 3> gives a rough idea of the pattern of the issuing bank choice for each letter-of-credit transaction by an importer-exporter pair. Each row in the table represents the average share of letters of credit issued by the nth most-used bank for each importer-exporter pair, and each column corresponds to those importer-exporter pairs that used total n issuing banks. The first cell on the diagonal is 100 percent because there is only one issuing bank for these importer-exporter pairs. The second column shows that those importer-exporter pairs that had letters of credit issued by two different banks tend to get 70 percent of total transactions covered by the major bank, and the remaining 30 percent by the secondary bank. Likewise, the third column shows that when an importer-exporter pair uses three different issuing banks, on average, 62 percent of the total transaction is supported by the first bank, 26 percent by the second bank, and the remaining 11percent by the third bank. One pattern that arises is that the issuance of letters of credit is not evenly distributed across banks within each importer-exporter pair.[16] The first few banks support most of the transactions, while the least-used banks cover only a small part of transactions. One rationale behind the pattern is that each bank imposes a credit line for each transaction, just as it does for other types of loans. If the total value of the transaction to be covered by letters of credit exceeds a credit limit at the first bank, the importer-exporter pair will apply the remainder to the second bank, and then repeat that until they get the transaction fully covered by letters of credit. Accordingly, the pair will use the first $n-1$ banks until the value covered by a letter of credit reaches the maximum available at each bank, and the last nth bank will take whatever remains with the share far below $1/n$. All else being equal, this would also imply that when the value of the transaction is larger, an importer-exporter pair is more likely to receive letters of credit from multiple issuing banks. This is consistent with <Table 2>, which showed that the mean and median value of total letter-of-credit transactions is much larger for importer-exporter pairs with multiple issuing banks. The implication of this pattern of issuing bank choices will be discussed in more detail in the empirical strategy introduced at the end of the next section.

Additional annual bank-level data compiled by the Bankscope database are incorporated into the primary import transactions data. Among 16 banks that provided letters of credit to Colombian importers in the pre-crisis period, three banks are excluded because their balance sheets data are not available in the Bankscope database.[17] <Table 4> presents summary

[16] Had that been the case, the diagonal would have been filled by (100, 50, 33, 25, 20, 16, 14) instead of the current one.

[17] These three banks were collectively responsible for less than 1 percent of total letter-of-credit transactions during the period. The remaining 13 banks are: AV Villas, Banco Agrario de Colombia, Banco Colpatria - Red Multibanca, Banco Davivienda, Banco de Bogota, Banco de Credito (Helm Bank), Banco de Occidente, Banco Popular, Banco Santander Colombia, Banco Sudameris Colombia, Bancolombia, BBVA Banco Ganadero, Citibank Colombia.

statistics for some of the key bank-level variables.[18] Banks in the sample reduced total loans, on average, by 20 percent during the two-year period from 2007 to 2009. During the same period, although total deposits at these banks kept growing by 22 percent on average, the growth rate almost halved from preceding periods, which have been perceived as large adverse liquidity shocks by the banks. The loan reduction rate appears to be moderate compared to an average 88 percent decline in the issuance of letters of credit between the pre- and the post-crisis periods.[19]

<Figure 5> illustrates the relationship between the growth in the issuance of letters of credit (y-axis) and the growth in total deposits (x-axis). Both are expressed as the deviation from the mean. The figure shows a weakly positive relationship between them, suggesting that banks with bigger adverse liquidity shocks reduced the supply of letters of credit supply more. The subsequent sections will be devoted to confirming the pattern and providing the precise estimate of the relationship by carefully controlling for demand-side factors.

4. Empirical Strategy

Every international transaction takes place between an importer and an exporter. When the transaction is backed by a letter of credit, it involves, in addition, a bank that issues a letter of credit and thereby promises to pay on behalf of an importer. Hence, the proper starting point for understanding letter-of-credit transactions is set at an importer-exporter-bank (ijb) level.[20]

The amount outstanding for each letter of credit will be determined by the supply and demand and supply for issuance of letters of credit. Once an importer and an exporter agree to transact a certain value using letters of credit, the importer applies to a bank for a letter of credit, and the bank decides whether to issue it to support all or part of the transaction. An exporter's bank then decides whether to accept a letter of credit issued by the importer's bank, and thus whether to oblige itself to make payments to the exporter. Accordingly, just as with other general types of loans, the demand for letters of credit comes from importers and exporters in the real sector, while the supply of letters of credit is determined in the financial sector by issuing and confirming banks. The goal here is to identify the pure supply shocks for letters of credit triggered by an issuing bank's liquidity shocks, which can be achieved only if demand shocks are isolated from supply shocks.

We begin by specifying the changes in the value of letter-of-credit transactions for each

[18] An accounting year closes at the end of each year. During the period from December 2007 to December 2009, consumer price level (i.e., CPI) increased by 10 percent in Colombia.

[19] Although this may suggest that the supply of letters of credit is more sensitive to bank liquidity shocks than the general supply of loans, the possibility that the same is true for the demand side during financial crises is not excluded.

[20] Strictly speaking, there is an additional dimension: the exporter's bank. Since the dataset does not identify exporters' banks, it is not made explicit in the expression. However, the presence and the role of confirming banks is taken into account in the analysis.

importer (i)-exporter (j)-bank (b) triplet between the pre-crisis and the post-crisis periods as:

$$\Delta LC_{ijb} = \beta_0 + \beta_1 \Delta B_b + \beta_2 \Delta V_{ijb} + \varepsilon_{ijb}, \tag{1}$$

where β_0 is a constant capturing economy-wide shocks, ΔB_b is the issuing bank's liquidity shocks, and $\Delta V_{ijb} = \Delta V_i' + \Delta V_{ij}'' + \Delta V_{ijb}'''$ is the composite of various factors at the importer, importer-exporter, and importer-exporter-bank levels, with β_2 being a vector of corresponding coefficients. β_1 is the coefficient of interest that measures the effects of bank-level liquidity shocks on the supply of letters of credit. This is the letter-of-credit channel through which financial shocks affect international trade.

Assume for now that importer-exporter-bank-level shocks are not correlated with bank-level liquidity shocks and thus can be absorbed into the error term (i.e., $corr(\Delta B_b, \Delta V_{ijb}''') = 0$), which will be relaxed and discussed further at the end of this section. Then, we can rewrite equation (1) as:

$$\Delta LC_{ijb} = \beta_0 + \beta_1 \Delta B_b + \beta_2 \Delta V_{ij} + \varepsilon_{ijb}, \tag{2}$$

where $\Delta V_{ij} = \Delta V_i' + \Delta V_{ij}''$ is now composed of factors at two levels, the importer and importer-exporter levels. The main component of the importer-level shocks will be importer-specific demand and credit shocks. An importer may decide to reduce overall imports by, say, 10 percent. Also, when an importer's creditworthiness deteriorates, it will adversely affect banks' decisions to issue letters of credit on behalf of the importer. Furthermore, when an importer imports from several exporters, each of which is selling different types of goods, it is very likely that demand shocks will occur at the importer-exporter level even within an importer. For example, demand for high-quality goods tends to decline relatively more than demand for low-quality goods during recessions. Similarly, the demand for durable goods tends to decline more than that for nondurable goods. Although there is no doubt that there are various shocks at both the importer and importer-exporter levels, a more relevant question here is whether they are correlated with bank-level liquidity shocks, ΔB_b.

Assume further that importer-exporter-level shocks are not correlated with bank-level liquidity shocks (i.e., $corr(\Delta B_b, \Delta V_{ij}'') = 0$). Then, one can aggregate them over exporters for each importer-bank pair:

$$\Delta LC_{ib} = \beta_0 + \beta_1 \Delta B_b + \eta_i + \varepsilon_{ib}, \tag{3}$$

where $\Delta LC_{ib} = \Sigma_j \Delta LC_{ijb}$ and η_i captures all variations collapsed into the importer level. This is exactly the specification that previous studies employed in studying the impact of bank liquidity shocks on lending supply, with j denoting loan types instead of exporters in the case here (e.g., Khwaja and Mian, 2008; Schnabl, 2012). The estimate from a simple

OLS will be biased when the importer-specific shock is correlated with bank-level liquidity shocks (i.e., $corr(\Delta B_b, \eta_i) \neq 0$), which is very likely to be the case. One simple example will be that an importer tends to receive a letter of credit from its main bank such that bad shocks on the importer side generate bad news for the bank, worsening the bank's liquidity shocks. Since many importers receive letters of credit from multiple banks in a given period, a novel remedy to address such bias developed in the above-mentioned studies can also be applied to this setting by including importer fixed effects to absorb all importer-level shocks. Therefore, as long as our underlying assumption holds ($corr(\Delta B_b, \Delta V''_{ij}) = 0$), running a regression in equation (3) with importer fixed effects will deliver the unbiased estimate of β_1.

However, there are good reasons to believe that importer-exporter-level shocks are correlated with bank-level liquidity shocks (i.e., $corr(\Delta B_b, \Delta V''_{ij}) \neq 0$), which will invalidate the specification in equation (3) in the first place. Here is one example in which the correlation may arise from the selection process by exporters' banks. In deciding whether to accept a letter of credit, an exporter's bank will prefer a letter of credit issued by a healthier bank. To the extent that exporters' banks with relatively weaker balance sheets showed stronger preference patterns and thus were more likely to be self-selected into the relationship with healthier issuing banks, this will generate a negative correlation between importer-exporter-level shocks and the importer's bank-level liquidity shocks (i.e., $corr(\Delta B_b, \Delta V''_{ij}) < 0$). This is because exporters' banks with relatively weaker balance sheets before the crisis are more likely to have been hit harder by global financial shocks, and thus to have more actively reduced overall exposure to letters of credit, while ex ante healthier issuing banks are more likely to have weathered the storm of liquidity shocks. In other words, since the composition of exporters' banks, and hence that of exporters at each importer-bank-level matters, the aggregation process that results in equation (3) is not warranted and should be avoided.[21]

For this reason, we will go back to the importer-exporter-bank-level specification in equation (2). Of course, working with the importer-exporter-bank-level data does not automatically solve the problem. We need to control for importer-exporter-specific shocks that would generate downward bias if they were negatively correlated with bank-level liquidity shocks as reasoned above. One natural candidate is including importer-exporter-level fixed effects, which will deliver the unbiased estimate of β_1 as long as our first assumption holds ($corr(\Delta B_b, \Delta V'''_{ijb}) = 0$). This methodology, however, imposes strict restrictions on the sample that only those importer-exporter pairs receiving letters of credit from multiple issuing banks can be included. A great advantage of the current dataset is that, as described in the previous section, it indeed includes many importer-exporter pairs with multiple issuing banks. Had it not been for such a unique feature of the data, it might have been necessary

[21] Khwaja and Mian (2008) and Schnabl (2012) try to address the issue by including the share of each type of loan as additional control variables. The results here suggest that composition matters even within a letter of credit, a narrowly defined type of loan.

to rely on importer-country-level fixed effects instead. To the extent that the vulnerability of exporters' banks was relatively homogeneous and thus they behaved similarly within a country, importer-country-level fixed effects could alleviate the omitted variable bias to some degree, but not as much as importer-exporter-level fixed effects do.

The final step is to question the validity of our first assumption that importer-exporter-bank-level shocks are not correlated with bank level liquidity shocks (i.e.,$corr(\Delta B_b, \Delta V'''_{ijb}) = 0$). The answer lies in better understanding why an importer-exporter pair would ever use multiple issuing banks for their letter-of-credit transactions in a given period. One possible explanation is that each bank imposes a credit line for each transaction. If the total value of the transaction to be covered by letters of credit exceeds a credit limit at the first bank, the importer-exporter pair will apply the remainder to other banks until they get the transaction fully covered by letters of credit. Alternatively, exporters' banks may want to diversify their risk exposures across issuing banks. In either case, the pair will use the first $n-1$ banks until the value covered by a letter of credit reaches the maximum available at each bank, and the last nth bank will take whatever remains.

This implies that it is very likely for the estimate to be seriously biased when this process is not properly accounted for. The reason is as follows. Any given importer-exporter pair will tend to approach the most creditworthy bank first, and use the least creditworthy bank last, not least because of the exporter's bank's preference. At the same time, the amount of letters of credit issued by the first few banks is most likely to have reached credit limits, while it is likely to be below the credit limit at the last one. Suppose now that liquidity shocks occur across banks. Even if the ex ante healthier banks are hit less, they will also be forced to lower credit limits for each line of credit just as–but less than–the other banks. Since lowering credit limits will affect binding cases most (i.e., those letters of credit that have already reached credit limits) and these cases are likely to have been more prevalent in ex ante healthier banks, this will generate bias toward zero, in particular for intensive margin analysis that looks at continuing letter-of-credit issuances.

The opposite will be true for extensive margin analysis that focuses on discontinuing the importer-exporter-bank relationship. When import demand falls, an importer-exporter pair is most likely to drop out of the relationship with the last nth banks because the pair no longer needs the bank that had mostly provided the final portion of the importer-exporter pair's financing needs. To the extent that the last nth banks are the weakest banks hit most, this will overestimate the effect of bank liquidity shocks on the banks' decision to discontinue the issuance of letters of credit.

As an attempt to eliminate such bias, we include the pre-crisis value of letter of credit issued by a bank for each importer-exporter pair ($LC_{ijb,pre}$). This variable will capture the relative distance from credit limits at each bank for an importer-exporter pair. The higher the pre-crisis value, the lower the subsequent intensive growth and the probability of exit

during crises. Consequently, the main specification that is free from any potential bias is given as:

$$\Delta LC_{ijb} = \beta_0 + \beta_1 \Delta B_b + \beta_2 LC_{ijb,pre} + \eta_i + \eta_{ij} + \varepsilon_{ijb}, \tag{4}$$

where β_0 is a constant capturing economy-wide shocks, and ΔB_b is the issuing bank's liquidity shock measured by the difference in log deposits at a bank between two periods.[22] Lower deposit growth corresponds to larger adverse liquidity shocks. $LC_{ijb,pre}$ is the importer-exporter-bank-level log pre-crisis value of the letter of credit, and η_i denotes importer fixed effects, which will be wiped out when η_{ij} is controlled for by importer-exporter fixed effects. The dependent variable is the difference in the log value of the letter of credit issued by a bank (b) for an importer-exporter pair (ij) between the pre- and the post-crisis periods for intensive margin analysis, and an exit dummy variable for extensive margin analysis.

In sum, β_1 is the coefficient of interest that is supposed to capture the impact of bank-level liquidity shocks on letters of credit supply. This is the letter-of-credit channel through which financial shocks affect international trade. $\beta_1 > 0$ (or $\beta_1 < 0$ for extensive margin analysis) will imply that each importer-exporter pair finds it harder to get letters of credit issued by a bank with bigger adverse liquidity shocks. This will be a result of the fact that (a) a bank hit harder by liquidity shocks reduces the supply of letters of credit more (supply reduction by issuing banks), and (b) an exporter's bank reduces an exposure to a harder-hit bank more (supply reduction by confirming banks).

5. Results

5.1. Bank Liquidity Shocks and the Supply of Letters of Credit

<Table 5> presents the regression results when the dependent variable captures both intensive margin growth and extensive margin growth due to exit. In particular, the dependent variable is constructed as the change in the value of letters of credit issued by a bank b for an importer-exporter pair ij between the pre-crisis and the post-crisis periods scaled by the sum of these two values.[23] The sample is restricted to importer-exporter-bank triplets that appear in the pre-crisis period.[24] Columns (1)-(3) report the regression results from the most preferred specification that includes importer-exporter-level fixed effects. Column

[22] Bank deposit has been shown to be a good measure of bank liquidity during crisis periods (e.g., Khwaja and Mian, 2008; Ivashina and Scharfstein, 2010).

[23] By construction, this measure is bounded between -1 and 1, unlike the traditional growth measure scaled by the pre-crisis value that is not bounded above. A similar measure is used in Antràs and Foley (2011), Chodorow-Reich (2013).

[24] This is the subset of the sample with all importer-exporter pairs that received letters of credit from multiple issuing banks for which importer-exporter fixed effect regressions are justified.

(1) includes bank-level deposit growth only, and column (2) adds the importer-exporter-bank-level pre-crisis value of the letter-of-credit transaction. The result does not vary much when the pre-crisis value is added, perhaps because the opposing effects are offset between intensive and extensive margins. The coefficient on bank liquidity shocks is greater than 1 and statistically significant at the 10 percent level. Given that the estimation is based on within-importer-exporter pair variations, the estimate reflects pure supply effects as long as reduced demand within an importer-exporter pair is in equal proportion across banks after controlling for the pre-crisis value. Adding log total assets value as a proxy for bank size reduces the size of the estimated coefficient on bank liquidity shocks but the qualitative interpretation remains the same (column (3)).[25] The results from columns (1)-(3) reveal significant effects of bank liquidity shocks on the supply of letters of credit, and thus identify one particular channel through which financial shocks are transmitted to real activity, namely the letter-of-credit channel.

In order to highlight the role of importer-exporter level-fixed effects in eliminating potential biases, columns (4)-(9) report corresponding regression results with importer-country fixed effects (columns (4)-(6)) and importer-fixed effects (columns (7)-(9)). When importer-country fixed effects are included instead of importer-exporter fixed effects, the estimate of bank liquidity shocks tends to be lowered across all specifications. This reflects potential downward bias caused by failure to control for the self-selection pattern of exporters' banks, as discussed in detail in the previous section. Columns (7)-(9) show even lower estimates, which implies more severe downward bias when only importer-level fixed effects are included. This shows that adding importer-country-level fixed effects corrects downward bias in the estimated coefficient a little bit, but cannot eliminate all.

Despite its advantage in presenting the overall impact, the dependent variable in <Table 5> makes it hard to interpret the size of the estimated coefficient. In order to deliver a meaningful interpretation, it is useful to break it down to intensive and extensive margin effects. <Table 6> presents the regression results when the dependent variable captures intensive margin growth only. The dependent variable is now the difference in log value of the letter of credit issued by bank b for an importer-exporter pair ij between the pre-crisis and post-crisis periods. Therefore, the sample is restricted to importer-exporter-bank triplets that appear in both periods among those importer-exporter pairs with multiple issuing banks. As earlier, columns (1)-(3) report the most preferred regression results with importer-exporter-level fixed effects. The coefficient on bank liquidity shocks is around 3 but not statistically significant in column (1), but adding the pre-crisis level raises the size as well as the statistical significance of the coefficient estimate substantially. At the same time, the coefficient on the pre-crisis value is estimated to be negative and statistically sig-

[25] Including additional sets of bank-level controls such as pre-crisis values of total deposits, bank-to-bank deposits, liquid assets, and/or total equity gives qualitatively similar results.

nificant. Thus, column (2) confirms the discussion in the previous section that the closer the previously issued letter of credit is to a credit limit, the larger the subsequent decline is for intensive margin growth, and that failing to control for this will cause downward bias in estimating the effects of bank liquidity shocks on intensive-margin growth of letter-of-credit issuance. Adding bank size as an additional bank-level control lowers the estimate a little bit (column (3)). The estimated coefficient implies that a 1 percentage point decline in bank liquidity leads to a 4.5 percentage point decline in the bank's letter-of-credit issuances. Columns (4)-(6) repeat these regressions with importer-country-level fixed effects instead of importer-exporter-level fixed effects. The coefficient is underestimated across all three specifications compared to the one in a corresponding column in (1)-(3). This again confirms the earlier discussion on potential downward bias that may persist in the absence of importer-exporter fixed effects. Columns (7)-(9) report the results with importer level fixed effects only, and they reveal even worse downward bias, further supporting the point. It is also worth noting the consistent role of adding the pre-crisis value in these alternative fixed effects regressions (column (4) versus (5) and column (7) versus (8)).

Turning to extensive margin impact due to exit, <Table 7> presents the regression results from a linear probability model with an exit dummy as the dependent variable. The sample is the same as the one in <Table 5> that includes importer-exporter-bank triplets that appear in the pre-crisis period. The exit dummy is equal to 1 for those that disappear in the post-crisis period, and 0 otherwise. Columns (1)-(3) report the regression results with importer-exporter-level fixed effects. Column (1) shows the negative and statistically significant coefficient on bank liquidity shocks, implying that a bank with bigger adverse liquidity shocks is more likely to discontinue issuing a letter of credit to a given importer-exporter. Adding the pre-crisis value moves the estimate to a smaller negative value with its own coefficient being negative and statistically significant (column (2)). The lower the pre-crisis value, the higher the probability of exit during crises, and failing to control for this overestimates the extensive margin impact of bank liquidity shocks. This is exactly what was discussed in the previous section: the value of letters of credit issued by a bank is not randomly assigned within an importer-exporter pair. Adding bank size as an additional bank level control lowers the estimate a little bit. Columns (4)-(6) and columns (7)-(9) are the results from importer-country-level fixed effects and importer-level fixed effects, respectively. As earlier, these results confirm that including importer-country-level fixed effects instead of importer-exporter-level fixed effects underestimates the impact of bank liquidity shocks on the supply of letters of credit, and that the downward bias is much worse when only importer fixed effects are included. The importance of adding the pre-crisis value is also found in these alternative cases (column (4) versus (5) and column (7) versus (8)).

Despite its clearness, the sheer size of the coefficient in <Table 7> makes it hard to

deliver a reasonable interpretation. For example, column (3) suggests that a 2 percentage point decline in bank deposits leads to an increase in the exit probability by 1.9, which is clearly incorrect given that the probability is defined between 0 and 1. This is a common drawback of the linear probability model. Instead, one can employ the logit model, and the results are reported in <Table 8>. Since the logit model discards observations without any variation in the dependent variable within a group, the sample now includes only those importer-exporter pairs (importer-country pairs in columns (4)-(6) and importers in columns (7)-(9)) that discontinued receiving letters of credit from at least one bank, but not from all.[26] The qualitative patterns in the coefficient estimate are exactly the same as those found in <Table 7> from the linear probability model. The interest here is in the odds ratio reported at the bottom of each column, which gives an easy interpretation addressing the drawback of the linear probability model. Column (1) shows that a 1 percentage point increase in bank liquidity shocks reduces the exit probability by 6 percent (1-0.938). Column (2) shows that controlling for the pre-crisis value can correct the overestimated value, and lowers the estimated impact on the exit probability to 5 percent (1-0.946). Importer-country fixed effects and importer fixed effects regressions report similar but underestimated results (columns (4)-(9)).

This section concludes by presenting the regression results from the importer-bank level data as specified in equation (3). Columns (1)-(3), columns (4)-(6), and columns (7)-(9) replicate the regression results reported in <Table 5>, <Table 6>, and <Table 7> respectively, at the importer-bank-level with importer fixed effects. In all cases, the coefficient on bank-level liquidity shocks is not precisely estimated, and none is statistically significant. This highlights the caution against aggregating the data over exporters to an importer-bank level, or over loan types to a borrower-lender level in more general cases.

5.2. The Supply of Letters of Credit Supply and the Collapse of Imports

The main results so far have confirmed that bank liquidity shocks lead to a reduction in the issuance of letters of credit. However, it is important to note that the results were all in *relative* terms, and that they do not necessarily identify the presence of the transmission channel from financial shocks to the real economy. Banks hit harder by liquidity shocks reduced the supply of letters of credit *relative to* other banks hit less, to a given importer-exporter pair. It is perfectly plausible that the results were mainly driven by switching across issuing banks within an importer-exporter pair, without any significant effect on total imports by the importer-exporter pair. That is, if banks with smaller liquidity shocks had absorbed the market share of issuance of letters of credit from those with bigger adverse liquidity shocks, the sizable estimate of the letter-of-credit channel would still have been

[26] Another change made here is that bank deposit growth is now multiplied by 100 in order to deliver a more simple and intuitive interpretation on the odds ratio.

obtained, but there would have been no such transmission of bank liquidity shocks to import transactions.

In order to check this possibility, we aggregate the specification in equation (4) over banks for each importer-exporter pair:

$$\Delta LC_{ij} = \beta_0' + \beta_1' \Delta \overline{B}_{ij} + \beta_2' LC_{ij,pre} + \eta_i + \eta_{ij}, \tag{5}$$

where $\Delta \overline{B}_{ij}$ is now the average liquidity shocks faced by an importer-exporter's pre-crisis issuing banks. This is measured as the importer-exporter-level average bank liquidity shocks weighted by the pre-crisis value of the letter of credit issued by each bank. The more an importer-exporter pair had initially received letters of credit from banks with bigger adverse liquidity shocks, the lower $\Delta \overline{B}_{ij}$ is. If the share of letters-of-credit issuance was simply reallocated across banks for import transactions by an importer-exporter pair, the coefficient estimate β_1' will be close to zero because the average liquidity shocks would have no impact on the importer-exporter pair's total letter-of-credit import transactions. On the other hand, if an importer-exporter pair could not easily switch across banks to compensate for letters of credit cut by the hardest-hit banks, we would obtain the coefficient estimate β_1' greater than zero, proving the presence of the transmission channel from bank liquidity shocks to import transactions.

Since observations are now at the importer-exporter level and there are many importers that transacted with multiple exporters using letters of credit, importer fixed effects can be included to control for importer-specific demand and credit shocks. In other words, we ask whether an importer reduced imports by letters of credit relatively more from an exporter with which the importer had received letters of credit from banks with larger negative liquidity shocks.

The regression results are reported in <Table 10>. The coefficient estimate of the bank liquidity shocks is big, positive, and statistically significant (column (2)), and omitting the pre-crisis value of letters of credit transaction leads to downward bias (column (1)). Admittedly, running a regression specified in equation (2) implicitly assumes that the importer-exporter-level shock is uncorrelated with independent variables, including the average bank liquidity shocks (i.e., $corr(\Delta \overline{B}_{ij}, \eta_{ij}) = 0$), which may not hold for a similar reason discussed earlier. To the extent that potential bias arises mostly from exporting-country-level shocks, one remedy to reduce potential bias is to include an exporter's country fixed effects along with an importer fixed effects. The results in the previous section that importer-country fixed effects reduce potential bias support the idea. Columns (3) and (4) report the regression results when country fixed effects are added.[27] Including country fixed effects raises the coefficient estimate on the bank liquidity shocks, reflecting downward

[27] In fact, there are two observations unused in these regressions because two countries in the sample have only one exporter each.

bias in a regression with importer fixed effects only. The size of the coefficient estimate is comparable to the one from the importer-exporter-bank-level regression reported in <Table 6>. This is the evidence against the possibility that an importer-exporter pair could turn to another bank when it became hard to receive a letter of credit from a bank.

Still, there is another possibility that might have dampened the letter-of-credit channel through which bank liquidity shocks deliver real effects. If an importer-exporter pair could find alternative sources of trade financing easily, and thus could switch to other types of payment methods from a letter of credit, a reduction in letter-of-credit transactions would not necessarily lead to an overall reduction in import transactions. To see if this is actually what had happened, we replace our dependent variable with total value of import transactions between an importer and an exporter, which now includes, if any, cash-in-advance and open account transactions. A lower coefficient estimate on the average bank liquidity shocks than the ones in previous columns would imply that trading partners could use alternative payment methods when they found it hard to receive letters of credit. The results reported in columns (5)-(8) show strong evidence against this possibility. The coefficients do not change much, suggesting that it was not easy for them to find alternative sources of trade financing at the time of bank liquidity shocks.

Overall, the results in <Table 10> strongly confirm that the letter-of-credit channel identified in the previous section has real consequences: bank liquidity shocks are directly passed on to the real economy via a reduction in the supply of letters of credit.

Having addressed major issues in estimating the real impact of bank liquidity shocks, the study turns to another potential concern about the estimation process. Although the main estimation strategy that employs fixed effects at various levels allow for controlling for demand as well as credit shocks in a very careful manner, it is not costless. We are restricted to narrow samples such as importer-exporter pairs with multiple issuing banks (importer-exporter-bank-level analysis) or importers with multiple exporters and issuing banks (importer-exporter-level analysis). It remains to be seen if the results are the outcome of these inadvertent sample selections or the reflection of the economy-wide phenomenon.

Summary statistics presented earlier in <Table 2> shed some light on the question. At both the importer and importer-exporter levels, the relationship with multiple issuing banks corresponds to larger letter-of-credit transaction values. Similarly, an importer with multiple trading partners tends to have larger letter-of-credit transaction values in terms of both median and mean. To the extent that the value of letter-of-credit transactions proxies the size of the importer, the sample is likely to be skewed toward larger importers. The question is then confined to differential effects of bank liquidity shocks across importer size. The empirical evidence that larger firms are more likely to weather credit shocks than smaller firms (Khwaja and Mian, 2008) suggests that the analysis will deliver lower bounds for the estimated impact of bank liquidity shocks.

The above conjecture can be checked in a formal way by including *all* importers that undertook letter-of-credit transactions in the pre-crisis period. The strategy is to use the value of total imports per importer as the proxy for the importer size. Although we can no longer control for importer-level shocks with importer fixed effects, we can investigate if smaller importers excluded in the main analysis had been hit harder by bank liquidity shocks. The bank liquidity shocks term and its interaction term with the importer size will show differential effects of bank liquidity shocks on importer-exporter level import transactions.

<Table 11> summarizes the results. Compared to the regression with importer fixed effects (column (4) in <Table 10>), the estimated coefficient is lower. The average impact of bank liquidity shocks on letter-of-credit transactions is estimated to be around 2.6 when all importer-exporter pairs are included (column (1)). It is not yet clear if the estimate is lower because smaller firms are included or because importer fixed effects are excluded. Column (2) adds an importer size dummy and its interaction term with the average bank liquidity shocks variable. The importer size dummy is defined as big (Big=1) if an importer is one of top 90 percent of all importers in terms of total import value. The bottom 10 percent of all importers is treated as small (Big=0). The coefficient estimate indicates that the bottom 10 percent of importers were largely and disproportionately affected by bank liquidity shocks relative to the top 90 percent of importers. Smaller importers reduced letter-of-credit imports by 8.3 percentage point in response to a 1 percentage point increase in adverse bank liquidity shocks, whereas bigger importers reduced such imports only by around 2.5 percentage point (8.332-5.761). As we tighten up the importer size dummy by classifying the top 80 percent (column (3)) and top 50 percent (column (4)) importers as big, the coefficient estimate of the average bank liquidity shocks decreases to 5 and 4 respectively, and bigger importers constantly exhibit lower coefficient estimates, albeit the difference is now statistically insignificant. Exactly the same patterns are found when we look at the growth in total imports by importer-exporter pairs (columns (5)-(8)). This is consistent with the idea that smaller firms were affected by adverse liquidity shocks even more than bigger firms, and the main estimation strategy that focuses on bigger firms is likely to underestimate the impact of bank liquidity shocks.

5.3. Quantifying the Relative Role of Bank Liquidity Shocks in the Import Collapse

Given the results presented so far, it is tempting to further explore the estimates in order to gauge the relative role of trade finance in the great trade collapse. Although this is not an easy task because neither import demand shocks nor trade finance supply shocks are fully observable, we nevertheless apply several methods to quantify the relative role of trade finance in the import collapse, albeit only suggestive, for the sample of importer-exporter pairs included in regressions reported in <Table 10>.

The basic idea is to calculate the hypothetical aggregate imports growth that would have been obtained if trade finance shocks had been the only factor causing the trade collapse, and compare it to actual aggregate import growth. The hypothetical value can be obtained by (a) collecting importer-exporter level predicted growth rates from a simple OLS regression with the average bank liquidity shock variable; (b) backing out importer-exporter level predicted import values in the post-crisis period; and (c) summing them up over importer-exporter pairs to calculate the aggregate import growth rate. We choose to run a simple OLS regression because it is the correct model under the hypothetical scenario, and this will allow us to be conservative because a simple OLS regression underestimates the impact of bank liquidity shocks.[28] The resulting hypothetical growth rate for the sample is -6.4 percent, which is about 47 percent of the actual growth rate (-13.7 percent).

Alternatively, we can follow the methodology employed in Mian and Sufi (2012) in order to remove economy wide shocks that are included in the above calculation but may not necessarily be attributable to trade finance shocks. This requires a simple fix for the above procedure, which amounts to subtracting the predicted growth rates for the least affected importer-exporter pair from the importer-exporter-level predicted growth rates. Following their approach to remain conservative, we pick the importer-exporter pair with the 95th percentile of average bank deposit growth (i.e., the importer-exporter pair with the top 5 percentile of predicted import growth (-0.2 percent) as the least affected. This exercise yields the hypothetical growth rate of -6.3 percent, which is not very different from our earlier figure.

Yet another possible approach is to use the regression result in column (1) in <Table 10> by collecting predicted values excluding the ones from importer fixed effects. This is supposed to deliver aggregate import growth due only to bank liquidity shocks with the idea that importer fixed effects capture any other demand shock operating at the importer level. Again, this will deliver a conservative quantification because some portions of importer fixed effects would include importer-level credit shocks attributable to the trade finance channel. This approach gives the predicted aggregate import growth rate of -5.2 percent, implying that about 38 percent of the actual import collapse is explained by bank liquidity shocks.

6. Conclusion

The main goal of this paper has been to identify and provide a precise estimate of the direct impact of bank liquidity shocks on real economic activity by achieving the goal by exploring letter-of-credit import transactions in Colombia during the 2008-2009 global financial crisis. The detailed dataset on letter-of-credit transactions allows for exploiting within-importer-exporter variations across issuing banks. The study finds substantial ef-

[28] The estimated coefficient on bank liquidity shocks from an OLS regression is 1.851 with the standard error 1.012.

fects of bank liquidity shocks on import transactions via letters of credit. The estimate suggests that adverse bank liquidity shocks played a significant role in the collapse in import transactions via letters of credit in Colombia.

The contribution of this paper is important in several ways. First, it minimizes the potential omitted variable bias by employing highly disaggregated data. Second, the estimates fully capture the real impact of letter-of-credit supply shocks thanks to their non-fungible nature. Third, it provides a quantitative evaluation of the role of trade finance in the great trade collapse.

The process of checking the validity of the estimates revealed the interesting fact that smaller importers are hit by the bank liquidity shock more severely than bigger importers. This finding may suggest an additional mechanism that brings about distributional consequences of financial crises. To the extent that imported intermediate inputs are important determinants of productivity, financial crises can generate unequal productivity shocks across firms. This will be an interesting topic for future research.

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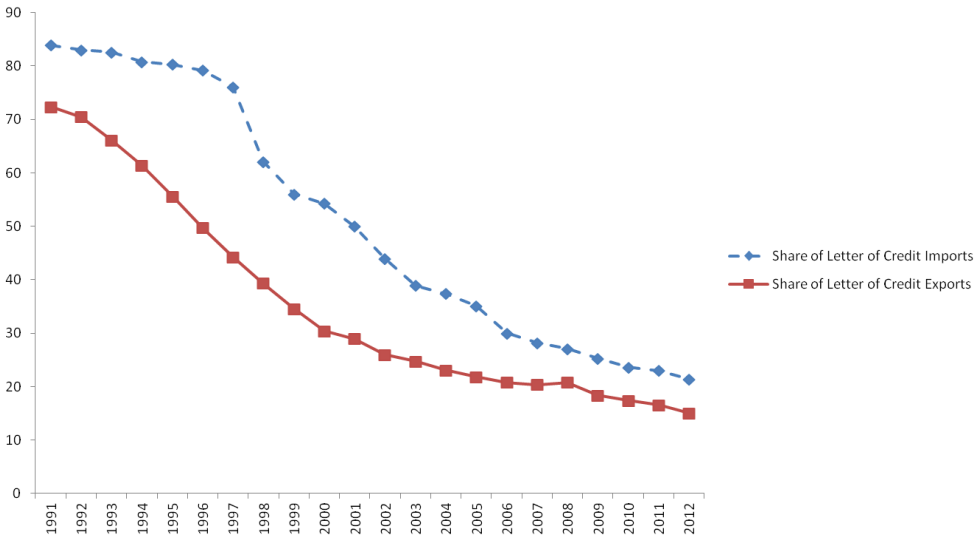
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Figures



Note: This figure presents time-series changes in the share of letter of credit transactions in South Korean trade.
Source: Korea Customs Service. Data are available at the website of The Korea International Trade Association (http://www.kita.net/statistic/index_eng.jsp).

Figure 1: Share of Letter-of-Credit Transactions in South Korean Trade from the period 1991-2012

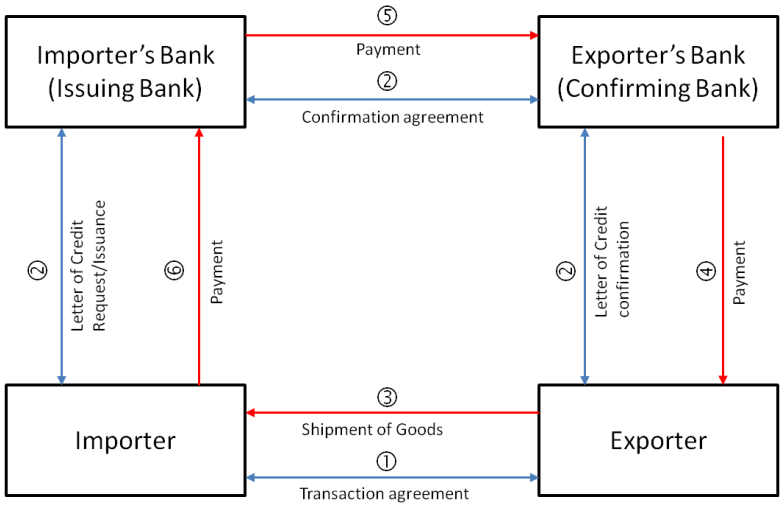
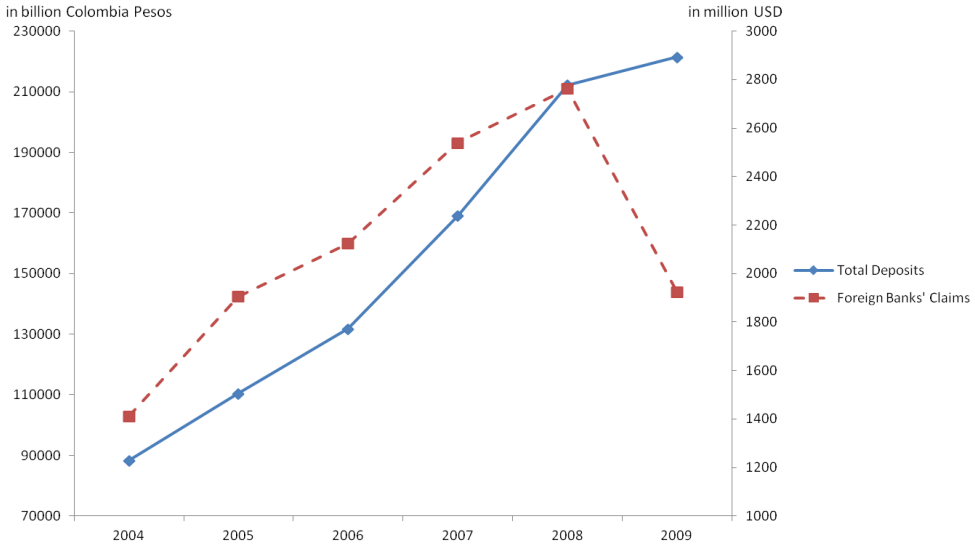
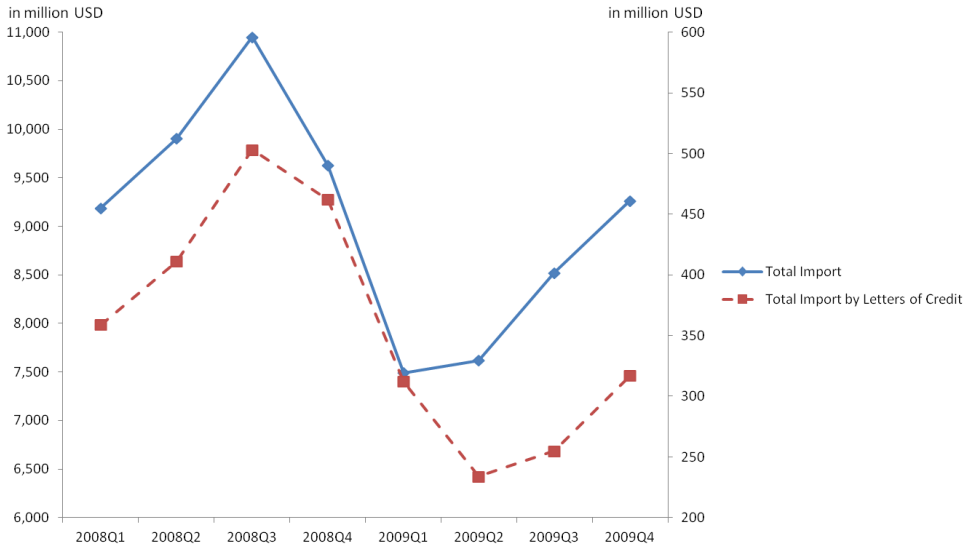


Figure 2: An Illustration of a Letter-of-Credit Transaction



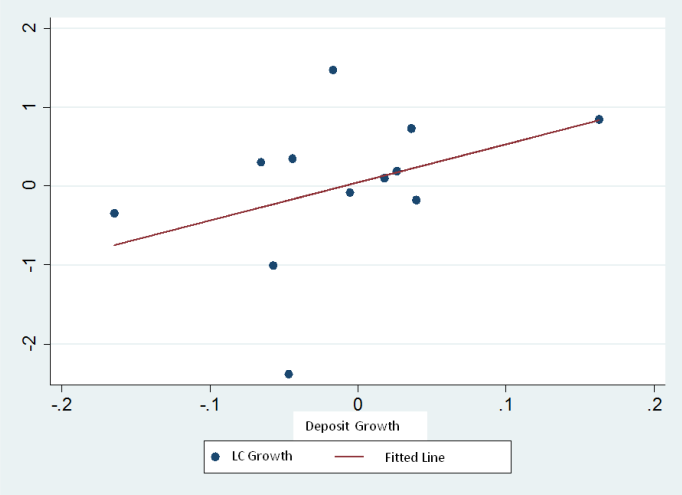
Note: This figure depicts annual total deposits at financial institutions in Colombia (solid line, left axis), and foreign banks' claims on Colombian banks (dashed line, right axis). Total deposits are summed over financial institutions listed in the Bankscope database, and foreign banks' claims data are from the BIS database.

Figure 3: Total Deposits and Foreign Banks' Claims in Colombia



Note: This figure depicts quarterly total imports (solid line, left axis), and total imports by letters of credit (dashed line, right axis) in Colombia.

Figure 4: Quarterly Total Imports and Quarterly Total Imports by Letters of Credit



Note: This figure provides scatter plots between bank-level deposit growth between 2007 and 2009 (x-axis), and bank-level growth in the issuance of letters of credit between the pre- and post-crisis periods (y-axis). Both are expressed as the deviation from the mean.

Figure 5: Bank-Level Deposit Growth and Growth in the Issuance of Letters of Credit

Tables

	2008	2009
Value (million USD)	1,736	1,116
Percentage of total	4.41%	3.42%
Transactions	42,179	34,253
Percentage of total	2.39%	2.10%

Note: This table provides the share of letter-of-credit transactions in total Colombian imports in terms of value and number of transactions.

Table 1: Share of Letter-of-Credit Transactions in Total Imports

Panel A	All		Continue		Exit	
	All	Bank>1	All	Bank>1	All	Bank>1
Mean (1000 USD)	269	446	591	892	161	187
Median (1000 USD)	54	75	93	130	47	58
Obs	4,706	1,823	1,189	670	3,517	1,153

Panel B	Importer			Importer-Country			Importer-Exporter	
	All	Bank>1	Exporter>1	All	Bank>1	Exporter>1	All	Bank>1
Mean (1000 USD)	1,058	2,937	2,330	596	1,690	1,246	349	1,090
Median (1000 USD)	82	420	359	78	325	288	58	213
Number	1,197	351	436	2,125	542	496	3,629	746
Obs	4,706	3,498	3,838	4,706	2,769	2,744	4,706	1,823

Note: Panel A provides summary statistics at importer-exporter-bank level. The sample includes all importer-exporter-bank triplets that appear in the pre-crisis period. The sample is classified as Continue if an importer-exporter pair used letter of credit from an issuing bank in both the pre- and the post-crisis periods. The sample is classified as Exit if an importer-exporter pair used letter of credit from an issuing bank in the pre-crisis period but not in the post-crisis periods. Bank>1 denotes observations by importer-exporter pairs that used multiple issuing banks in the pre-crisis period. Panel B provides summary statistics for the same sample but at differing levels: importer, importer-country, and importer-exporter-level. Bank>1 at the importer-level section refers to observations by importers that used multiple issuing banks in the pre-crisis period. Exporter>1 are observations by importers that transacted with multiple exporters in the pre-crisis period. Definitions hold similarly for importer-country-level and importer-exporter-level sections.

Table 2: Summary Statistics for Letter-of-Credit Transactions

	Bank=1	Bank=2	Bank=3	Bank=4	Bank=5	Bank=6	Bank=7
rank=1	100.00%	69.86%	61.87%	56.68%	54.61%	56.65%	82.65%
rank=2		29.68%	26.37%	23.12%	23.17%	25.78%	12.38%
rank=3			11.54%	12.85%	11.32%	13.82%	3.02%
rank=4				7.35%	7.06%	2.87%	1.05%
rank=5					3.84%	0.54%	0.46%
rank=6						0.34%	0.34%
rank=7							0.10%

Note: This table describes the pattern of issuing bank choices by importer-exporter pairs in the pre-crisis period. Each row corresponds to the share of letter of credit issued by the *n*th most used bank averaged over importer-exporter pairs. Each column restricts the sample to importer-exporter pairs that used *n* issuing banks.

Table 3: Pattern of Issuing Bank Choices

	Mean	Median	S.D
Growth in letter-of-credit issuance (post-pre)	-0.89	-0.74	0.98
Growth in Loans (2007-09)	-0.21	-0.25	0.15
Growth in Deposits (2007-09)	0.23	0.22	0.08
Assets in 2007 (in log)	9.22	9.05	0.77
Equity/Assets Ratio in 2007	0.10	0.09	0.03
Liquid Assets/Assets Ratio in 2007	0.17	0.17	0.10

Note: This table provides summary statistics for bank-level variables. The data come from the Bankscope database except for the letter-of-credit data calculated from the import transactions data. The sample includes 13 banks that provided letters of credit for import transactions in Colombia in the pre-crisis period and for which balance sheets data are available at the Bankscope database. Growth is measured as the difference in log. Growth in letter-of-credit issuance is the summary of 12 banks because one bank stopped servicing letter of credit in the post-crisis period. S.D = standard deviation.

Table 4: Summary Statistics for Bank-Level Variables

Dependent variable	$(LC_{ijb,post}-LC_{ijb,pre})/(LC_{ijb,post}+LC_{ijb,pre})$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δln(Deposits)$_b$	1.256 **	1.257 *	1.205 *	1.104 *	1.073 *	1.013 *	1.037 *	1.008 *	0.946
	(0.570)	(0.584)	(0.594)	(0.547)	(0.543)	(0.550)	(0.571)	(0.562)	(0.565)
ln(LC)$_{ijb,pre}$		-0.001	0.000		0.022 *	0.023 *		0.026 ***	0.027 ***
		(0.024)	(0.024)		(0.012)	(0.012)		(0.008)	(0.008)
ln(Assets)$_{b,pre}$			-0.027			-0.034			-0.037
			(0.044)			(0.045)			(0.044)
Fixed effects	imp-exp	imp-exp	imp-exp	imp-cty	imp-cty	imp-cty	importer	importer	importer
Obs	1,823	1,823	1,823	1,823	1,823	1,823	1,823	1,823	1,823
R squared	0.514	0.514	0.515	0.346	0.348	0.349	0.234	0.237	0.239

Note: The dependent variable is the importer-exporter-bank-level growth in the value of letter-of-credit transactions measured as the change in the value of letter of credit transactions between the pre-crisis and the post-crisis period scaled by the sum of the value of letter-of-credit transactions in these two periods. The sample includes all importer-exporter pairs for which letter-of-credit transactions were undertaken by multiple issuing banks in the pre-crisis period. Independent variables are the bank-level growth in the deposits between two periods, importer-exporter-bank-level pre-crisis value of letter-of-credit transactions in logarithm, and bank's pre-crisis asset value in logarithm. Columns (1)-(3) include importer-exporter fixed effects, columns (4)-(6) include importer-country fixed effects, and columns (7)-(9) include importer fixed effects. Standard errors in parentheses are clustered at the bank level. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 5: Impact of Bank Liquidity Shocks on Letter-of-Credit Issuance: Overview

Dependent variable	Δln(LC)$_{ijb}$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δln(Deposits)$_b$	2.964	4.605 **	4.499 **	2.419	3.481 *	3.378 *	2.554	3.486 **	3.352 **
	(1.710)	(1.953)	(1.969)	(1.727)	(1.658)	(1.672)	(1.432)	(1.353)	(1.351)
ln(LC)$_{ijb,pre}$		-0.472 ***	-0.473 ***		-0.431 ***	-0.431 ***		-0.420 ***	-0.421 ***
		(0.109)	(0.108)		(0.062)	(0.062)		(0.056)	(0.055)
ln(Assets)$_{b,pre}$			-0.085			-0.100			-0.122
			(0.147)			(0.125)			(0.112)
Fixed effects	imp-exp	imp-exp	imp-exp	imp-cty	imp-cty	imp-cty	importer	importer	importer
Obs	670	670	670	670	670	670	670	670	670
R squared	0.584	0.678	0.679	0.379	0.499	0.501	0.239	0.387	0.390

Note: The dependent variable is the importer-exporter-bank-level growth in the value of letter-of-credit transactions measured as the change in the log value of letter-of-credit transactions between the pre-crisis and the post-crisis period. The sample is the subset of all importer-exporter pairs for which letter-of-credit transactions were undertaken by multiple issuing banks in the pre-crisis period, which is restricted to importer-exporter-bank triplets that undertook letter-of-credit transactions in both periods. Independent variables are the bank-level growth in the deposits between two periods, importer-exporter-bank-level pre-crisis value of letter-of-credit transactions in logarithm, and bank's pre-crisis asset value in logarithm. Columns (1)-(3) include importer-exporter fixed effects, columns (4)-(6) include importer-country fixed effects, and columns (7)-(9) include importer fixed effects. Standard errors in parentheses are clustered at the bank level. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 6: Impact of Bank Liquidity Shocks on Letter-of-Credit Issuance: Intensive Margin

Dependent variable	EXIT=1_{ijb}								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δln(Deposits)$_b$	-1.124 **	-0.973 **	-0.955 **	-0.963 **	-0.819 **	-0.793 *	-0.805	-0.697	-0.667
	(0.425)	(0.386)	(0.389)	(0.412)	(0.374)	(0.386)	(0.458)	(0.421)	(0.427)
ln(LC)$_{ijb,pre}$		-0.090 ***	-0.090 ***		-0.102 ***	-0.102 ***		-0.100 ***	-0.100 ***
		(0.014)	(0.014)		(0.006)	(0.006)		(0.007)	(0.008)
ln(Assets)$_{b,pre}$			0.009			0.015			0.018
			(0.030)			(0.031)			(0.031)
Fixed effects	imp-exp	imp-exp	imp-exp	imp-cty	imp-cty	imp-cty	importer	importer	importer
Obs	1,823	1,823	1,823	1,823	1,823	1,823	1,823	1,823	1,823
R squared	0.545	0.575	0.575	0.370	0.422	0.423	0.256	0.316	0.317

Note: The dependent variable is the importer-exporter-bank-level dummy variable equal to 1 if an importer-exporter pair discontinued letter-of-credit transactions supported by a bank in the post-crisis period, and 0 otherwise. The sample includes all importer-exporter pairs for which letter-of-credit transactions were undertaken by multiple issuing banks in the pre-crisis period. Independent variables are the bank-level growth in the deposits between two periods, importer-exporter-bank-level pre-crisis value of letter-of-credit transactions in logarithm, and bank's pre-crisis asset value in logarithm. Columns (1)-(3) include importer-exporter fixed effects, columns (4)-(6) include importer-country fixed effects, and columns (7)-(9) include importer fixed effects. Standard errors in parentheses are clustered at the bank level. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 7: Impact of Bank Liquidity Shocks on Letter-of-Credit Issuance: Extensive Margin (Linear Probability)

Dependent variable	EXIT=1_{ijb}								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δln(Deposit)$_{b*100}$	-0.064 ***	-0.055 ***	-0.054 ***	-0.051 ***	-0.047 ***	-0.045 ***	-0.040 ***	-0.041 ***	-0.039 ***
	(0.012)	(0.013)	(0.013)	(0.011)	(0.012)	(0.012)	(0.010)	(0.011)	(0.011)
ln(LC)$_{ijb,pre}$		-0.554 ***	-0.559 ***		-0.591 ***	-0.595 ***		-0.561 ***	-0.567 ***
		(0.078)	(0.078)		(0.061)	(0.062)		(0.054)	(0.054)
ln(Assets)$_{b,pre}$			0.089			0.107			0.139
			(0.098)			(0.090)			(0.084)
Fixed effects	imp-exp	imp-exp	imp-exp	imp-cty	imp-cty	imp-cty	importer	importer	importer
Obs	869	869	869	1,212	1,212	1,212	1,450	1,450	1,450
Odds Ratio	0.938 ***	0.946 ***	0.948 ***	0.950 ***	0.954 ***	0.956 ***	0.960 ***	0.960 ***	0.962 ***
Δln(Deposit)$_b$	(0.011)	(0.012)	(0.012)	(0.011)	0.011	(0.011)	(0.010)	(0.011)	(0.011)

Note: The dependent variable is the importer-exporter-bank-level dummy variable equal to 1 if an importer-exporter pair discontinued letter-of-credit transactions supported by a bank in the post-crisis period, and 0 otherwise. The sample is the subset of all importer-exporter pairs for which letter-of-credit transactions were undertaken by multiple issuing banks in the pre-crisis period, which is restricted to those that have any variation in the dependent variable within importer-exporter pair (Columns (1)-(3)), importer-country pair (Columns (4)-(6)), or importer (Columns (7)-(9)). Independent variables are the bank-level growth in the deposits between two periods, importer-exporter-bank-level pre-crisis value of letter-of-credit transactions in logarithm, and bank's pre-crisis asset value in logarithm. Columns (1)-(3) include importer-exporter fixed effects, columns (4)-(6) include importer-country fixed effects, and columns (7)-(9) include importer fixed effects. Standard errors in parentheses are clustered at the bank level. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 8: Impact of Bank Liquidity Shocks on Letter-of-Credit Issuance: Extensive Margin (Logit)

Dependent variable	$(LC_{ib,post}-LC_{ib,pre})/(LC_{ib,post}+LC_{ib,pre})$			$\Delta \ln(LC)_{ib}$			$EXIT=1_{ib}$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta \ln(Deposit)_b$	0.451	0.257	0.243	2.148	3.556	3.485	-0.537	-0.148	-0.159
	(0.494)	(0.377)	(0.372)	(2.073)	(2.614)	(2.733)	(0.601)	(0.343)	(0.339)
$\ln(LC)_{ib,pre}$		0.066 ***	0.067 ***		-0.188 **	-0.185 **		-0.132 ***	-0.132 ***
		(0.010)	(0.009)		(0.081)	(0.083)		(0.010)	(0.010)
$\ln(Assets)_{b,pre}$			-0.006			-0.038			-0.005
			(0.022)			(0.217)			(0.015)
Fixed effects	importer	importer	importer	importer	importer	importer	importer	importer	importer
Obs	1,033	1,033	1,033	365	365	365	1,033	1,033	1,033
R squared	0.418	0.452	0.619	0.579	0.597	0.597	0.464	0.579	0.619

Note: The dependent variable in columns (1)-(3) is the importer-bank-level growth in the value of letter-of-credit transactions measured as the change in the value of letter-of-credit transactions between the pre-crisis and the post-crisis period scaled by the sum of the value of letter-of-credit transactions in these two periods. The dependent variable in columns (4)-(6) is the importer-bank-level growth in the value of letter-of-credit transactions measured as the change in the log value of letter-of-credit transactions between the pre-crisis and the post-crisis period. The dependent variable in columns (7)-(9) is the importer-bank-level dummy variable equal to 1 if an importer-exporter pair discontinued letter-of-credit transactions supported by a bank in the post-crisis period, and 0 otherwise. The sample is the subset of all importers for which letter of credit transactions were undertaken by multiple issuing banks in the pre-crisis period. Independent variables are the bank-level growth in the deposits between two periods, importer-bank-level pre-crisis value of letter-of-credit transactions in logarithm, and bank's pre-crisis asset value in logarithm. All columns include importer fixed effects. Standard errors in parentheses are clustered at the bank level. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 9: Impact of Bank Liquidity Shocks on Letter-of-Credit Issuance: Importer-Bank Level

Dependent variable	$\Delta \ln(LC)_{ij}$				$\Delta \ln(Import)_{ij}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta \ln(Deposits)_{ij}$	2.644	2.893 *	2.870	3.339 *	2.488	2.698 *	3.019 *	3.428 **
	(1.681)	(1.726)	(1.818)	(1.767)	(1.531)	(1.543)	(1.588)	(1.553)
$\ln(LC)_{ij,pre}$		-0.267 ***		-0.281 ***		-0.225 ***		-0.245 ***
		(0.053)		(0.056)		(0.044)		(0.048)
Fixed effects	imp	imp	imp+cty	imp+cty	imp	imp	imp+cty	imp+cty
Obs	715	715	715	715	715	715	715	715
R squared	0.430	0.487	0.467	0.523	0.441	0.491	0.467	0.534

Note: The dependent variable in columns (1)-(4) is the importer-exporter-level growth in the value of letter-of-credit transactions measured as the change in the log value of letter-of-credit transactions between the pre-crisis and the post-crisis period. The dependent variable in columns (5)-(8) is the importer-exporter-level growth in the value of total import transactions measured as the change in the log value of total imports between the pre-crisis and the post-crisis period. The sample includes, among all importers with multiple exporters, all importer-exporter pairs that undertook letter-of-credit transactions in both periods and received letters-of-credit from more than one bank during the periods. Independent variables are the importer-exporter-level (pre-crisis value of letter-of-credit issuance) weighted average of the bank deposit growth between two periods, importer-exporter-level pre-crisis value of letter-of-credit transactions in logarithm. Columns (1)-(2) and (5)-(6) include importer fixed effects, and columns (3)-(4) and (7)-(8) include both importer and country fixed effects. Standard errors in parentheses are clustered at the importer level. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 10: Impact of Bank Liquidity Shocks on Letter-of-Credit Issuance: Importer-Exporter Level I

Dependent variable	$\Delta\ln(LC)_{ij}$				$\Delta\ln(Import)_{ij}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$(Big)_i$		1.678 ***	0.803 ***	0.518 *		1.589 ***	0.466	0.412 *
		(0.457)	(0.282)	(0.286)		(0.448)	(0.280)	(0.243)
$\Delta\ln(Deposits)_{ij}$	2.604 ***	8.332 ***	5.005 ***	3.974 ***	1.686 ***	7.897 ***	3.401 **	3.117 ***
	(0.672)	(3.052)	(1.786)	(1.267)	(0.564)	(2.347)	(1.327)	(1.137)
$(Big)_i \times$		-5.761 *	-2.555	-1.813		-6.270 **	-1.823	-1.794
$\Delta\ln(Deposits)_{ij}$		(3.140)	(1.781)	(1.451)		(2.574)	(1.498)	(1.280)
$\ln(LC)_{ij,pre}$	-0.260 ***	-0.263 ***	-0.264 ***	-0.267 ***	-0.191 ***	-0.192 ***	-0.192 ***	-0.193 ***
	(0.026)	(0.024)	(0.025)	(0.028)	(0.018)	(0.018)	(0.018)	(0.020)
Fixed effects	country	country	country	country	country	country	country	country
Obs	1,147	1,147	1,147	1,147	1,147	1,147	1,147	1,147
R squared	0.180	0.182	0.182	0.183	0.136	0.138	0.137	0.138

Note: The dependent variable in columns (1)-(4) is the importer-exporter-level growth in the value of letter-of-credit transactions measured as the change in the log value of letter-of-credit transactions between the pre-crisis and the post-crisis period. The dependent variable in columns (5)-(8) is the importer-exporter-level growth in the value of total import transactions measured as the change in the log value of total imports between the pre-crisis and the post-crisis period. The sample includes all importer-exporter pairs that undertook letter-of-credit transactions in both periods. $\Delta\ln(Deposits)$ is the importer-exporter-level (pre-crisis value of letter-of-credit issuance) weighted average of the bank deposit growth between two periods. (Big) is dummy variable equal 1 if an importer's total imports value is above 10th (columns(2) and (6)), 20th (columns (3) and (7)), and 50th percentile (columns (4) and (8)) of all importers. $\ln(LC)_{ij,pre}$ is importer-exporter-level pre-crisis value of letter-of-credit transactions in logarithm. All columns include country fixed effects. Standard errors in parentheses are clustered at the country level. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 11: Impact of Bank Liquidity Shocks on Letter-of-Credit Issuance: Importer-Exporter Level II