Cross-Border Interbank Liquidity, Crises, and Monetary Policy*

Puriya Abbassi **Falk Bräuning** **Falko Fecht** **José-Luis Peydró**

Abstract

We analyze how the Lehman and sovereign crises affect cross-border interbank liquidity, exploiting euro-area proprietary interbank data, crisis and monetary shocks, and loan terms to the same borrower during the same day by domestic versus foreign lenders. Crisis shocks reduce the supply of cross-border liquidity, with stronger volume than pricing effects. On the extensive margin, results suggest that the cross-border credit crunch is independent of borrower quality, while—on the intensive margin—riskier borrower banks suffer more. Moreover, the cross-border liquidity crunch is substantially stronger for term loans, and weaker for foreign lender banks that have a subsidiary in the same country than the borrower. Finally, nonstandard monetary policy improves interbank liquidity, but without fostering strong re-integration of cross-border interbank markets.

Keywords: international liquidity, financial crises, cross-border lending, monetary policy, banks.
JEL classification codes: E52, F30, G01, G21, G28.

* Puriya Abbassi: Deutsche Bundesbank, puriya.abbassi@bundesbank.de; Falk Bräuning: Federal Reserve Bank of Boston, Falk.Braeuning@bos.frb.org; Falko Fecht: Frankfurt School of Finance and Management, f.fecht@fs.de; José-Luis Peydró: Imperial College London, and CEPR, jose.peydro@gmail.com (corresponding author). This version is from August 2020. We would like to thank Franklin Allen, Markus Brunnermeier, Adam Copeland, Martin Diehl, Darrel Duffie, Ralph de Haas, Heinz Herrmann, Emmanuel Farhi, Daniel Ferreira, Xavier Freixas, Jordi Gali, Matti Hellqvist, Luc Laeven, Christoph Memmel, Alexander Müller, Joe Peek, Jean-Charles Rochet, Philipp Schnabl, Philip Strahan, Harald Uhlig, Andreas Worms, two anonymous referees, the editor, and participants at seminars at the Deutsche Bundesbank, the European Central Bank, the European Commission, Tilburg University, Maastricht University, and University of Zurich, and conferences at the Barcelona GSE Summer Forum, the LSE conference on Economic Networks and Finance and the AFA 2016, and Elizabeth Murry for providing language and grammar suggestions. Puriya Abbassi is member of one of the user groups with access to Target2 data in accordance with Article 1(2) of Decision ECB/2010/9 of July 29, 2010, on access to and use of certain Target2 data. The Deutsche Bundesbank and the PSSC have checked the paper against the rules for guaranteeing the confidentiality of transaction-level data imposed by the PSSC pursuant to Article 1(4) of the above-mentioned issue. José-Luis Peydró acknowledges financial support from project ECO2015-68182-P (MINECO/FEDER, UE) and the European Research Council Grant (project 648398). The views expressed in the paper are only those of the authors and do not necessarily represent the views of any of the institutions to which the authors are affiliated.

1. INTRODUCTION

In stark contrast to historical systemic crises that were mainly plagued by retail runs, the global financial crisis—that started with the Lehman Brothers' failure on September 15, 2008, and intensified in the euro area after April 2010 with the sovereign debt crisis—was largely characterized by a reduction in wholesale funding liquidity (Freixas, Laeven and Peydró 2015). The last global crisis is however not different in key aspects with historical crises. Jordá, Schularick and Taylor (2011) and Gourinchas and Obstfeld (2012) show that financial crises tend to follow periods of strong private credit financed partly with foreign liquidity, and one important outcome of the last global financial crisis has been a geographic fragmentation of international liquidity in global financial markets, partially unwinding the trend in financial globalization that occurred since the mid-1980s (Broner et al. 2013; IMF 2013). To combat this recent crisis, central banks have mainly responded using nonstandard monetary policies (Draghi 2013, Stein 2014).

In this paper, we offer an in-depth analysis of how the recent Lehman and sovereign debt crises affect cross-border interbank liquidity, including whether the new, expansionary nonstandard monetary policy actions may help to re-integrate money market disruptions.[1] Despite the utmost importance of this question for scholars and policymakers, empirical analysis is scarce, mainly due to the lack of comprehensive micro-datasets—especially on cross-border liquidity—since wholesale credit transactions are mostly over-the-counter trades. Comprehensive micro-credit datasets, however, are necessary both to control for borrower fundamentals (e.g. foreigner banks may lend to different local borrowers than domestic lenders) and to examine heterogeneity in cross-border versus domestic loan terms. In this paper, we use new lender-borrower transaction-level data from the euro area interbank market, derived from its interbank payment system Target2, and hence we analyze cross-border interbank lending during key crises.

The strengths of these data are various. First, different from other loan data, we can compare, for otherwise *identical* loans to the same borrower on the same day, the volume and spread of a foreign vs. a domestic lender. In other credit markets, loans among different lenders to the same

[1] Throughout the paper, we use changes to the flows of cross-border interbank credit as proxying for changes in cross-border liquidity more broadly, though we only analyze one particular market. The literature uses a variety of measures of financial integration (see, e.g., Edison, Levine, Ricci, and Slok 2002; Kalemli-Ozcan, Papaioannou, and Peydró 2010; Bai and Zhang 2012), but our measure of cross-border liquidity does not aim to measure changes in financial integration (which are about many different markets and also not only within but also outside the euro area). We will use the terminology 'cross-border bank loans' and 'international liquidity' interchangeably.

borrower are not granted on the same day (thus the borrower's risk is different) and have different maturities, currencies, or collateral; however, in interbank markets, if one exploits the data on (standard, plain vanilla) overnight loans in the central-bank payment system, one can avoid this problem. Hence, not only is analyzing the interbank wholesale market key for studying recent financial and sovereign debt crises, but it is also key for identifying the effects of crises on cross-border liquidity. Second, as compared to the global financial market, the euro area is a single currency union and with a bank-dominated economy. In contrast to the U.S. interbank data, we can study the cross-border dimension—which is the question that we address in this paper—and our database also provides us with identifiers for interbank credit transactions and the ultimate borrower and lender banks involved in the loan, all of which are crucial for identification. Moreover, the euro area had risks associated with various countries' sovereign debt, which gives our data larger cross-sectional and time variation in crisis shocks. Finally, before the Eurosystem's announcement of quantitative easing in January 2015, the Eurosystem pursued several new and nonstandard monetary policies whose main effects centered on its banking system, given the importance of banks in the European financial and economic system (Praet 2016).

To identify the impact of financial crises on lending terms across borders as compared to domestically, we restrict the Target2 dataset interbank overnight loans. We analyze loans granted to the same borrower on the same day, thus controlling for time-varying unobserved borrower fundamentals, thereby isolating differential (lender)bank-to-(borrower)bank loan conditions (access, volume, and spread) by domestic versus foreign lenders (abstracting from other loan differences such as, e.g., maturity and currency). This empirical strategy implies—in the intensive and extensive margin of lending—analyzing the data at the *borrower-lender-day* level and adding borrower*day fixed effects. To further control for time-varying creditor bank conditions (e.g., liquidity hoarding or differently affected by the crisis) and for time-invariant lender-borrower bank relations (e.g., similar business models), we can add lender*day and lender*borrower fixed effects. Moreover, in conjunction with the euro area interbank data, we exploit both the Lehman failure and the sovereign debt shocks. We analyze separately the Lehman collapse and the sovereign debt crisis, as the former is more bank-related and the latter is more dependent on sovereign risk, especially in countries rescued by the Troika (an ECB-EU-IMF bailout to Greece, Ireland, and Portugal, or to Spain's banking sector, the *GIPS* countries).

For both shocks, we not only identify the impact of the financial and sovereign debt crises

events on cross-border loan conditions, but we also provide suggestive evidence on the role of asymmetric information problems behind potential changes in cross-border liquidity during crises. Our results are, however, suggestive, as we cannot empirically account for the individual interaction between any bank's incentives to run its business activities and the member state's national interest (e.g., Bolton and Oehmke, 2019). In our analysis, we examine whether there is a differential effect of domestic versus cross-border depending on whether the foreign lender has a subsidiary in the borrower bank's country, and hence has better information as compared to a foreign lender without a subsidiary in that country. Moreover, we also analyze whether term loans behave differently than overnight loans as the banking literature suggests that the former ones are more affected by information problems. In addition, we study the role of (observed and unobserved) risk characteristics of the borrower bank. As a measure for observable borrower characteristics, we use an identifier for GIPS-headquartered borrowing banks, as these countries were at the core of the European sovereign debt crisis.[2] As a proxy for unobserved borrower-specific risk, we use average past loan-level interest rates that the borrower paid in the OTC-market for interbank overnight loans during the month prior to the immediate trade ('high-spread borrower', hereafter). This variable captures all information that interbank lenders use when pricing overnight loans, and it is thus a more comprehensive measure than balance sheet or location information to assess the role of borrower-level risk for the extensive and intensive margin of credit during crises times.[3] Finally, we analyze the role of nonstandard monetary policy in affecting the interbank liquidity supply, especially to the cross-border segment.

Our robust findings suggest that financial crisis shocks reduce the supply of interbank liquidity on both the extensive and intensive margins, exerting a substantially stronger negative effect for cross-border loans. Specifically, when comparing the same borrower bank on the same day, the foreign lender is less likely to grant an interbank loan than the domestic lender as the crisis intensifies. Conditioning on granting the overnight loan, the foreign lender reduces the loan amount and increases the loan spread. During the worst part of each crisis event, compared to the

[2] This variable is a natural candidate to account for observable bank risk characteristics and also for investment opportunities and legal institutions, among others. Apart from this variable, we have collected other key borrower-bank and borrower-country level variables commonly used in the literature (e.g. size and leverage). We will discuss this further in Section 3.2.

[3] Credit risk is a key factor determining interbank spreads, but also other variables could matter (e.g., investment opportunities and financial constraints). In additional analysis, we also complement this analysis with different regressions where we analyze whether borrower*time fixed effects (which incorporate all unobserved time-varying borrower-level risk) matter or not for our cross-border results, in the spirit of Altonji et al. (2005) and Oster (2017).

domestic lender, the foreign lender reduces access to the same borrower on the same day by 29% during the Lehman crisis and by 24% during sovereign debt crisis, and reduces volume by 12% and by 10%, respectively. Moreover, the impairment of cross-border liquidity is substantially stronger for volumes than pricing. Cross-border spreads further increase by 7 basis points during the Lehman shock; during the sovereign crisis, cross-border spreads only increase for GIPS-headquartered bank borrowers.

In the extensive margin (access to interbank liquidity), we find in both crisis periods that the reduction of the supply of cross-border liquidity is independent of observed and unobserved borrower bank characteristics.[4] These results suggest that the cross-border crunch during crisis times in the extensive margin is independent of borrower bank risk and quality, i.e. the flight home is independent of flight to quality.

Differently, once a cross-border loan is granted, borrower risk characteristics matter for the volume and spread (intensive margin). In particular, within the cross-border segment, there is further heterogeneity depending on the risk of borrower banks. Interestingly, during the Lehman crisis, comparing with other cross-border borrower banks, high-risk borrower banks pay up to 15 basis points higher spreads for cross-border (as opposed to domestic) liquidity. During the sovereign debt crisis, however, GIPS-headquartered borrower banks obtain substantially smaller cross-border loan amounts (reduction of up to 38%), in addition to paying higher spreads on these international loans (up to 14 basis points).

Consistent with theories about the presence of asymmetric information problems across borders (e.g., Freixas and Holthausen 2005), we show that the documented cross-border liquidity crunch during crises is driven by a reduction of lending by foreign banks that are located in a different country than the borrowing bank (foreign lender banks are banks controlled by parents of different nationality than the borrower bank's parent and without a subsidiary in the borrower country). In contrast, we do not find a robust contraction in liquidity supply by foreign banks that are located in the same country than the borrowing bank; instead, those foreign banks behave similarly to domestic banks. Moreover, we show that, after Lehman's failure, term lending volumes experience a very strong and sudden collapse by up to 80 percent (our results do not

[4] There are no heterogeneous effects across borrowers with different observed and unobserved risk. Moreover, borrower*time and borrower*lender fixed effects, despite capturing a large R2, do not significantly change the estimated coefficients.

suggest that borrower banks in the term market are riskier than in the overnight market.). Importantly, and consistent with asymmetric information problems as a key driver, the term liquidity freeze was more pronounced for cross-border loans on all margins of credit. For example, we find in the first two weeks after Lehman's failure an additional reduction in cross-border term loan volumes of up to 52 percent relative to overnight loans. Interestingly this crunch has not recovered until the end of our sample.

Finally, we find that expansionary nonstandard monetary policy partly mitigates interbank liquidity restrictions during crisis periods, but this public policy has limitations in fostering strong re-integration of cross-border interbank markets. For identification, we use a short time window (+/–1 week) to measure the effects around the three main expansionary monetary policy measures enacted over our sample period: during the Lehman crisis, (i) the fixed-rate full allotment (FRFA), and during the sovereign debt crisis, (ii) the first two 3-year long-term refinancing operations (LTROs), (iii) and Draghi's "whatever-it-takes" speech, including the related outright monetary transactions (OMT) program (ECB 2008; Draghi 2012a). Exploiting the impact of these monetary policy changes on cross-border versus domestic loans, we find that all three measures improve more the supply of cross-border loans in the extensive margin, compared to domestic lending, but not in the intensive margin.[5] For example, all three expansionary monetary policies reduce the interbank rates for all loans, but with a similar effect on domestic and cross-border loans (despite that the crisis shocks were more negative on the cross-border segment). In addition, effects are similar for riskier banks (e.g., highly-leveraged GIPS-borrowers). Moreover, the OMT policy—both the Draghi speech and the announcement by the Eurosystem—has positive effects on (private) interbank liquidity despite that there was no actual injection of public liquidity, i.e., just the suggested possibility that this policy tool might be used.

CONTRIBUTION TO THE LITERATURE.

Our main contribution to the literature is analyzing how key financial crises impacted cross-border interbank liquidity, with a strong emphasis on identification, and then offering an in-depth analysis of the factors explaining the reduction in cross-border lending, and the role that monetary policy can play in promoting international financial re-integration in interbank markets. Our paper also provides suggestive evidence on the role of information asymmetry in generating cross-border

[5] Our monetary policy analysis focuses on overnight loans given that the term segment completely collapsed after the Lehman failure and has not recovered since (see Appendix Figure A1).

liquidity crunches.

It is known that during financial crises, international markets often fall. For example, the 2008–2009 financial crisis was accompanied by a reduction both in global trade (Levchenko, Lewis and Tesar 2010) and in gross capital flows (Broner et al. 2013), including a decline in international bank lending (Cetorelli and Goldberg 2011). Micro studies, such as Giannetti and Laeven (2012), have shown that the collapse of the global market for syndicated loans during financial crises can partly be explained by a reduction in cross-border lending. We contribute to this literature by studying the euro area interbank data in conjunction with the Lehman and sovereign debt shocks to identify the cross-border effects, analyzing also the factors explaining the reduction in cross-border lending, and the role that monetary policy can play.

Importantly, we find that for otherwise identical loan contracts, cross-border loans are penalized more than domestic ones, and even more so on volumes than on interest rate spreads. Analyzing the interbank wholesale market is an important question in itself, as the series of global financial crises that began with the Lehman failure was mainly concentrated in the wholesale funding market. However, it is important to note that identifying the supply of cross-border loans is also important. We isolate the loan volume and spread to the same borrower by foreign versus domestic lenders in otherwise identical loan contracts, since borrowers that also have foreign lenders tend to be different from those borrowers without foreign lenders. Note also that in a global financial crisis, international banks can be more negatively affected, and as these banks have more cross-border loans than local banks, this fact will in turn mechanically reduce cross-border loan volumes even if the supply of cross-border loans would not change.[6] In fact our results suggest

[6] In a global financial crisis, global (international) banks are in general more affected. These banks have more cross-border loans, and therefore, the volume of cross-border loans will be reduced because the typical borrower of these loans is more negatively affected by the crisis. In consequence, the reduction of cross-border loans is not due to financial disintegration, but just due to the fact that the typical borrower bank of these loans is riskier in the global crisis. Our empirical setup controls for these issues as compared to the existing literature. As we explained above, in contrast to the literature using macro-, bank- or firm-level data, or even the literature using loan-level data, we can isolate differential bank-to-bank loan terms (volume and spread) for overnight-euro-denominated-uncollateralized loans granted to the same borrower on the same day for the same maturity by distinguishing between domestic and foreign lenders. Therefore, we also contribute to the literature on the credit channel by identifying the supply of credit. Khwaja and Mian (2008) show that—in order to identify the credit supply—loan-level (lender-borrower level) data are required; see also Paravisini (2008). They compare different business loans to the same borrower in the same quarter or year and argue that variations in lending from different banks must be associated with bank-related shocks. A critique of this line of research is that business loans from different banks are different for the same firm; for example, the purpose of the loan or its maturity or currency, and moreover the moment in which the contract is granted, and thus borrower fundamentals differ. Since we exploit *identical* loan contracts granted to the same borrower from different lenders on the same day using a standard, plain vanilla overnight loan in the central bank payment system

that in the intensive margin borrower risk and cross-border reduction are related, differently from the intensive margin.

There is also a large and growing literature on the euro area sovereign debt crisis that started in 2010 (see, e.g., Sinn 2013; Acharya, Drechsler, and Schnabl 2014; Farhi and Tirole 2014; Uhlig 2014). The euro area sovereign debt crisis is generally perceived as being caused by increased concern about sovereign debt defaults, which could make the euro area's financial system to become increasingly fragmented (IMF 2013). Our results show that—even for the highly integrated interbank market—cross-border reduction of liquidity in the crises was crucial. More importantly, our results show that the geographic market segmentation during the euro area crisis is not only due to the elevated risk of sovereign defaults, as we also find that the Lehman shock particularly affected cross-border lending. However, unlike the Lehman crisis shock that was further affected by high-risk borrower banks, the sovereign debt shocks differentially affected more GIPS-headquartered borrower banks.[7]

Our paper also adds to the banking literature by contributing to the studies investigating interbank liquidity. During financial crises, there may be a reduction in interbank lending (Acharya, Gale, and Yorulmazer 2011) due to borrowers' counterparty risk (Flannery 1996; Furfine 2001; Freixas and Jorge 2008) or because of lenders' liquidity hoarding (Allen, Carletti, and Gale 2009; Caballero and Krishnamurthy 2008; Diamond and Rajan 2011). In a seminal paper, Afonso, Kovner, and Schoar (2011) analyze conditions in the U.S. unsecured interbank market around the time of the Lehman Brothers' bankruptcy, show that counterparty credit risk plays a larger role than liquidity hoarding in tightening interbank loan terms, and do not find an interbank market freeze. Similarly, Pérignon, Thesmar, and Vuillemey (2017), analyzing bank-level unsecured certificates of deposits in the European market, do not find any market-wide freeze during the 2008–2014 period. We contribute to this literature by empirically identifying the *supply of cross-border interbank liquidity*, and showing that in the cross-border market there was a *strong freeze*, and even more in the term segment. Freixas and Holthausen (2005) theoretically analyze

(with potential different loan volumes and spreads by foreign versus domestic lenders), we can identify a better measure of credit supply restrictions (in this case, those related to the cross-border dimension in the interbank market).

[7] It is important to highlight that in our period of analysis, there was no banking union yet in the euro area, and policy-makers argued that there was a significant reduction in integration, though the euro area has been more financially integrated that other areas around the world, e.g. by not allowing discrimination of locals and (intra-EU) foreigners in financial markets. The ECB became the supervisor only in November 2014, the EU resolution directive is from 2014 (2014/59/EU), which passed into local law later, and the third leg of the Banking Union is not yet passed.

the impairment of cross-border interbank lending due to noisy information across borders. We empirically show a reduction in the supply of cross-border interbank liquidity by foreign banks in a different country than the borrowing bank, and without a subsidiary in the borrower country—and its determinants (a flight to home—but not to better quality—in the extensive margin; however, a flight to home depending on borrower quality in the intensive margin, with stronger effects on volumes than on pricing).[8]

Finally, we contribute to the literature on monetary policy. The interbank market is a key channel for transmitting monetary policy to the real economy, but in a financial crisis, this transmission mechanism may be impaired (Draghi 2012b). On the theoretical front, Gertler and Kiyotaki (2010) show how problems in the interbank market can generate aggregate real effects in the macroeconomy and how nonstandard monetary policy can alleviate these problems (see also Gertler and Karadi 2011, 2013; Kiyotaki and Moore 2012); at the micro level, Bolton and Freixas (2006), Diamond and Rajan (2006) and Stein (2012) highlight the importance of monetary policy for banking, while Freixas, Martin, and Skeie (2011) and Allen, Carletti, and Gale (2014) argue that monetary policy can directly improve liquidity conditions in the interbank market (Bolton, Santos and Scheinkman (2011) show the limits of private liquidity in crises). Despite the importance of these questions for theory and policy, as far as we are aware, there is no other paper using bank-to-bank micro-level data to identify the effects of monetary policy on interbank liquidity supply in crises. Our evidence shows the positive role that monetary policy can play in improving interbank liquidity, yet it also suggests limitations of monetary policy in promoting re-integration of cross-border interbank market.

The remainder of this paper is as follows. Section 2 describes our dataset. Section 3 discusses our identification strategy and results. Section 4 concludes.

2. DATA

[8] Furfine (2003), Iyer and Peydró (2011), and Acharya and Merrouche (2013) respectively analyze the U.S., Indian, and U.K. interbank markets during a financial crisis. Moreover, some policy papers have analyzed cross-border loans (Bindseil, Cour-Thimann, and König 2012; Garcia-de-Andoain, Hoffmann, and Manganelli 2014), but unlike these papers, we identify the effects at the *lender-borrower-day* level. As we explain in this paper, this empirical strategy is crucial for identifying the cross-border effects, especially to account for borrower-specific unobserved time-varying heterogeneity, which, we show, matters in the intensive margin.

We have access to transaction-level data on interbank loans with information on the price, volume, maturity, time of the loan transaction, and the identity of the ultimate borrower and lender, for all loans settled via Target2 by euro area banks from June 1, 2008, to December 31, 2014. Target2 is the Eurosystem's main payment and settlement system and carries out more than 90% of all fund flows between pairs of credit institutions in the euro area. 91% of the aggregate Target2 turnover refers primarily to interbank payments as it settles payments on a continuous basis, in central bank money, and with immediate finality.[9] From the Target2 payment data, as we explain below, we obtain wholesale interbank funding information at the bank-to-bank level, data that are otherwise not observable due to the bilateral nature of over-the-counter trades.

There are three main advantages of using Target2 interbank transaction data compared with data from the U.S. Fedwire system or any other major payment system. First, in Target2 the payment legs of interbank money market transactions are classified as interbank credit payments, which are crucial for identifying interbank loans. Given that we only focus on these interbank transactions, we match the two payment legs of an interbank loan (i.e., the initial payment of the principal amount and the repayment of the principal plus an additional amount that acts as interest) and obtain further details on the transactions (prices and maturities) in addition to the volume, by employing a refined version of Furfine (1999)'s algorithm as developed by Arciero et al. (2016).[10]

Second, for each loan, Target2 interbank credit payments reflect the information on the ultimate lender and borrower. This information is crucial for the identification of the lender's and borrower's country of origin that in turn is essential to identify cross-border versus domestic loans (the key question of this paper, along with other related questions such as borrower banks headquartered in crisis countries, i.e., Greece, Ireland, Portugal, and Spain, to which we will refer as the GIPS countries, hereafter). In comparison, Fedwire data only have information on the

[9] The value of all interbank payments executed in Target2 in four days corresponds to the total annual GDP of the euro area. Money market transactions may also be settled via EURO1, the second, yet much smaller, large-value payment system with a daily turnover of less than 8.3% of Target2 (Arciero et al. 2016).

[10] The algorithm matches payment legs such that the implied loans have a minimum amount of 1 EUR million (a volume-dependent minimum increment amount), an interest rate that lies in a corridor depending on the average European money market interbank rate, EONIA, and interest rates in multiples of 0.005 percentage points. Note that this identification strategy, by construction, does not capture defaulted loans. For an explanation and validation of the algorithm, please refer to Arciero et al. (2016). To ensure robustness, we try several parameter combinations and find that our results are not driven by the choice of the algorithm. In particular, we run the algorithm for various symmetric and asymmetric corridor widths around EONIA. Furthermore, we employ a corridor-free approach on overnight loan payments. Our main results remain unaffected by these changes to the algorithm-based identification technique.

settling institutions.[11] In addition to the information on the borrower location (country of origin), Target2 contains information on each bank's parent nationality to identify cross-border and domestic trades from foreign-controlled banks (e.g., Deutsche Bank in Spain lending to Banco Santander in Spain would be classified as a domestic loan, but from a foreign bank).

Third, the algorithm-based estimation quality has been checked by other studies against actual loans from some euro area countries using transaction-level information from either supervisory datasets (Bank of Spain) or from private datasets (Italy's e-MID). Arciero et al. (2016) and De Frutos et al. (2014) validate the Target2 interbank loan data using the Italian e-MID trading platform and the Spanish post-trading platform MID, respectively. The quality checks provided by these studies reveal that the Target2 interbank loan-level data match very well the actual Italian and Spanish money market data (identifying incorrectly less than 1% of payment legs as interbank loans). The quality of the interbank data for the United States and the United Kingdom is not easy to validate due to the lack of actual transaction-level data (Armantier and Copeland 2012).[12]

We supplement our database on interbank loans with information on the borrowing institution, both at the borrower-country and borrower-bank level, to investigate if the supply of cross-border liquidity depends on borrower characteristics. More precisely, we compute an identifier for GIPS-headquartered borrowing banks, i.e., banks headquartered in Greece, Ireland, Portugal, or Spain, as these countries were at the core of the European sovereign debt crisis.[13] This variable captures an observable borrower-specific characteristic. To account for borrowers' unobserved (i.e., unknown to the econometrician) heterogeneity, we compute a binary variable for each borrower that specifies 'high-risk borrower' banks as follows: the variable equals the value

[11] In our analysis, we exclude intra-group transactions as the risk of a loan between two banks of the same banking group is not as risky as a loan granted to another, external bank. For cross-border trades, this ensures that loans between banks belonging to the same holding group are excluded. Target2 has an indicator variable that identifies interbank payments within the same banking group. We have left these cross-border transactions within a bank holding group for future research. Moreover, we also use the unique bank identifier code (BIC) and consolidate banks on their first six digits (from the initial eleven digits) to account for the different branches and subsidiaries in the domestic market.

[12] Kovner and Skeie (2013) assess the U.S. data using banks' fed funds borrowing as reported in the quarterly FR Y-9C filings. They show that flows of overnight loans extracted from Fedwire payments data explain 78% of these outstanding overnight loans at quarter ends reported by big U.S. bank holding companies.

[13] While this variable enters our benchmark specifications, we have collected multiple other borrower- and country-level variables that did not turn out to be relevant factors in our analysis. For instance, we follow Djankov, McLiesh and Shleifer (2007) and use the index on the borrower-country's protection of creditor rights. Moreover, given the interrelation between a country's public finances and the banking sector, we collect data on each borrower-country's level of public debt as a fraction of its GDP from Eurostat. Further, we obtain standard information on bank balance sheet characteristics for each borrowing bank, i.e., asset size and equity, which we collect from Bureau van Dyk's Bankscope. We discuss these and other variables as part of our robustness checks in the results section.

of one when the borrower's average interest-rate spread paid during the last period (month during the Lehman period and quarter during the sovereign debt crises, respectively) was above the median of the cross-sectional distribution, and zero otherwise.

3. EMPIRICAL STRATEGY AND RESULTS

This section starts with a discussion of the general empirical strategy that we use to identify how the recent financial and sovereign debt crises impact cross-border lending and provide some summary statistics. Furthermore, we present and discuss the results, both for the period surrounding the Lehman failure and the sovereign debt shocks. First, we examine the overall effects of both the recent financial crises on cross-border versus domestic lending. Second, we examine the drivers behind the reduction in cross-border (versus domestic) interbank liquidity during crises. Third, we show the results on monetary policy.

3.1. IDENTIFICATION STRATEGY

To identify the impact of the recent financial and sovereign debt crises on cross-border lending, we examine the differential cross-border lending behavior of euro area banks relative to domestic lending using the data at the *lender-borrower-time* level for two main reasons. First, this allows us to control for unobserved and observed heterogeneity in time-varying fundamentals for borrowers and lenders, and also for unobserved and observed heterogeneity in time-invariant fundamentals for borrower-lender pairs. Second, loan-level data allow us to isolate the heterogeneous effects across bank-pairs in providing credit; specifically, whether the cross-border versus domestic loan terms to the *same* borrower on the *same* day are different.

In our main analysis, we focus only on *overnight* interbank loans, but we also examine interbank loans with longer maturity than overnight in Section 3.4.[14] Unlike other credit markets, the overnight segment of the interbank market is very active—even during crisis periods—and thus allows comparing truly identical loans—i.e., overnight-uncollateralized-euro-denominated

[14] In 2008, the turnover in the overnight interbank credit market was about 5.2 times the size of the GDP of the entire euro area. Relative to the market capitalization of all euro area banks, the size of the overnight interbank market equals 12.4%. The overnight interbank market is less risky than the longer-term segment, implying that our economic effects can be considered as a lower bound. After the Lehman's failure, the interbank term lending activity dropped by more than 80%, and did not recover in the period thereafter. The remaining term lending is not sufficient for the application of our tight identification strategy that we introduce in this section as we do not have enough multiple loans with the same maturity granted by a foreign and a domestic lender to the same borrower on the same day.

loans to the same borrower on the same day—with characteristics only differing in the volume and spread of the associated loan depending on whether the lender is a domestic or a foreign bank.[15] To identify this differential effect, it is crucial to control for time-varying observed and unobserved borrower-bank-specific fundamentals, such as higher counterparty risk with borrower*day fixed effects (Khwaja and Mian 2008).[16] Hence, on the same day for the same borrower, we compare the loan conditions among foreign vs. domestic lenders for otherwise identical loans.[17]

To further isolate the supply of cross-border (versus domestic) loans, where the variation is at the bank-to-bank level, we control for lenders' time-varying unobserved and observed fundamentals by adding lender*day fixed effects (Jiménez, Ongena, Peydró, and Saurina 2014). By adding these effects, we control whether the lender has, for instance, more or less liquidity (volume and cost) to lend on a given day (thus controlling, e.g., for lender's liquidity hoarding). Finally, we add lender*borrower fixed effects to account for time-invariant effects of persistent lender-borrower characteristics such as the overall amount of cross-border versus domestic loans or similar business models. Hence, we identify the pure effects of time-varying crisis shocks on cross-border versus domestic loan conditions (i.e., we employ a difference-in-differences analysis).

Given these sets of fixed effects that we use for our empirical identification, we consider only loans where both the lender *and* the borrower have at least two counterparties per day and where at the same time the lender-borrower pair has at least traded twice in our sample. Moreover, to analyze the cross-border versus domestic funding effects, in all our regressions we exclude loans from borrowers and lenders that have not borrowed or lent at least once both domestically *and* across borders in the period prior to August 2008 (i.e., before the sample we use for the Lehman's period). Hence, our analysis focuses precisely on those banks that had cross-border loans before

[15] Note that interbank loans are ultimately central bank reserves reallocated by banks. That is, overnight interbank loans are in essence identical except for the price, loan amount and the involved lender-borrower at a particular day.
[16] We apply the borrower fixed effects estimator as in Khwaja and Mian (2008). This estimator has been used extensively in the literature to analyze granted loans by controlling for borrower unobserved heterogeneity as a proxy for demand. Jiménez, Ongena, Peydró, and Saurina (2012) analyze loan applications, but these data are not available for interbank liquidity. In Appendix Table A3, we also assess the importance of our identification strategy for measuring the cross-border differential effect during crises times both in the extensive and intensive margin of credit.
[17] Note that we do not identify syndicated loans, which are longer-term than overnight. This is important as an extension of such a loan to a borrower might appear as a loan from a syndicate of different banks to the same borrower, while the key decisions are made by the lead arranger, which might or might not be in the same country.

the Lehman failure.[18] Given these identification restrictions, our final sample consists of interbank loans between 141 borrower banks and 196 lender banks, making a total of 3,136 distinct bank pairs, which corresponds to the approximately 200 largest banks operating in the euro area.

To empirically proxy for the access to overnight credit, we create a binary variable at the borrower-lender-day level as follows. Given our final sample of 3,136 bank pairs (after applying all restrictions as discussed above) we set the binary variable to the value one on any day on which we observe a loan between the given bank pair (a given borrower and a given lender) in our sample, and zero on any other day on which there is not an interbank loan for the same bank pair in our sample. We refer to this binary variable as the extensive margin of credit (Access).

The intensive margin of credit denotes the loan terms—volume and spread—for all the granted loans (i.e., when Access equals the value one). We measure the volume as the logarithm of the respective loan amount (in EUR million), and the interest rate spread as the difference between the interest rate paid on the loan and the deposit facility rate, i.e., the interest rate paid on excess reserves (IOER).[19] We refer to these variables as Volume and Spread. In case of multiple loans for the same bank pair during one day, we aggregate volumes and compute the quantity-weighted interest rate, i.e., all the different loans between a lender and a borrower in a day are aggregated and thus in our paper we use the expression at the loan-day level to denote the lender-borrower-day level.

In conjunction with the euro area interbank data, we exploit the Lehman and sovereign debt shocks to identify the effects that the recent financial crises have on the supply of cross-border lending. We analyze the Lehman failure and the sovereign debt crisis as separate events, as the former one is more bank-related and the latter one depends on GIPS sovereign risk. Consistent with the differential nature of the two crisis periods, we proxy the crisis intensity in the euro area—our variable Crisis—in the Lehman period by the three-month Euribor-OIS spread (in percentage points), and in the sovereign debt crisis period by the mean of the logarithm of the five-year periphery country CDS spreads (in basis points).[20] Note that both of our crisis variables intend to

[18] In robustness regressions (unreported), we show that our main results are robust to the full sample of banks in our data set.

[19] During the crisis, the Eurosystem's expansionary monetary policy via the fixed-rate full allotment procedure pushed the overnight interest rates far below the main refinancing rate (the pre-crisis instrument to steer interbank interest rates), and toward the deposit facility rate, i.e., the rate paid on excess reserves (e.g., ECB 2013). Therefore, we use the deposit facility rate to measure the interest rate spread.

[20] In (unreported) regressions, we checked the robustness of our results to using indicator crisis variables. For the Lehman crisis sample, which is an aggregate banking crisis, we find qualitatively similar results suggesting that this

capture a time-varying measure of risk across the two periods. In this regard, we follow the related literature and use the Euribor-OIS spread and the CDS spread as measures for risk in general, as opposed to a proxy for a specific type of risk (e.g., Taylor and Williams, 2009; Acharya and Steffen, 2015). In (unreported) robustness regressions, we show that using the Euribor-OIS spread to capture the sovereign crises yields similar estimated coefficients, but somewhat lower statistical power, which implies that access loses statistical significance at conventional levels.

For the sake of presentation, we rescale the range of both crisis variables in our regressions to [0,1], such that the value one represents the highest crisis intensity in each period and zero its lowest value.[21] We use the period from August 18, 2008, to November 9, 2008, to analyze the Lehman crisis (60 days, with four weeks preceding and eight weeks following the Lehman's failure). We study the sovereign debt crisis over the period from July 1, 2009, to December 31, 2014 (1,356 days).[22] We analyze the impact of the recent financial and sovereign debt crisis shocks on cross-border loan conditions using the following linear regression model:

$$Loan_{i,j,t} = \beta \cdot Crisis_t \cdot Cross\text{-}border_{\mathrm{i,j}} + \alpha_{j,t} + \alpha_{i,t} + \alpha_{i,j} + \varepsilon_{i,j,t} \qquad (1)$$

where Loan refers to the loan conditions (Access, Volume, and Spread) that borrower *j* receives from lender *i* on day *t*. Cross-border is a dummy variable that equals the value one if borrower and lender banks are headquartered in different countries, and zero otherwise. Equation (1) represents our benchmark regression that includes the strongest set of fixed effects: borrower*day, lender*day, and borrower*lender fixed effects.

---

crisis sample represents a period of elevated aggregate financial stress in cross-border interbank markets. For the sovereign debt crisis, however, which is a sovereign crisis, we find that our results depend on using the continuous variable (as opposed to a binary crisis variable that equals one after Greece's problems start in April 2010), which suggests that the continuous variable is more appropriately capturing the dynamics associated with the sovereign debt crisis than one specific dummy variable. It is important to highlight that during the sovereign debt crisis there were different specific-sovereign-related shocks (Greek but also Italian, Spanish, Irish and Portuguese problems) across different periods with different intensity (see e.g. Garcia-de-Andoain, Hoffmann, and Manganelli 2014; Acharya and Steffen 2015).

[21] We rescale each variable X in the following way: $(\mathrm{X}-\mathrm{X}_{\min})/(\mathrm{X}_{\max}-\mathrm{X}_{\min})$, where the index 'min' and 'max' denote the minimum and maximum value of X in either the Lehman and sovereign sample, respectively.

[22] We choose the estimation sample for the Lehman period to start four weeks before Lehman's failure on September 15, instead of eight weeks as our data only start in June 2008 but we need some pre-sample loans to identify banks that are active in the cross-border segment (see previous pages). We extend the sample to eight weeks after Lehman as a decline in overnight credit was only observed two weeks after Lehman's failure (see the initial version of this paper where we have documented that, immediately after Lehman failure, term credit dropped dramatically while overnight volumes increased and only fell after term volumes stabilized at virtually zero). For the sovereign debt sample, we choose mid-2009 as the start to have sufficient pre-crisis interbank loans before the sovereign debt problems of Greece began in April–May 2010. Also, money market tensions relaxed and returned to their pre-Lehman means around mid-2009, as, e.g., indicated by the three-month Euribor-OIS spread.

We start our regression with borrower fixed effects, then saturate the regressions with different fixed effects progressively, and then move to equation (1) that refers to the specification with the strongest set of fixed effects (and thus with our strongest identification).[23] We estimate equation (1) with least squares (due to the presence of a large set of fixed effects) and compute heteroskedasticity-robust standard errors clustered at the bank-pair level given that the main variable we are interested in is the cross-border dummy, which varies at the bank-pair level.[24] Finally, we slightly vary the main specification when we analyze the results on the factors explaining the cross-border results and on the monetary policy part. We explain these variations to our main specification when we introduce those results.

Table 1 presents the summary statistics of the interbank overnight loans covering our two financial crisis periods. Out of 7,348 overnight loans during the Lehman period (August 18, 2008, to November 9, 2008), 49.13% are lent out to foreign borrowers as cross-border loans. In the sovereign debt period from July 1, 2009, to December 31, 2014, the fraction of cross-border loans amounts to 38.20% (out of a total of 38,294 overnight loans). Note that the number of interbank loans refers to the dataset after we have imposed all the restrictions for the identification, in particular related to the fixed effects (i.e., borrower*day, lender*day, and borrower*lender fixed effects) that we explained above.

For the granted loans, the median loan amount is twice as large for cross-border loans as for domestic loans (see Table A2 in the appendix). During the Lehman period, the mean amount of cross-border loans amounts to 198 EUR million (median: 100 EUR million) as compared to 109 EUR million (median: 50 EUR million) for domestic loans; in the sovereign period, the mean amount of cross-border loans is 268 EUR million (median: 150 EUR million) as compared to 132 EUR million (median: 50 EUR million) for domestic loans.[25] For the same borrower on the same day, the median loan in our Lehman sample (sovereign debt period) amounts to 123 (140) EUR million from cross-border loans and 75 (53) EUR million for domestic loans; for the same borrower on same day, the total amount borrowed from cross-border amounts on average to 468 EUR million (median: 655 EUR million) during the Lehman period, while the daily total amount

[23] In a previous version of the paper, we had many more specifications with all the different sets of fixed effects, but for the sake of brevity (both in terms of pages and tables), in the current draft we do not show those robustness tests.
[24] See Moulton (1986, 1990) and, e.g., Wooldridge (2002). Our results, however, are all robust to multi-way clustering at the bank-pair and time level.
[25] In the raw dataset, the average weekly total borrowing volume before the Lehman failure in the cross-border segment is 146.8 EUR billion and 128.85 EUR billion in the domestic segment.

borrowed from domestic lenders amounts on average to 287 EUR million (median: 137 EUR million); during the sovereign period, the total cross-border borrowing amount is on average 416 EUR million (median: 200 EUR million), while the total domestic borrowing volume equals 211 EUR million on average (median: 94 EUR million).[26]

Borrowers with higher cross-border loans are substantially larger (in total assets) than borrower banks with more domestic borrowing. Also, for the same borrower on the same day, cross-border lenders are on average 2.5 times larger in size (total assets) and twice as leveraged than the domestic ones.[27] Moreover, the average interbank spread paid for cross-border trades corresponds to 88.19 basis points in the Lehman period (and 22.06 basis points in the sovereign debt sample) with a standard deviation of 32.06 basis points (21.61 basis points during the sovereign debt crisis). In the domestic segment, the spread amounts to 80.17 basis points during the Lehman period and 22.65 basis points during the sovereign debt sample with a standard deviation of 39.11 basis points and 23.94 basis points, respectively.

These summary statistics again highlight the importance of examining the interbank credit supply at the lender-borrower level, since using aggregate data at the bank or country level on interbank lending would mask these differences and could therefore be misleading. For example, in a global financial crisis, global (international) banks are in general more affected. These banks have more cross-border loans, and therefore, the volume of cross-border loans will be reduced because the typical borrower of these loans is more negatively affected by the crisis. Then the reduction of cross-border loans would not be due to financial disintegration, but just because of the fact that the typical borrower bank of these loans is riskier in the global crisis. Therefore, bank-level data—as compared to bank-to-bank (loan) level data—are not adequate for identification. Moreover, apart from the loan-level data, borrower*day fixed effects are crucial to control for unobservable time-varying borrower risk.

Figure 1 shows our crisis measure for both samples. The spread between the three-month Euribor and the correspondingly-dated OIS rate (Figure 1.A) substantially increases after the Lehman failure on September 15, 2008, to a maximum of 207 basis points. The crisis measure was stable in our pre-Lehman sample despite that there were significant turbulences during the summer of 2007. In Figure 1.B, we plot the average of the five-year periphery-country CDS spreads over

[26] The results referring to the last sentence are not reported in the tables for the sake of saving space.
[27] If we control for loan size in interactions and in levels, our results are robust.

the sovereign debt crisis period, which increases from 89 basis points at the beginning of our sample on July 1, 2009, to values of 296 basis points when Greece experienced its first difficulties in April 2010, and reaches 772 basis points in the Summer of 2011. Both figures show that our crisis measures are well suited to measure the crisis shocks and their intensification in each of our two crisis shock periods accordingly.

3.2 IMPACT OF RECENT FINANCIAL CRISES ON CROSS-BORDER LENDING

In this section, we analyze the impact of the two recent financial crisis shocks on credit supply, and particularly, on the cross-border lending segment. We first analyze the extensive lending margin in Table 2 and then the intensive lending margin in Table 3. The results in this section provide the paper's basic findings.

Before we move to the lender-borrower-level data, we start by examining whether the two crisis shocks reduce borrower banks' overall access to interbank credit. In Table 2, columns 1 and 5, we examine the impact of the recent financial crisis shocks on the daily access to interbank credit at the borrower bank level during the Lehman and sovereign debt period, respectively. Our results suggest that, during both crisis periods, the crisis shocks imply a reduction in access to interbank borrowing, which is binding at the borrower bank level; i.e., a given borrower is not able to (fully) offset a contraction in credit supply by one lender through an increase in borrowing from another lender, thereby affecting its overall credit availability. During the Lehman period, this decline amounts to a maximum of 2.89 percentage points at the worst moment of the crisis, which—compared to the pre-Lehman average borrowing probability of 12.93 percentage points—translates into a relative credit reduction in funding access by about 22.35% (2.89/12.93). For the sovereign debt period, the absolute decrease of 1.34 percentage points corresponds—when compared to the pre-sovereign-debt-crisis average borrowing probability of 10.64 percentage points—to a relative reduction in access by about 12.59% at the worst moment of the crisis. Therefore, conditioning on the same borrower, the results suggest that banks experience a strong decline in interbank overnight funding access during the crisis. (Arguably, our data does not cover all bank liabilities, but GIPS banks could not easily pledge their local public debt in collateralized markets during the crisis, suggesting that collateralized lending has important frictions and may not provide the alternative funding for the cross-border transactions, e.g. Boissel et al. 2017).

We next analyze the supply of interbank credit at the loan level. Controlling for borrower, lender, and time (day) fixed effects, in Table 2, columns 2 and 6, we find that the overall credit access of cross-border loans is lower than the one of domestic loans (3.86 percentage points less likely during Lehman and 1.92 percentage point less likely during the sovereign debt period). More importantly, in columns 3 and 7, we add the variable Crisis*Cross-border to examine whether there is an additional time-varying differential cross-border effect related to the crisis. In both crisis periods, we find that the estimated coefficient on the interaction between cross-border lending and the crisis variable is negative and significant. At the worst moment of the Lehman crisis, we find that the access to cross-border loans is reduced by up to an additional 37.22%. During the sovereign debt period we estimate the additional relative decline of cross-border loans of up to 35.08%.[28] Thus, the negative impact of the crisis shocks is substantially stronger for cross-border loans.

We also find that the crisis shocks lead to a reduction in the supply of cross-border loans when we control for borrower*time, lender*time, and borrower*lender fixed effects (Table 2, columns 4 and 8, which reports our benchmark regressions). Notice that all these estimations refer to the part of our sample that complies with the restrictions needed to identify the full set of fixed effects, and only includes loans between banks that actively traded both across borders *and* domestically before the onset of the recent financial crisis (as explained above in the section on empirical identification).[29] The estimated coefficients are statistically not different than those of the previous model despite a large increase in the R-squared (thus suggesting strong exogeneity to unobservable variables, following Altonji et al. 2005), and, second, they remain economically significant and large (an additional relative reduction for cross-border loans in access to interbank credit by 29.21% during Lehman and by 24.38% during the sovereign debt sample). All in all, the results suggest that the recent financial crisis shocks reduce the supply of interbank liquidity in the extensive margin of lending, with substantially stronger negative effects for cross-border loans.

In Table 3, we analyze the intensive margin of credit, i.e., volume and spread for the granted loans. From columns 1 and 6, we find that the crisis shock implies a reduction of credit volume that banks borrow in the interbank market, which is binding at the (borrower) bank level.

[28] The absolute additional reduction during the Lehman crisis is of up to 3.16 percentage points, relative to the pre-Lehman average loan probability of 8.49 percentage points. The absolute additional change is of 1.20 percentage points during the sovereign debt crisis relative to the average pre-crisis loan probability of 3.42 percentage points.
[29] We keep the same number of observations in all the columns of the loan-level analysis to facilitate the comparison of the results depending on the different set of controls.

During the height of each crisis, there is an overall 33.92% decrease in interbank borrowing during the Lehman period and a 28.84% decline during the sovereign debt crisis.

Columns 2 and 7 report the coefficients for the loan-level analysis tracing the crises' impact on cross-border versus domestic loan volumes. We find that the crisis shocks imply a stronger reduction of the supply of credit volume for the cross-border as compared with the domestic segment (for the same borrower on the same day, also adding lender*day and borrower*lender fixed effects). When considering the worst moments of the respective crisis periods, we find an additional reduction in cross-border versus domestic loan volumes by up to 12.45% during the Lehman crisis and by 10.04% during the sovereign debt period.

In columns 3–5 and 8–10 of Table 3, we show the same results for the spreads of granted loans. In columns 3 and 8, controlling for borrower fixed effects, we find that the sovereign debt crisis shock increases the cost of borrowing by 32.01 basis points at the borrower bank level (see column 8). However, in column 3 we find that during the Lehman crisis banks pay significantly lower spreads for overnight credit (i.e., interest rates are closer to the rate paid on excess reserves). This finding is in line with other studies that document for the period after the Lehman failure a decrease of the overnight rate while the Libor-OIS spread increased (e.g., Taylor and Williams 2009; ECB 2013). This is partly due to the decrease of the OIS rate in the second week after the Lehman's failure suggesting that the market was expecting monetary policy to reduce interest rates (Taylor and Williams 2009). So, in column 4, we restrict our analysis of the recent financial crisis on spreads to the first week after the Lehman failure (i.e., with 4 weeks before and 1 week after Lehman Brothers' failure) and find a positive and significant impact of the crisis on spreads at the bank level immediately after the Lehman shock.

Interestingly, our results on the loan-level analysis with the full set of fixed effects show that, during the Lehman sample, lenders charge to the same borrower on the same day significantly higher spreads for cross-border loans as compared with domestic loans during the crisis. Economically, this differential effect in the interest rate spread amounts to 6.97 basis points (column 5) at the worst moment of the crisis (or 6.92% when compared to the average spread of 1.01 percentage points before the Lehman failure). During the sovereign debt crisis, we find no significant *average* cross-border differential effect during the crisis (see column 9). However, once we allow for heterogeneous effects depending on borrower location, we find an additional increase

of 13.61 basis points for cross-border loans to borrower banks headquartered in GIPS countries (see column 7 of Table 4 Panel B and column 10 of Table 3).

Overall, the results suggest that the recent financial and sovereign debt crisis shocks reduce the supply of interbank liquidity (credit supply) on the extensive and intensive margin of lending (access, volume, and spreads), with substantially stronger adverse effects for cross-border loans.[30] Moreover, the effects are binding at the (borrower) bank level and are significant both for the Lehman and the sovereign debt crises. Importantly, despite of analyzing the less risky segment of just overnight loans (as compared to loans with longer-term maturities, which we analyze in Section 3.4.), the results are quantitatively strong, especially on access and volume. It is important to highlight that our baseline result holds after controlling for any unobserved time-varying borrower (and lender) heterogeneity through borrower*time (and lender*time) fixed effects, where time refers to daily fixed effects.[31] Hence, unlike with aggregate or even bank-level data, we can control for any time-varying compositional differences in the sample of domestic vs. foreign borrowers; moreover, as compared with other loan-level data, our loans are identical standardized overnight deposits. Moreover, our results are based on an identification strategy that controls for time-varying borrower-specific credit quality changes. That is, changing borrower qualities and risks cannot drive our results.[32]

We next analyze whether the tightly identified differential effect (domestic versus cross-border) varies depending on borrower or borrower-country risk characteristics, or is independent on their risk characteristics. Note that while we identify the average cross-border differential effect by comparing loan conditions to the same borrower on the same day by a foreign vs. domestic lender (borrower*time fixed effects), this differential effect might still be more or less pronounced depending on borrower characteristics.

---

[30] During the Lehman crisis there were a lot of USD funds placed into the system by the ECB through swap lines, see https://www.ecb.europa.eu/mopo/implement/omo/html/top_history.en.html. If banks substituted for EUR funds, one might think that this may have artificially created an additional dip in EUR loan volumes. In robustness tests (not reported), however, we find that our results are robust to the inclusion of USD amounts outstanding associated with the ECB's dollar swap line.

[31] In robustness regressions (not reported), we show that our results are robust to including different borrower-lender relationship specific controls.

[32] In Appendix Table A3, we find that our results become weaker on the intensive margin once we exclude borrower*time and borrower*lender fixed effects, but not on the extensive margin. This result further suggests: (i) that borrower-specific credit quality is related to cross-border loans for the loan volume and rate but unrelated to granting a loan; and (ii) if those fixed effects are not taken into account, they blur the cross-border differential effect in interbank lending with borrower quality. This gives rise for our strong identification strategy in light of our overarching research question.

To estimate the sensitivity of the cross-border differential effect during the crisis depending on observable and unobservable debtor-bank characteristics, in Table 4, we interact crisis*cross-border with two borrower-specific variables. Our first variable is a binary variable that equals the value of one whenever the borrowing bank is headquartered in one of the GIPS countries, i.e., Greece, Ireland, Portugal, and Spain. This variable is a natural candidate to account for observable bank risk characteristics (and also for investment opportunities and legal institutions, among others). While this variable fits our analysis surrounding the sovereign debt crisis, which was centered on these countries, we also use this variable in the Lehman period to ensure consistency in our analysis. Second, we introduce an interaction term of our crisis measures with the variable 'High-Spread Borrower'. We construct 'High-Spread Borrower' as a dummy variable that equals one if the borrower bank paid an higher (above the median) average interest rate spreads (relative to the average daily interbank rate) for overnight loans during the last period (month for the Lehman period and quarter for the sovereign debt crises) prior to the trade, and zero otherwise. This variable is a natural candidate for assessing the role of borrower risk as it measures the lender's differential pricing of an interbank loans to a given borrower that incorporates on all information the lender has about this borrower (i.e., both observed and unobservable information to the econometrician).[33] We first introduce each interaction term individually and then combined.

Our results for the extensive margin, i.e., access to interbank loans (columns 1 to 3 of Panel A and B, respectively), suggest that the reduction of the supply of cross-border loans is independent of observed and unobserved debtor bank characteristics. While our high-spread variable is supposedly a comprehensive measure (i.e., sufficient statistic) of borrower risk characteristics, in robustness regressions (not reported), we have also checked the results against the inclusion of multiple other variables used in the literature. These variables include the borrower bank's size and leverage, and borrower-country's bank capital regulation, common language between the lender and borrower country (Rose 2004), on bilateral trust, biological distance, and differences in economic conditions (per capita GDP) between the lender and borrower country (Guiso, Sapienza, and Zingales 2006, 2009), protection of creditor rights (La Porta et al. 1998; Djankov, McLiesh, and Shleifer 2007), the degree of government bank ownership as well as trade

[33] This is not to say that prices are unobservable. Instead, we consider the concept of borrower risk to be of multi-dimensional nature and to a large degree not captured by observable balance sheet measures. Higher rates may thus indicate higher risk, but there may also be other factors than risk that can affect prices, which the econometrician cannot directly observe.

flows between the two countries (Giannetti and Laeven 2012; Houston, Lin, and Ma 2012). However, in all cases, we do not find that the reduction of cross-border funding access is coherently dependent on any of these borrower-specific variables, neither in the Lehman crisis nor in the sovereign debt crisis. Therefore, the dry-up of cross-border liquidity on the extensive margin is independent of debtor bank fundamentals.

In columns 4–6 and 7–9, we replicate the estimation from column 1–3 for the intensive margin of credit, i.e., volume and spread. We find that, during the Lehman crisis, the cross-border differential effect in spreads is more pronounced for high-risk borrower banks. In column 9 of Panel A, during the worst moment of the Lehman crisis, high-risk borrowers face an additional increase in cross-border interest rate by 14.65 basis points. From column 6 of Panel B, we find that during the sovereign debt crisis, the reduction in cross-border loan amounts is especially stronger for GIPS-headquartered debtor banks. For example, during the worst moment of the crisis, GIPS-headquartered borrower banks experience an additional contraction in cross-border loan volumes by 37.9% as compared with the general cross-border loan volume contraction. High-risk foreign borrower banks, however, leave the cross-border differential effect statistically unaffected. Overall, these results suggest that, unlike the extensive margin of credit (access to interbank loans), the reduction in the supply of cross-border loan amount is affected by the country where the borrowers are headquartered.

In columns 7, 8 and 9 of Panel B, we find that during the sovereign debt crisis, the cross-border differential effect in spreads is stronger from GIPS-headquartered debtor banks. The estimates indicate an additional increase in spreads for cross-border loans by up to 13.4 basis points. Note that this is the additional increase in spreads for GIPS-headquartered borrowers as compared to the general increase in cross-border loan spreads during the crisis. In robustness regressions, we find that the results for the intensive margin, i.e., both volume and spreads, are robust to the inclusion of other variables used in the literature (as previously discussed). In fact, the impact of GIPS-headquartered debtor banks strikes out as the most important variable affecting the cross-border differential in both loan amount and spreads during the sovereign period.[34]

In sum, our previous results show that the crisis shocks reduce the supply of interbank liquidity, but especially the cross-border liquidity. Importantly, in the extensive margin (access to

[34] Similar to the extensive margin, we do not find that the borrower bank's size coherently matters for the differential effect on the intensive margin of credit.

inter-bank loans) differently from the intensive margin (volume and price), results suggest that the reduction of the supply of cross-border loans is independent of debtor bank characteristics (i.e., observed and un-observed). This is also supported by the fact that our point estimates from a regression of the extensive margin without controlling for borrower*time and borrower*lender fixed effects are very similar to our baseline results that include these controls (Appendix Table A3, columns 1 and 7, respectively).

Interestingly, and in contrast to the general reduction in cross-border credit on the extensive margin independent of borrower quality, on the intensive margin, already during the Lehman crisis, high-risk debtor banks pay higher spreads for cross-border liquidity. The cross-border liquidity crunch, however, is stronger for GIPS-borrowers during the sovereign debt crisis, when GIPS-headquartered debtor banks also obtain substantially smaller cross-border loan amounts in addition to paying higher spreads on these international loans. Table A3 also shows that results are substantially stronger when we control for borrower selection (borrower*time and borrower*lender fixed effects).

3.3. What is Cross-Border? Lender Location versus Nationality

Our baseline results consistently (across margins and crisis samples) show that the interbank liquidity crunch during crisis periods is more pronounced in the cross-border segment; and even more for high-risk borrowers during the Lehman sample and for GIPS-headquartered debtor banks during the sovereign crisis. This finding is consistent with theory (e.g., Freixas and Holthausen 2005) arguing that asymmetric information problems are stronger for cross-border trades, especially during crisis times.

To further substantiate the role of asymmetric information problems as a key driver of the documented cross-border liquidity crunch, we next test whether the documented cross-border crunch is related to either the lender bank's location or its nationality (relative to the borrower). That is, in a next step, we examine why cross-border liquidity dries up during crisis times. To that aim, we raise the following two questions. Is the cutback in lending driven by foreign banks located in a foreign country as opposed to foreign banks located in the same country as the borrower (location, hereafter)? Or is it rather because all foreign banks withdraw funding independent of their location (nationality, hereafter)? For example, we analyze whether, say, Commerzbank in

Frankfurt and, say, Deutsche Bank in Spain differentially provide liquidity to, say, Banco Santander in Spain during crisis periods.

To do so, we refine our cross-border dummy variable as follows: 'Cross-border (foreign lender)' is a dummy variable that equals one if lender bank i and borrower bank j are headquartered in different countries and their bank parents are of different nationality, and zero otherwise; 'Domestic (foreign lender)' is a dummy variable that equals one if lender bank i and borrower bank j are headquartered in the same countries and their bank parents are of different nationality, and zero otherwise. That is, the latter case captures foreign banks with subsidiaries, while the former indicator variable does not. During the Lehman crisis, we observe 3,513 cross-border loans from foreign lenders and 885 domestic loans from foreign lenders. During the sovereign debt crisis period, we 14,191 cross-border loans from foreign lenders and 5,441 domestic loans from foreign lenders, respectively.

We provide results on lender location versus nationality in Table 5. The estimations follow our benchmark approach with a full set of borrower * time fixed effects, lender * time fixed effects, and borrower * lender fixed effects. Columns (1) and (5) show that, for the extensive margin, foreign banks in a different location than the borrower cut back on lending significantly more than domestic banks during both crisis periods (the benchmark group is a domestic loan between two banks controlled by parents of the same nationality). This result effectively resembles our main finding from the previous tables that cross-border credit (defined by location) dries up.[35] However, in stark contrast to this result, foreign lenders that are *based in the same country* than the borrower do *not* cut back lending differentially than domestic banks do during the crisis.[36]

Similarly, in columns (2), we find that, during the Lehman period, on the intensive margin, foreign banks strongly and significantly decrease their loan volume to borrowers in a different location compared to local, domestic banks. Our estimated coefficient is roughly similar (in absolute values) than in Table 3, column (2), where we also consider cross-border loans by lender banks of the same parent nationality than the borrower. During the Lehman crisis, the point

[35] In fact, in (unreported) robustness regressions, we can show that all our results can be replicated with this definition of cross-border loans suggesting that location is the key driver of cross-border credit crunch during crises times. Also, we can show similar results when we restrict the sample to banks that operate in a single country (i.e., without foreign banks with subsidiaries in the country of the borrower).

[36] For a clean identification, all specifications in Table 5 include as controls interaction terms between the crisis variable and a dummy variable for cross-border loans from lenders with the same bank-parent nationality than the borrower bank. These loans however account for less than 1.5 percent of the data. The output is omitted to avoid cluttering.

estimate also indicates that foreign banks reduce loan volumes on local loans to borrowers in the same location compared to local, domestic banks, although the effect is only marginally significant (at 10% level of significance), and more importantly this result is not robust to all the other eight columns (margins and crises). Moreover, as column (6) and (7) show, during the sovereign crisis, foreign banks in a different location significantly reduce the supply of volume to borrowers to GIPS-headquartered borrower banks (differential reduction of up to 40 percent during the worst moments of the crisis). On the other hand, foreign banks in the same location behave very similarly to domestic, local bank.

Column (3)–(4) and (8)–(9) show the results for the spreads of granted loans. As before, we find that cross-border loans by foreign banks trade at substantially higher spreads during the crisis period, both during the Lehman and sovereign period. In line with our results in Table 4, the differential effect is driven by high-spread borrowers during the Lehman period and by GIPS-headquartered borrowers during the sovereign period. Moreover, results are again different for "Crisis * Domestic (foreign lender)" indicating that, unlike foreign banks in a different location, domestic loans by foreign lenders do not trade at higher rates than domestic loans by local, domestic banks.

Overall, these results show that the cross-border credit crunch during crisis is driven by *lender location* rather than lender nationality. Only foreign lenders that do *not* have a subsidiary in the borrower country tighten lending conditions when the crisis intensifies (note also that these subsidiaries were in the borrower country before the crisis shocks). This is consistent with the notion that foreign banks that have a subsidiary in the country have better information about borrower quality and local economic conditions. Our results are therefore in line with theories suggesting asymmetric information problem to be at the core of the documented cross-border liquidity credit crunch.

While our results are consistent with asymmetric information problems about borrower quality and local economic conditions, they also speak to the uncertainty about bailouts in the European context, which could affect the identified cross-border differential in interbank liquidity as well. On the one hand, discrimination between (intra-EU) foreign and local agents in the bailout case would likely violate basic equality principles of the European Union (e.g., Article 21 of the EU Charter and Article 18 of the Treaty on the Functioning of the European Union). On the other hand, uncertainty about national bailout structures and potentially differential recovery rates

between foreign and domestic creditors could lead to differential access and conditions for cross-border versus domestic loans. The adoption of the bank recovery and resolution directive (BRRD) and the implementation of the single resolution mechanism (SRM) in 2014 speak to this uncertainty. But, as Bolton and Oehmke (2019) argue, an effective framework re-quires a design which accounts for the individual interaction between any bank's incentives to run its business activities and the member state's national interest (both ex ante and ex post).[37]

3.4. Cross-Border Credit Crunch in the Term Segment

Previous results are based on overnight loans only, given that the overnight segment of the interbank market is very active—even during crisis periods—and thus allows comparing truly identical loans, i.e., overnight-uncollateralized-euro-denominated loans to the same borrower on the same day. However, while we do not observe all bank liabilities, our dataset also contains loans with maturity longer than overnight (henceforth, term loans), which allows us to analyze the reduction of term lending during the crisis, in particular, in the cross-border segment. In light of the results presented in the previous subsection, we would expect that our reported effects are stronger in the term segment (given that shorter maturity is safer and can be seen a substitute for collateral relative to term loans), if asymmetric information problems are at the core of the documented cross-border liquidity crunch during crises.

Figure 2 plots the turnover in the overnight segment and the term segment during the Lehman period. The figure shows a strong and sudden collapse of interbank lending in the term segment of about 80 percent after Lehman's failure. The freeze in term lending is accompanied by an initial increase in overnight lending (suggesting a substitution from the less liquid and thus riskier term segment towards the more liquid and less risky overnight segment). However, the overnight lending itself also starts to decrease in the period subsequent. Interestingly, Appendix Figure A1 shows that the term segment did not recover in the years following Lehman's failure, unlike the overnight segment. This finding highlights the role and importance of overnight lending for euro area interbank money markets, which is also why, in addition for a clean identification we focus in our main analysis on overnight loans.

[37] For a thorough discussion of bank bailouts in the European context, see Gabrieli and Labonne (2018).

In Table 6, we study the collapse in term lending after Lehman's failure in more detail, and examine, in particular, whether the dry-up was more pronounced for the cross-border term segment. Our regression setup is (once again) consistent with our baseline loan-level analysis presented in Tables 2 and 3, but now also includes term loans in addition to overnight loans. That is, for the bank-pairs in our overnight loan dataset, we now add interbank loans with maturity larger than overnight.[38] To assess the differential reaction of cross-border loans to the crisis in the term versus overnight segment, we include the triple interaction "Crisis * Cross-border * Term" as our main independent variable of interest. That is, we expand our main variable of interest in our baseline regressions, "Crisis * Cross-border", along the term dimension, which allows us to study whether the cross-border credit crunch during the crisis is more pronounced in the term segment. Similar to our benchmark results, all specifications include borrower*time fixed effects, lender*time fixed effects, and borrower*lender fixed effects (though in this case, different from previous tables, not all loans are identical).

In columns (1) and (2), we present results for the extensive margin of credit. The negative coefficient estimate on the triple interaction shows that the cross-border credit crunch during the crisis is significantly stronger in the term segment of the interbank market. In column (2), we include, in addition to our baseline controls, Cross-border * Time fixed effects, Cross-border * Term fixed effects, and Term * Time fixed effects, thereby only focusing on the differential reaction of cross-border credit in the term segment during the crisis, while netting out general time-variation in cross-border and term liquidity, as well as a different maturity structure in the cross-border segment. In column (2), the estimated coefficient indicates a strong differential reduction of about up to 16 percentage points during the crisis, which is economically very strong.

Columns (3) and (4) present results for granted loan volume. Similar to access, we find a significantly stronger reduction in cross-border loan amounts for term loans when the crisis intensifies. For example, during the first two weeks after Lehman's failure, when our crises variable increased from 0.02 to 0.34, our estimate from model (4) suggests an additional reduction

[38] More precisely, we construct our measure of the extensive margin in the full sample of loans as follows. For each bank pair, in each maturity, we construct a dummy variable that equals one if the pair trades on a given day, and zero otherwise. Bank pairs that are not trading in a given maturity (and thus have only zeros in the dummy variable) are discarded from the sample. For the intensive margin, we measure volume as the logarithm of the respective loan amount (in EUR millions), while the interest rates spread refers to the difference between the interest rates on the loan and the prevailing deposit facility rate (in case of multiple loans between bank pairs on the same day in the same maturity, we aggregate volumes and use the quantity-weighted interest rate spread). This is in analogy to our approach above (compare Section 3.1).

in cross-border term loan volumes by 53.8 percent relative to overnight loans. In columns (5) and (6), we also show that spreads of granted loans increase substantially more in the cross-border term segment during the crisis. Our tightly identified estimate from column (6) points toward a differential increase of up to 16 basis points during the first two weeks after the Lehman failure. Again results on volumes are substantially stronger than pricing.

In sum, these results show that the cross-border liquidity crunch as the crisis intensifies is economically stronger in the term interbank segment. Indeed, because results are weaker for overnight loans, our main analysis of overnight lending (which is excellent for identification) can be seen as conservative. Moreover, our results on term lending support our previous finding, i.e. that the results presented here are consistent with the notion that asymmetric information problems are at the core of the documented cross-border credit crunch during both crises periods.[39]

3.5. IMPACT OF EXPANSIONARY MONETARY POLICY

Overall, our basic results suggest that the crisis shocks imply a reduction of the supply of credit with a stronger negative differential effect on the supply of cross-border as compared to domestic loans. Expansionary monetary policy via the credit channel (e.g., Bernanke and Gertler 1995; Bernanke 2007) may relax financial constraints by reducing the crisis severity in general and also by relaxing the financial constraints of riskier loans (e.g., a cross-border loan in crisis times).[40] Moreover, nonstandard monetary policy has been the most important policy to combat illiquidity in the euro area. Therefore, a crucial question that arises is whether nonstandard, expansionary monetary policy helps to mitigate credit supply restrictions, notably cross-border frictions, thereby helping to promote international financial re-integration in crisis times.

[39] Due to the small number of observations, we cannot analyze additional heterogeneity in the term segment. Also, we cannot entirely rule out the possibility that our results may be (at least partly) due to selection; there are, however, several reasons supporting the information story. First, if term loans indeed attract riskier borrowers, one should observe higher rates paid by the borrower in the overnight segment that also has a term loan as compared to another bank that has no term loans to begin with. In unreported analysis, we find no differential effect between the rates paid in the overnight segment by borrowers that only trade in the overnight market versus those that also trade in the term segment. At the same, we find that borrower-level CDS spreads are somewhat similar (slightly smaller) for borrowers that also trade term loans. Second, the introduction of longer-term refinancing operations (of three-, six-, twelve-month and later three-year duration) by the ECB supports the notion that the market for term loans dried up entirely (i.e., as a whole) as opposed to a type of borrower. Third, many theory papers (and anecdotal evidence) suggest that in fact riskier borrower tend to revert to shorter maturities when borrowing (e.g., Broner, Lorenzoni, and Schmukler, 2013).

[40] As we have seen, there are frictions between foreign and local lenders that make cross-border loans riskier than domestic ones for lenders.

To identify the effect of expansionary monetary policy, we continue exploiting the data at the lender-borrower-day level, but now with a short time window of +/– 1 week around the main monetary policy measures undertaken in each crisis period: (i) the fixed-rate full allotment (FRFA) in October 2008 (the Lehman period); (ii) the first three-year long-term refinancing operations (LTRO) during the sovereign debt period in December 2011 and the second one in February 2012; and (iii) the Draghi's "whatever-it-takes" speech in July 2012 with the related announcement of the outright monetary transaction (OMT) policy by the Eurosystem in August 2012.[41] We use a difference-in-differences approach for the analysis of the impact of the different monetary policy changes:

$$\text{Loan}_{i,j,t} = \beta \cdot \text{Monetary Policy}_{t} \cdot \text{Cross-border}_{i,j} + \alpha_{i,t} + \alpha_{j,t} + \alpha_{i,j} + \varepsilon_{i,j,t} \qquad (2)$$

where the dependent variable is the interbank overnight loan condition granted to borrower *j* by lender *i* at day *t*. Monetary Policy is a binary variable that equals the value one on any day in the week after the key public policy change, and zero in the week before. That is, for the Lehman period, during the +/– 1 week window, the Monetary Policy dummy equals the value of one in the week after the implementation of the FRFA policy on October 15, 2008, and zero on the days prior to that date. For the sovereign debt crisis period, we independently study the effect of the two LTROs using the Monetary Policy dummy that takes the value of one in the week after December 21, 2011, for the first LTRO, and the week after February 29, 2012, for the second LTRO, and zero for the week before, respectively. To study the effect of Draghi's "whatever-it-takes" speech, we define the dummy variable such that it takes the value of one in the week after July 26, 2012, and zero in the week before. Moreover, because in the week after Draghi's speech, the Eurosystem announced its OMT program on August 2, 2012, we also consider another regression where we take the week before Draghi's speech and the week after the OMT announcement (thus leaving out the week from July 28 through August 2).[42]

[41] The outright monetary transaction (OMT) is a program of the Eurosystem under which the euro area system of central banks purchases in secondary markets bonds issued by Eurozone member-states under strong conditionality. In (unreported) robustness analyses, we use the shadow rate from Wu and Xia (2016) and show that these monetary policy measures in general affect the shadow rate in the euro area in a significant and plausible way.

[42] We use for the FRFA and LTRO measures the actual implementation day, because those monetary policy measures were directly impacting the interbank market through central bank liquidity allocation. We use the announcement day of the OMT instead, because the OMT was primarily focused on sovereign yields, thus only affected banks indirectly and, in addition, the OMT program was never actually used (i.e., there has not been an actual liquidity provision as compared to the FRFA and LTROs). The Draghi's "whatever-it-takes" speech in 2012 was unanticipated, came by large surprise and affected markets immediately and persistently, see e.g., Financial Times on 'ECB "read to do

For empirical identification, we use borrower*time fixed effects, lender*time fixed effects, and borrower*lender fixed effects, where time is daily, thus mimicking the strong identification from our benchmark equation (1). However, this identification strategy can only be employed for the extensive margin (access) as, within a very short window of time (as in this case for the identification of monetary policy changes), the requirements needed for the identification of the fixed effects cannot be met for the intensive margin of credit (volume and spread) due to the lack of statistical power. We therefore study the intensive margin with a specification including only borrower, lender, and time fixed effects (note, however, that in Table 2 we find that the estimated cross-border effects do not change if we add the strongest set of fixed effects). We focus in all our monetary policy analysis on the overnight segment given that the term segment collapsed completely after Lehman's failure and has not recovered since then over our sample. Cross-border in equation (2) refers to the refined variable from Section 3.3, where we redefined our cross-border dummy variable such that it takes the value of one for cross-border loans where the lender is a foreign bank (as opposed to a lender that has a bank-parent with the same nationality as the borrower bank), and zero otherwise.

In Table 7, Panel A, we investigate the effect of expansionary monetary policy on the access to cross-border credit. In column 1, we find that the FRFA policy improves the cross-border funding access during the crisis. The effect of the improvement amounts to 1.72 percentage points, thus suggesting a relative improvement for cross-border foreign lender loans of 31.7% when compared to the average loan probability of 5.43 percentage points in the week before the policy intervention. Our results on the effect of the first LTRO in December 2011 suggest no effect on the differential access in cross-border; however, the implementation of the second LTRO in February 2012 significantly improves the cross-border foreign lender loans by 2.83 percentage points, (86.5% when compared to the average loan probability of 3.27 in the week before the LTRO).[43]

The Draghi speech to do "whatever-it-takes" to save the euro moreover improves the supply of access to cross-border foreign lender loans by 1.54 percentage points. When compared to the average loan probability of 3.61 percentage points in the week before the speech, this

whatever it takes'", on July 26, 2012 (available at: https://www.ft.com/content/6ce6b2c2-d713-11e1-8e7d-00144feabdc0).

[43] The first LTRO took place on December 21, 2011, and provided 489.2 EUR billion. The second operation took place on February 29, 2012, and provided 529.5 EUR billion.

amounts to a relative improvement of 42.7%. In the alternative specification, when we look at the change during the week after the OMT announcement on August 2, 2012, as compared to the week before the Draghi speech, we even find a stronger improvement of cross-border access of 2.33 percentage points or 64.5% as compared to the week before the speech. In sum, the overall results for access suggest a strong impact of monetary policy for the cross-border segment.

In Table 7, Panel B and C, we find that monetary policy does not differentially affect cross-border credit on the intensive margin, thus showing that monetary policy has limitations in ameliorating the cross-border liquidity problems in crisis times.[44] However, in Appendix Table A4—where we do not control for time fixed effects, and hence can estimate the level effect of monetary policy—we find that overall monetary policy affects the intensive margin of credit. In particular, within the intensive margin, the effects are stronger for reducing spreads than for increasing volume. For spreads, we find that the FRFA has *no* differential effect depending on cross-border versus domestic loans (despite that the crisis shocks implied worse effects on cross-border loans). But, we find that the first LTRO increases the overall borrowing amount by 13.9% and reduces spreads by 15.1 basis points. Economically, the improvement of interbank spreads corresponds to a relative decline in spreads by 39.7% (when compared to the average spread in the week before the first LTRO). Yet, there is *no* differential effect depending on foreign lender cross-border loans for volumes and spreads, respectively (the first and second coefficients add up to zero). All in all, different from the extensive margin (access to liquidity), in the intensive margin we do not find that expansionary monetary policy improves more the cross-border foreign lender loan (relative to the domestic) segment, despite that the cross-border margin was more negatively affected by the crisis.

We do not find a significant effect of the Draghi speech on volumes or spreads (differently than for access). However, after the related OMT announcement, we find an improvement of overall spreads by 11.0% (when compared to the average spread before the Draghi speech). It is interesting to note that the OMT—both the Draghi speech as well as the announcement by the Eurosystem—improves (private) interbank liquidity despite that there was no actual injection of public liquidity, just the possibility of using this policy tool.

[44] Both in the extensive and intensive margin, we do not find further differential effect for the cross-border segment along the crisis depending on borrower bank risk or location, i.e., GIPS- versus non-GIPS-headquartered banks (not reported).

In sum, all these results highlight the positive role of monetary policy to improve interbank liquidity during crisis times. Yet, our findings also suggest that there are significant limitations to the effectiveness of monetary policy, especially on the cross-border segment.

4. CONCLUSION

In a seminal paper, Afonso, Kovner, and Schoar (2011) do not find a freeze in the U.S. unsecured interbank market around the time of the Lehman Brothers' bankruptcy. More recently, Pérignon, Thesmar, and Vuillemey (2017) do not find any market-wide freeze during the 2008–2014 period in the European market of unsecured certificates of deposits. In this paper, we study whether there is a freeze in *cross-border* interbank liquidity. Analyzing the euro area interbank market over the recent financial and sovereign debt crises, we find a strong freeze in the overnight market for the supply of cross-border liquidity, and even more for the term segment.

In particular, the crisis shocks strongly reduce the supply of interbank liquidity, in both the extensive and intensive margins, with substantially stronger negative effects for cross-border loans (a maximum of 29%). That is, comparing the same borrower on the same day, the foreign (as compared to the domestic) lender grants less interbank loans as the crisis intensifies; and conditioning on granting the overnight loan, the foreign lender reduces the loan amount and increases the loan spread. Moreover, the impairment of cross-border liquidity is quantitatively stronger on volumes than on pricing. These effects are even more pronounced for the term segment that, in response to the Lehman crisis shock, collapsed and did not recover until the end of our sample.

Importantly, we show that the documented cross-border liquidity crunch during the recent financial and sovereign debt crises is driven by a reduction of lending by foreign banks that are *located* in a *different* country than the borrowing bank. In contrast, we do not find a robust contraction in liquidity supply by foreign banks that are *located* in the *same* country than the borrowing bank (i.e. foreign banks that have a subsidiary in the borrower country); instead, those foreign banks behave similarly to domestic banks.

Moreover, on the extensive margin, our results suggest that the dry-up of cross-border liquidity is independent of debtor bank fundamentals. Differently, on the intensive margin, cross-border credit conditions depend on the risk of borrower banks. Interestingly, riskier debtor banks suffer in the Lehman crisis, but effects are stronger in the sovereign debt crisis especially for GIPS-

headquartered banks. Therefore, the (geographical) market segmentation is different for the extensive versus intensive margin of lending. Finally, we find that expansionary nonstandard monetary policy (fixed-rate full allotment, LTROs, and Draghi's OMT "whatever-it-takes") partly mitigates some of the (private) interbank liquidity supply restrictions during the crisis, but this public policy that provides public liquidity has significant limitations on delivering strong cross-border re-integration in the market for private (interbank) liquidity.

Our results suggest two important policy implications. First, they indicate that despite an integrated currency union and a common interbank payment system, the problem of asymmetric information can act as a limit for financial markets to become fully integrated. Second, our results give rise to initiatives that may motivate a higher participation by foreign banks in local markets through their local subsidiaries, instead of relying on cross-border lending, to overcome the adverse effects of asymmetric information during uncertain times. In this regard, our results are in favor of recent claims to foster stronger integration in European financial markets (e.g., Nouy 2018). The more recent coronavirus pandemic shows that concerns about market fragmentation remain to be substantial and an important cause for monetary policy makers to launch respective measures (e.g., Schnabel 2020a and 2020b).

REFERENCES

Acharya, V. V., I. Drechsler, and P. Schnabl (2014). A Pyrrhic Victory? - Bank Bailouts and Sovereign Credit Risk. *Journal of Finance* 69(6), 2689–2739.

Acharya, V. V., D. Gale, and T. Yorulmazer (2011). Rollover Risk and Market Freezes. *Journal of Finance* 66 (4),1177–1209.

Acharya, V. V. and O. Merrouche (2013). Precautionary Hoarding of Liquidity and Inter-Bank Markets: Evidence from the Sub-prime Crisis. *Review of Finance* 17 (1), 107–160.

Acharya, V.V., and S. Steffen (2015). The "Greatest" Carry Trade Ever? Understanding Eurozone Bank Risks, *Journal of Financial Economics* 115(2), 215–236.

Afonso, G., A. Kovner, and A. Schoar (2011). Stressed, Not Frozen: The Federal Funds Market in the Financial Crisis. *Journal of Finance* 66 (4), 1109–1139.

Allen, F., E. Carletti, and D. Gale (2009). Interbank Market Liquidity and Central Bank Intervention. *Journal of Monetary Economics* 56(5), 639–652.

Allen, F., E. Carletti, and D. Gale (2014). Money, Financial Stability and Efficiency. *Journal of Economic Theory* 149, 100–127.

Altonji, J.G., T.E. Elder, and C.R. Taber (2005). Selection on Observed and Unobserved Variables: Assessing the Effectiveness of Catholic Schools. *Journal of Political Economy* 113 (1),151–184.

Arciero, L., R. Heijmans, R. Heuver, M. Massarenti, C. Picillo, and F. Vacirca (2016). How to Measure the Unsecured Money Market: The Eurosystem's Implementation and Validation Using TARGET2 Data. *International Journal of Central Banking* 12(1), 247–280.

Armantier, O. and A. Copeland (2012). Assessing the Quality of 'Furfine-based' Algorithms. Staff Reports 575, Federal Reserve Bank of New York.

Bai, Y. and J. Zhang (2012). Financial Integration and International Risk Sharing, *Journal of International Economics* 86(1), 17–32.

Bernanke, B. S. and M. Gertler (1995). Inside the Black Box: The Credit Channel of Monetary Policy Transmission. *Journal of Economic Perspectives* 9(4), 27–48.

Bernanke, B. (2007). The Financial Accelerator and the Credit Channel. Speech. Available online at http://www.federalreserve.gov/newsevents/speech/bernanke20070615a.htm.

Bindseil, U., P. Cour-Thimann, and P. König (2012). Target2 and Cross-border Interbank Payments during the Financial Crisis. *CESifo Forum* 13, 83–92.

Bolton, P. and X. Freixas (2006). Corporate Finance and the Monetary Transmission Mechanism. *Review of Financial Studies* 19(3), 829–870.

Bolton, P. and M. Oehmke (2019). Bank Resolution and the Structure of Global Banks. *Review of Financial Studies*, 32(6), 2384–2421.

Bolton, P., T. Santos, and J. A. Scheinkman (2011). Outside and Inside Liquidity. *Quarterly Journal of Economics* 126 (1), 259–321.

Broner, F., T. Didier, A. Erce, and S. L. Schmukler (2013). Gross Capital Flows: Dynamics and Crises. *Journal of Monetary Economics* 60(1), 113–133.\

Broner, F.A., Lorenzoni, G. and Schmukler, S.L. (2013), Why Do Emerging Economies Borrow Short Term?. *Journal of the European Economic Association* 11(1), 67–100.Caballero, R. J. and A. Krishnamurthy (2008). Collective Risk Management in a Flight to Quality Episode. *Journal of Finance* 63 (5), 2195–2230.

Cetorelli, N. and L. S. Goldberg (2011). Global Banks and International Shock Transmission: Evidence from the Crisis. *IMF Economic Review* 59(1), 41–76.

Coeré, B. (2013). The way back to financial integration, Speech given at the conference on International Financial Integration and Fragmentation: Drivers and Policy Responses. Madrid, 12 March 2013.

De Frutos, J. C., C. Garcia, F. Heider, and P. Papsdorf (2014). Stressed Interbank Markets: Evidence from the European Financial and Sovereign Debt Crisis. mimeo.

Diamond, D. W. and R. G. Rajan (2006). Money in a Theory of Banking. *American Economic Review* 96(1), 30–53.

Diamond, D. W. and R. G. Rajan (2011). Fear of Fire Sales, Illiquidity Seeking, and Credit Freezes. *Quarterly Journal of Economics* 126(2), 557–591.

Djankov, S., C. McLiesh, and A. Shleifer (2007). Private Credit in 129 Countries. *Journal of Financial Economics* 12(2): 77–99.

Draghi, M. (2012a). Speech at the Global Investment Conference in London 26 July 2012. Speech. Available online at https://www.ecb.europa.eu/press/key/date/2012/html/sp120726.en. html.

Draghi, M. (2012b). The Monetary Policy of the European Central Bank and its Transmission in the Euro Area. Speech. Available online at https://www.ecb.europa.eu/press/key/date/ 2012/html/sp121115_1.en.html, retrieved March 11, 2016.

Draghi, M. (2013). The Role of Monetary Policy in Addressing the Crisis in the Euro Area. Speech. Available online at https://www.ecb.europa.eu/press/key/date/2013/html/sp130415.en.html.

Edison, H. J., R. Levine, L. Ricci, and T. Slok (2002). International Financial Integration and Economic Growth. *Journal of International Money and Finance* 21(6), 749–776.

ECB (2008). Changes in Tender Procedure and in the Standing Facilities Corridor. Press release. Available online at https://www.ecb.europa.eu/press/pr/date/2008/html/pr081008_2. en.html.

ECB (2013). ECB Monthly Bulletin, February 2013.

Farhi, E. and J. Tirole (2014). Deadly Embrace: Sovereign and Financial Balance Sheets Doom Loops. Working Paper 164191, Harvard University.

Flannery, M. J. (1996). Financial Crises, Payment System Problems, and Discount Window Lending. *Journal of Money, Credit and Banking* 28(4), 804–24.

Freixas, X. and C. Holthausen (2005). Interbank Market Integration under Asymmetric Information. *Review of Financial Studies* 18(2), 459–490.

Freixas, X. and J. Jorge (2008). The Role of Interbank Markets in Monetary Policy: A Model with Rationing. *Journal of Money, Credit and Banking* 40(6), 1151–1176.

Freixas, X., L. Laeven, and J.-L. Peydró (2015). Systemic Risk, Crises, and Macroprudential Regulation. MIT Press.

Freixas, X., A. Martin, and D. Skeie (2011). Bank Liquidity, Interbank Markets, and Monetary Policy. *Review of Financial Studies* 24(8), 2656–2692.

Furfine, C. H. (1999). The Microstructure of the Federal Funds Market. *Financial Markets, Institutions & Instruments* 8, 24–44.

Furfine, C. H. (2001). Banks Monitoring Banks: Evidence from the Overnight Federal Funds Market. *Journal of Business* 74(1), 33–58.

Furfine, C. H. (2003). Interbank Exposures: Quantifying the Risk of Contagion. *Journal of Money, Credit and Banking* 35(1), 111–128.

Gabrieli, S., and C. Labonne (2018), Bad Sovereign or Bad Balance Sheets? Euro Interbank Market Fragmentation and Monetary Policy, 2011-2015. Working Paper RPA 18-03, Federal Reserve Bank of Boston, Risk and Policy Analysis Unit.

Garcia-de-Andoain, C., P. Hoffmann, and S. Manganelli (2014), Fragmentation in the Euro Overnight Unsecured Money Market. *Economics Letters* 125(2), 298–302.

Gertler, M. and P. Karadi (2011). A Model of Unconventional Monetary Policy. *Journal of Monetary Economics* 58(1), 17–34.

Gertler, M. and P. Karadi (2013). QE 1 vs. 2 vs. 3. . . : A Framework for Analyzing Large-Scale Asset Purchases as a Monetary Policy Tool. *International Journal of Central Banking* 9(1), 5–53.

Gertler, M. and N. Kiyotaki (2010). Financial Intermediation and Credit Policy in Business Cycle Analysis. In B. M. Friedman and M. Woodford (Eds.), *Handbook of Monetary Economics*, Volume 3 of *Handbook of Monetary Economics*, Chapter 11, 547–599.

Giannetti, M. and L. Laeven (2012). The Flight Home Effect: Evidence from the Syndicated Loan Market During Financial Crises. *Journal of Financial Economics* 104(1), 23–43.

Gourinchas, P.-O. and M. Obstfeld (2012). Stories of the Twentieth Century for the Twenty-First, *American Economic Journal: Macroeconomics* 4(1), pages 226–265.

Guiso, L., P. Sapienza, and L. Zingales (2006). Does Culture Affect Economic Outcomes? *Journal of Economic Perspectives* 20(2), 23–48.

Guiso, L., P. Sapienza, and L. Zingales (2009). Cultural Biases in Economic Exchange? *Quarterly Journal of Economics* 124(3), 1095–1131.

Heider, F., and Hoerova, M., and C. Holthausen (2015). Liquidity Hoarding and Interbank Market Rates: The Role of Counterparty Risk. *Journal of Financial Economics* 118(2), 336–354.

Houston, J. F., C. Lin, and Y. Ma (2012). Regulatory Arbitrage and International Bank Flows *Journal of Finance* 67(5), 1845–1895.

IMF (2013). European Union: Publication of Financial Sector Assessment Program Documentation– Technical Note on Financial Integration and Fragmentation in the European Union. Staff Country Reports 13/71, International Monetary Fund.

Iyer, R. and J.-L. Peydró (2011). Interbank Contagion at Work: Evidence from a Natural Experiment. *Review of Financial Studies* 24(4), 1337–1377.

Jiménez, G., S. Ongena, J.-L. Peydró, and J. Saurina (2012). Credit Supply and Monetary Policy: Identifying the Bank Balance-Sheet Channel with Loan Applications. *American Economic Review* 102(5), 2301–2326.

Jiménez, G., S. Ongena, J.-L. Peydró, and J. Saurina (2014). Hazardous Times for Monetary Policy: What do Twenty-Three Million Bank Loans Say about the Effects of Monetary Policy on Credit Risk-Taking? *Econometrica* 82(2), 463–505.

Jordà, Ò., M. Schularick, and A. Taylor (2011). Financial Crises, Credit Booms, and External Imbalances: 140 Years of Lessons, *IMF Economic Review* 59(2): 340–378.

Kalemli-Ozcan, S., E. Papaioannou, and J.-L. Peydró (2010). What Lies Beneath the Euro's Effect on Financial Integration? Currency Risk, Legal Harmonization, or Trade?, *Journal of International Economics* 81(1), 75–88.

Khwaja, A. I. and A. Mian (2008). Tracing the Impact of Bank Liquidity Shocks: Evidence from an Emerging Market. *American Economic Review* 98(4), 1413–1442.

Kiyotaki, N. and J. Moore (2012). Liquidity, Business Cycles, and Monetary Policy. NBER Working Papers 17934, National Bureau of Economic Research.

Kovner, A. and D. Skeie (2013). Evaluating the Quality of Fed Funds Lending Estimates Produced from Fedwire Payments Data. Staff Reports 629, Federal Reserve Bank of New York.

La Porta, R. L., F. L. de Silanes, A. Shleifer, and R. W. Vishny (1998). Law and Finance. *Journal of Political Economy* 106(6), 1113–1155.

Levchenko, A. A., L. T. Lewis, and L. L. Tesar (2010). The Collapse of International Trade during the 2008–09 Crisis: In Search of the Smoking Gun. *IMF Economic Review* 58(2), 214–253.

Moulton, B. R. (1986). Random Group Effects and the Precision of Regression Estimates. *Journal of Econometrics* 32(3), 385–397.

Moulton, B. R. (1990). An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Units. *The Review of Economics and Statistics* 72, 334–338.

Nouy, D. (2018). Risk Reduction and Risk Sharing – Two Sides of the Same Coin. Speech. Available at https://www.bankingsupervision.europa.eu/press/speeches/date/2018/html/ssm.sp181031.en.html.

Oster, E. (2017). Unobservable Selection and Coefficient Stability: Theory and Evidence, *Journal of Business & Economic Statistics*, September, 1–18.

Paravisini, D. (2008). Local Bank Financial Constraints and Firm Access to External Finance. *Journal of Finance* 63 (5), 2161–2193.

Pérignon, C., D. Thesmar and G. Vuillemey (2017). Wholesale Funding Dry-Ups. *Journal of Finance* 73(2), 575–617

Praet, P. (2016). Monetary Policy and the Euro Area Banking System. Speech. Available online at https://www.ecb.europa.eu/press/key/date/2016/html/sp161004.en.html.

Schnabel, I. (2020a). The ECB's policy in the COVID-19 crisis - a medium-term perspective. Speech. Available online at https://www.ecb.europa.eu/press/key/date/2020/html/ecb.sp200610~a16c903e5c.en.html.

Schnabel, I. (2020b). The ECB's monetary policy during coronavirus crisis - necessary, suitable and proportionate. Speech. Available online at https://www.ecb.europa.eu/press/key/date/2020/html/ecb.sp200627~6009be389f.en.html.

Sinn, H.-W. (2013). Austerity, Growth and Inflation. Remarks on the Eurozone's Unresolved Competitiveness Problem. CESifo Working Paper Series 4086, CESifo Group Munich.

Stein, J. C. (2012). Monetary Policy as Financial Stability Regulation. *Quarterly Journal of Economics* 127(1), 57–95.

Stein, J. C. (2014). Incorporating Financial Stability Considerations into a Monetary Policy Framework, Speech given at the International Research Forum on Monetary Policy, Washington, D.C., March 21, and at the International Monetary Fund 2014 Spring Meetings.

Taylor, John B., and John C. Williams (2009). A Black Swan in the Money Market. *American Economic Journal: Macroeconomics* 1 (1), 58–83.

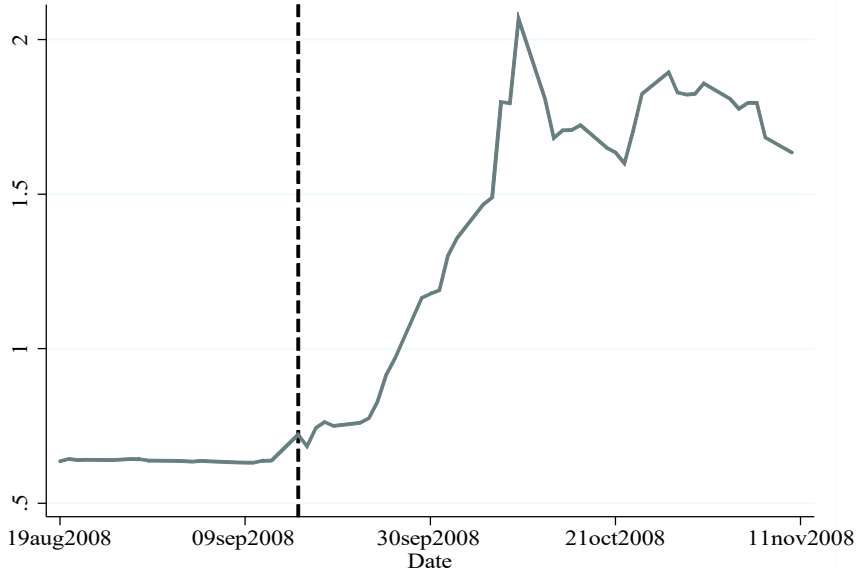
Uhlig, H. (2014). Sovereign Default Risk and Banks in a Monetary Union. *German Economic Review* 15 (1), 23–41.

Wooldridge, J. M. (2002). *Econometric Analysis of Cross Section and Panel Data*. MIT Press.

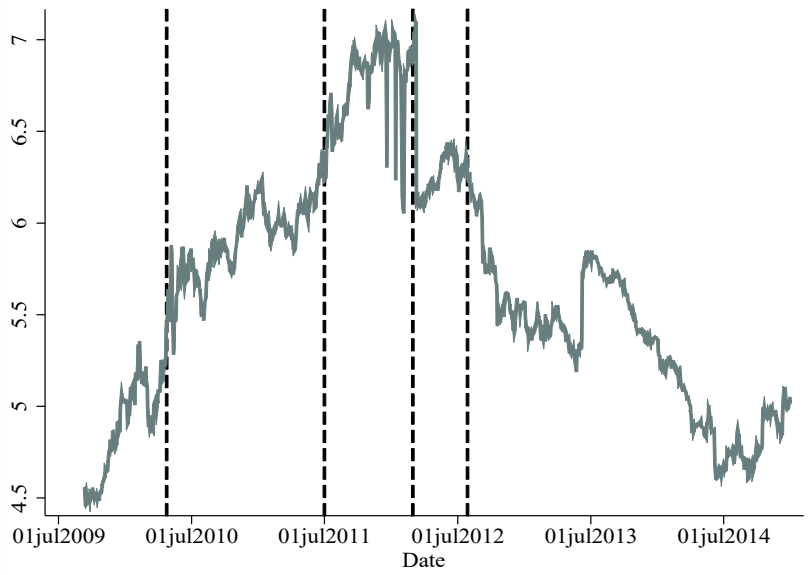
Wu, J. C., and F. D. Xia (2016). Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound", *Journal of Money, Credit, and Banking* 48(2-3). 253–291.

FIGURE 1: THREE-MONTH EURIBOR-OIS SPREAD AND MEAN PERIPHERY CDS DURING THE CRISIS

A. LEHMAN CRISIS

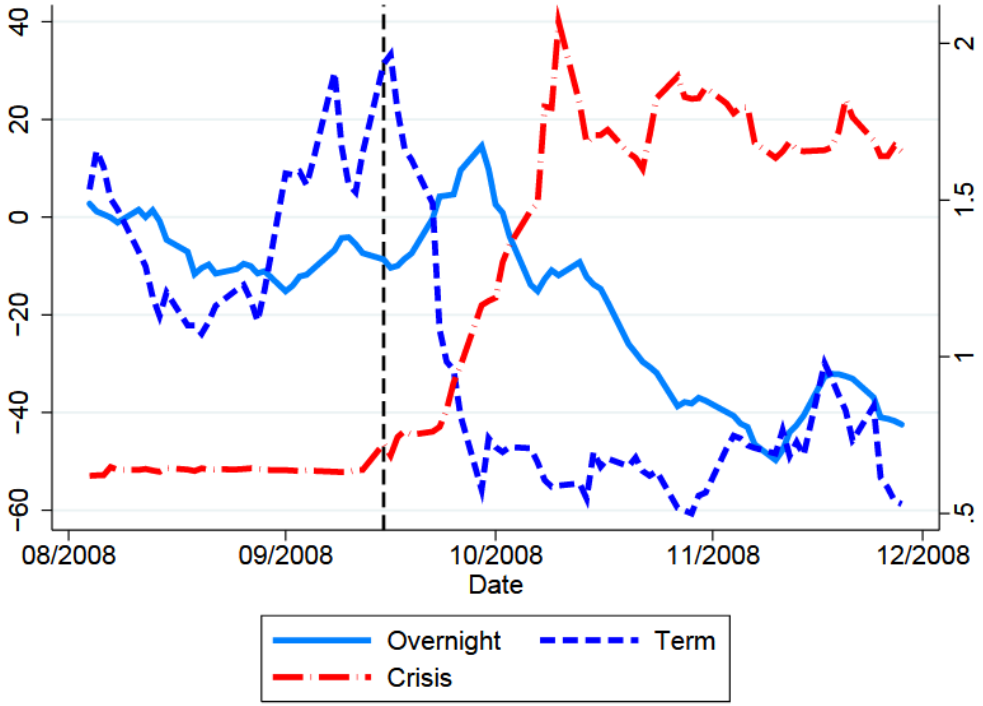


B. SOVEREIGN CRISIS



This figure shows our crisis measures for the Lehman crisis and sovereign debt crisis period, respectively. We define 'Lehman Crisis' (August 18, 2008, to November 9, 2008, daily frequency), and 'Sovereign Crisis' (July 1, 2009, to December 31, 2014, daily frequency). Subfigure (a) shows the difference (in percentage points) between the three-month Euribor rate and the correspondingly-dated overnight index swap (OIS) rate during the Lehman crisis sample. The dashed vertical line refers to September 15, 2008, i.e., the day on which Lehman Brothers filed for bankruptcy. Subfigure (b) plots the average of the logarithm of the five-year periphery country CDS spreads (in basis points). The first dashed vertical line denotes April 23, 2010, the day the Greek government activated the financial support mechanism. The second dashed vertical line refers to June 30, 2011, when market analysts became increasingly worried that Spain could keep refinancing its debt burden. The third dashed vertical line represents the second three-year LTRO on February 29, 2012, while the last dashed vertical line denotes the Draghi's "whatever-it-takes" speech on July 26, 2012.

FIGURE 2: OVERNIGHT VERSUS TERM INTERBANK LENDING AMOUNT AROUND LEHMAN



This figure shows the aggregate daily lending amount (in EUR million) during the Lehman sample for both the overnight (solid blue line, left axis) and term (dashed blue line, left axis) segment for the period from August 1, 2008 to December 31, 2008. 'Term' lending relates to transactions with maturity larger than one week. All three series are expressed as percentage deviations from the mean value of each respective series during the pre-Lehman period from August 1, 2008 to September 12, 2008. 'Crisis' denotes the three-month Euribor-OIS spread (long-dashed red line, in % on the right axis). All series (except 'Crisis') are smoothed with a 10-day moving average. The vertical dashed line corresponds to September 15, 2008, when Lehman Brothers filed for bankruptcy.

TABLE 1: SUMMARY STATISTICS

	Lehman Crisis					Sovereign Crisis				
Dependent Variable:	**Mean**	**Median**	**Std**	**p(10)**	**p(90)**	**Mean**	**Median**	**Std**	**p(10)**	**p(90)**
Access	6.557	0.000	24.752	0.000	0.000	2.170	0.000	14.569	0.000	0.000
Loan Amount	152.960	90.000	241.722	15.000	400.000	183.812	75.000	317.623	34.000	500.000
Amount	4.328	4.500	1.219	2.708	5.992	4.347	4.318	1.320	2.708	6.215
Spread	0.841	1.000	0.360	0.200	1.110	0.224	0.130	0.231	0.020	0.550
	Lehman Crisis					**Sovereign Crisis**				
Independent Variable:	**Mean**	**Median**	**Std**	**p(10)**	**p(90)**	**Mean**	**Median**	**Std**	**p(10)**	**p(90)**
Euribor-OIS (3M)	0.250	0.080	0.320	0.000	0.810					
Mean Periphery CDS (log)						0.490	0.520	0.240	0.140	0.800
Cross-border	0.491	0.000	0.500	0.000	1.000	0.382	0.000	0.486	0.000	1.000
GIPS Bank	0.162	0.000	0.369	0.000	1.000	0.071	0.000	0.258	0.000	0.000
Creditor Rights	2.110	2.000	0.837	1.000	3.000	2.253	2.000	0.880	1.000	3.000
Public Debt	72.929	64.400	24.891	35.500	99.800	88.070	79.000	20.427	72.400	112.500
Large Bank	0.660	1.000	0.474	0.000	1.000	0.618	1.000	48.590	0.000	1.000
High Leverage Bank	0.364	0.000	0.481	0.000	1.000	0.496	0.000	0.500	0.000	1.000

This table reports descriptive statistics of the main variables used in the paper, across two sub-periods. We define 'Lehman Crisis' (August 18, 2008, to November 9, 2008, daily frequency), and 'Sovereign Crisis' (July 1, 2009, to December 31, 2014, daily frequency). 'Access' denotes the extensive margin of credit. 'Loan Amount' reflects the loan volume in EUR million, 'Amount' refers to the logarithm of 'Loan Amount'. 'Spread' reflects the difference (in percentage points) between the interest rate of a loan and the interest rate paid on excess reserves (IOER). For the extensive and intensive margin, we have 188,160 and 7,348 observations during the Lehman crisis, and 4,252,416 and 38,294 observations during the sovereign debt crisis, respectively. Summary statistics for independent variables refer to sample for intensive margin. 'Cross-border' is a dummy variable that equals one if lender bank and borrower bank are headquartered in different countries, and zero otherwise. 'Euribor-OIS (3M)' refers to the spread between the three-month Euribor rate and the correspondingly-dated overnight index swap (OIS) rate (in percentage points). 'Mean Periphery CDS' is the average of the logarithm of the five-year credit default swap (CDS) spread of the periphery countries (in basis points). The definition of 'GIPS Bank', 'Creditor Rights', 'Public Debt', 'Large Bank', and 'High Leverage Bank' can be found in the Appendix Table A1. We scaled our crisis variables (Euribor-OIS spread, and mean (log) periphery CDS) such that the lowest value in each subsample equals zero, and the highest value equals one. The summary statistics for cross-border versus domestic are reported separately in the appendix.

TABLE 2: CROSS-BORDER DIFFERENTIAL IN ACCESS DURING THE CRISIS

	Lehman Crisis				Sovereign Crisis			
	Dependent Variable: Access							
	Bank Level	Loan Level			Bank Level	Loan Level		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crisis	–2.8978***				–1.3402**			
	(0.69)				(0.67)			
Cross-border		–3.8619***	–2.1072***			–1.9204***	–1.8213***	
		(0.45)	(0.60)			(0.19)	(0.19)	
Crisis * Cross-border			–3.1626***	–2.4846***			–1.2007***	–0.7925**
			(0.74)	(0.83)			(0.34)	(0.40)
Time FE	No	Yes	Yes	-	No	Yes	Yes	-
Borrower FE	Yes	Yes	Yes	-	Yes	Yes	Yes	-
Lender FE	No	Yes	Yes	-	No	Yes	Yes	-
Borrower * Time FE	No	No	No	Yes	No	No	No	Yes
Lender * Time FE	No	No	No	Yes	No	No	No	Yes
Pair FE	No	No	No	Yes	No	No	No	Yes
Observations	60,180	188,160	188,160	188,160	1,360,068	4,252,416	4,252,416	4,252,416
R-squared	0.659	0.096	0.096	0.360	0.384	0.078	0.078	0.306

This table shows the impact of the financial crisis on the extensive margin of credit, by domestic versus foreign lenders, across two subperiods. We define 'Lehman Crisis' (August 18, 2008, to November 9, 2008, daily frequency), and 'Sovereign Crisis' (July 1, 2009, to December 31, 2014, daily frequency). The dependent variable in columns 1 and 5 is at the borrower bank-time level and equals one if borrower bank j obtained an overnight loan on day t, and zero otherwise. The dependent variable in columns 2–4 and 6–8 is at the borrower-lender-time level and equals one if lender bank i grants an overnight loan to borrower bank j on day t, and zero if no loan is granted. For a thorough description of our dependent variable, refer to Section 3. 'Cross-border' is a dummy variable that equals one if lender bank i and borrower bank j are headquartered in different countries, and zero otherwise. 'Crisis' refers to the Euribor-OIS spread (3M) for the Lehman crisis and to the mean (log) periphery CDS spread for sovereign debt crisis. For the sake of representation, we have multiplied the estimated coefficients by 100. We scaled our crisis variables (Euribor-OIS spread, and mean (log) periphery CDS) such that the lowest value in each subsample equals zero, and the highest value equals one. The definition of our main variables can be found in the appendix. Fixed effects are included ('Yes'), are not included ('No'), or are spanned by another set of fixed effects ('-'). Where possible, a constant is included but its estimated value is not shown to avoid cluttering. Robust standard errors are presented in parentheses and are clustered at the bank level in columns 1 and 5, and at the bank-to-bank level in columns 2–4 and 6–8. *** p<.01, ** p<0.05, * p<0.1.

TABLE 3: CROSS-BORDER DIFFERENTIAL IN AMOUNT AND SPREAD DURING THE CRISIS

	Lehman Crisis					Sovereign Crisis				
	Dependent Variable:									
	Amount		Spread			Amount		Spread		
	Bank Level	Loan Level	Bank Level		Loan Level	Bank Level	Loan Level	Bank Level	Loan Level	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Crisis	–0.3392***		–0.7989***	0.8532***		–0.2884*		0.3201***		
	(0.11)		(0.04)	(0.13)		(0.16)		(0.03)		
Crisis * Cross-border		–0.1245**			0.0697***		–0.1004**		0.0062	0.1361***
		(0.06)			(0.02)		(0.05)		(0.01)	(0.04)
Time FE	No	-	No	No	-	No	-	No	-	-
Borrower FE	Yes	-	Yes	Yes	-	Yes	-	Yes	-	-
Lender FE	No	-	No	No	-	No	-	No	-	-
Borrower * Time FE	No	Yes	No	No	Yes	No	Yes	No	Yes	Yes
Lender * Time FE	No	Yes	No	No	Yes	No	Yes	No	Yes	Yes
Pair FE	No	Yes	No	No	Yes	No	Yes	No	Yes	Yes
Observations	1,941	7,348	1,941	901	7,348	13,368	38,294	13,368	38,294	38,294
R-squared	0.650	0.919	0.578	0.216	0.630	0.631	0.862	0.200	0.947	0.947

This table shows the impact of the financial crisis on the intensive margin of credit, by domestic versus foreign lenders, across two subperiods. We define 'Lehman Crisis' (August 18, 2008, to November 9, 2008, daily frequency), and 'Sovereign Crisis' (July 1, 2009, to December 31, 2014, daily frequency). The dependent variable in columns 1 and 6 is at the borrower bank-time level and equals the (log) total amount borrowed by bank j on day t. The dependent variable in columns 2 and 7 is at the borrower-lender-time level and equals the (log) amount of the loan lender bank i grants to borrower bank j on day t. The dependent variable in column 3–4, and 8 is at the borrower bank-time level and equals the difference (in percentage points) between the volume-weighted interest rate of the amount borrowed by bank j on day t and the interest rate paid on excess reserves (IOER) on day t. In column 4, we restrict the sample to one week after Lehman's failure to account for market expectations on monetary policy interest rate cuts (sample runs from August 18, 2008 to September 19, 2008, daily frequency). The dependent variable in columns 5, 9, and 10 is at the borrower-lender-time level and equals the spread between the interest rate of the loan lender bank i grants to borrower bank j on day t and the interest rate paid on excess reserves (IOER) on day t. For a thorough description of the dependent variables, refer to Section 3. In column 10, the coefficient for 'Crisis * Cross-border' is the estimated effect for GIPS banks from column 7 of Table 4, Panel B, where we decompose 'Crisis * Cross-border' into a GIPS and a non-GIPS part. 'Cross-border' is a dummy variable that equals one if lender bank i and borrower bank j are headquartered in different countries, and zero otherwise. 'Crisis' refers to the Euribor-OIS spread (3M) for the Lehman crisis and to the mean (log) periphery CDS spread for sovereign debt crisis. We scaled our crisis variables (Euribor-OIS spread, and mean (log) periphery CDS) such that the lowest value in each subsample equals zero, and the highest value equals one. The definition of our main variables can be found in the appendix. Fixed effects are included ('Yes'), are not included ('No'), or are spanned by another set of fixed effects ('-'). Where possible, a constant is included but its estimated value is not shown to avoid cluttering. Robust standard errors are presented in parentheses and are clustered at the bank level in columns 1, 3, 4, 6, and 8, and at the bank-to-bank level in columns 2, 5, 7, 9, and 10. *** p<.01, ** p<0.05, * p<0.1.

TABLE 4: OBSERVED VS. UNOBSERVED BORROWER CHARACTERISTICS

PANEL A: LEHMAN CRISIS

	Dependent Variable:								
	Access			Amount			Spread		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Crisis * Cross-border	-2.2756*	-2.2939***	-2.1554**	-0.1126*	-0.1079	-0.1056	0.0434**	-0.0007	-0.0033
	(0.88)	(0.84)	(0.91)	(0.06)	(0.07)	(0.07)	(0.02)	(0.02)	(0.02)
Crisis * Cross-border * GIPS Borrower	-1.0665		-0.8886	-0.0771		-0.0621	0.1705***		0.0706
	(2.58)		(2.56)	(0.12)		(0.13)	(0.05)		(0.05)
Crisis * Cross-border * High-Spread Borrower		-0.5400	-0.4391		-0.0391	-0.0220		0.1661***	0.1465***
		(1.11)	(1.09)		(0.08)	(0.09)		(0.03)	(0.04)
Borrower * Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lender * Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	188,160	188,160	188,160	7,348	7,348	7,348	7,348	7,348	7,348
R-squared	0.360	0.360	0.360	0.919	0.919	0.919	0.631	0.633	0.633

PANEL B: SOVEREIGN CRISIS

	Dependent Variable:								
	Access			Amount			Spread		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Crisis * Cross-border	-0.6931*	-0.7816*	-0.7159*	-0.0867*	-0.0836*	-0.0736	-0.0014	0.0041	-0.0024
	(0.39)	(0.41)	(0.41)	(0.05)	(0.05)	(0.05)	(0.01)	(0.01)	(0.01)
Crisis * Cross-border * GIPS Borrower	-0.5100		-0.5567	-0.4120**		-0.3794*	0.1361***		0.1338***
	(1.36)		(1.39)	(0.20)		(0.20)	(0.04)		(0.04)
Crisis * Cross-border * High-Spread Borrower		-0.0328	0.0959		-0.0874*	-0.0738		0.0105	0.0055
		(0.63)	(0.61)		(0.05)	(0.06)		(0.02)	(0.02)
Borrower * Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lender * Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,252,41(	4,252,416	4,252,416	38,294	38,294	38,294	38,294	38,294	38,294
R-squared	0.306	0.306	0.306	0.862	0.862	0.862	0.947	0.947	0.947

This table shows the impact of the financial crisis on the extensive and intensive margin of credit depending on observed and unobserved borrower risk, by domestic versus foreign lenders, across two subperiods. We define 'Lehman Crisis' (August 18, 2008, to November 9, 2008, daily frequency), and 'Sovereign Crisis' (July 1, 2009, to December 31, 2014, daily frequency). The dependent variables are at the borrower-lender-time level: In columns 1–3, the dependent variable 'Access' equals one if lender bank i grants an overnight loan to borrower bank j on day t, and zero if no loan is granted. In columns 4–6, the dependent variable 'Amount' equals the (log) amount of the loan lender bank i grants to borrower bank j on day t. In columns 7–9, the dependent variable 'Spread' equals the spread between the interest rate of the loan lender bank i grants to borrower bank j on day t and the interest rate paid on excess reserves (IOER) on day t. For a thorough description of the dependent variables, refer to Section 3. 'Cross-border' is a dummy variable that equals one if lender bank i and borrower bank j are headquartered in different countries, and zero otherwise. 'GIPS Borrower' is a dummy variable that equals one if the borrower bank is located in one of the GIPS countries, and zero otherwise. 'High-Spread Borrower' is a dummy variable that equals one if the borrower's average interest-rate spread paid during the last period was above the median of the cross-sectional distribution, and zero otherwise. 'Crisis' refers to the Euribor-OIS spread (3M) for the Lehman crisis and to the mean (log) periphery CDS spread for sovereign debt crisis. We scaled our crisis variables (Euribor-OIS spread, and mean (log) periphery CDS) such that the lowest value in each subsample equals zero, and the highest value equals one. The definition of our main variables can be found in the appendix. Fixed effects are included ('Yes'), are not included ('No'), or are spanned by another set of fixed effects ('-'). Where possible, a constant is included but its estimated value is not shown to avoid cluttering. Robust standard errors are presented in parentheses and are clustered at the bank-to-bank level. *** p<.01, ** p<0.05, * p<0.1.

TABLE 5: LOCATION VS. NATIONALITY (CROSS-BORDER AND DOMESTIC LOANS BY FOREIGN LENDERS)

	Lehman Crisis				Sovereign Crisis				
	Dependent Variable:								
	Access	Amount	Spread		Access	Amount		Spread	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Crisis * Cross-border (foreign lender)	–2.1466**	–0.1678***	0.0665***	–0.0063	–0.7737*	–0.0710	–0.0395	0.0095	–0.0019
	(0.92)	(0.06)	(0.02)	(0.03)	(0.46)	(0.05)	(0.05)	(0.01)	(0.01)
Crisis * Cross-border (foreign lender) * GIPS Borrower				0.0704			–0.3992**		0.1280***
				(0.05)			(0.20)		(0.04)
Crisis * Cross-border (foreign lender) * High-Spread Borrower				0.1377***			–0.0801		0.0101
				(0.04)			(0.06)		(0.02)
Crisis * Domestic (foreign lender)	1.2928	–0.1680*	–0.0407	–0.0683**	0.3015	0.0861	0.0443	0.0166	0.0088
	(1.72)	(0.09)	(0.03)	(0.03)	(0.75)	(0.07)	(0.08)	(0.02)	(0.02)
Crisis * Domestic (foreign lender) * GIPS Borrower				0.1564			–0.0642		–3.7808
				(0.10)			(0.05)		(3.47)
Crisis * Domestic (foreign lender) * High-Spread Borrower				0.0468			0.1482		0.0040
				(0.07)			(0.11)		(0.02)
Borrower * Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lender * Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	188,160	7,348	7,348	7,348	4,252,416	38,294	38,294	38,294	38,294
R-squared	0.360	0.919	0.630	0.634	0.306	0.862	0.862	0.947	0.947

This table shows the differential credit conditions by foreign lenders (both different and the same location than the borrowing bank) in the extensive and intensive margin of credit during the Lehman crisis (August 18, 2008, to November 9, 2008, daily frequency) and the Sovereign crisis (July 1, 2009, to December 31, 2014, daily frequency). In columns 1 and 5, the dependent equals one if lender bank i grants an overnight loan to borrower bank j on day t, and zero if no loan is granted. In columns 2 and 6–7, the dependent variable equals the (log) amount of the loan lender bank i grants to borrower bank j on day t. In columns 3–4 and 8–9, the dependent variable equals the spread between the interest rate of the loan lender bank i grants to borrower bank j on day t and the interest rate paid on excess reserves (IOER) on day t. 'Cross-border (foreign lender)' is a dummy variable that equals one if lender bank i and borrower bank j are headquartered in different countries and their bank parents are of different nationality , and zero otherwise. 'Domestic (foreign lender)' is a dummy variable that equals one if lender bank i and borrower bank j are headquartered in the same countries and their bank parents are of different nationality, and zero otherwise. 'Crisis' refers to the Euribor-OIS spread (3M) for the Lehman crisis, and to the mean (log) periphery CDS spread for sovereign debt crisis, which we scaled such that the lowest value in each subsample equals zero, and the highest value equals one. All regressions include for a clean comparison an additional interaction term between 'Crisis' and 'Cross-border (domestic lender)', a dummy variable that equals one if lender bank i and borrower bank j are headquartered in the same countries and their bank parents are of the same nationality , and zero otherwise. Estimated coefficients are omitted to avoid cluttering. The definition of our main variables can be found in the Appendix Table A1. Fixed effects are included ('Yes') as indicated. Where possible, a constant is included but its estimated value is not shown to avoid cluttering. Robust standard errors are presented in parentheses and are clustered at the bank-to-bank level. *** p<.01, ** p<0.05, * p<0.1.

TABLE 6: CROSS-BORDER DIFFERENTIAL IN THE TERM SEGMENT

	Dependent Variable:					
	Access		Amount		Spread	
	(1)	(2)	(3)	(4)	(5)	(6)
Crisis * Cross-border * Term Loan	–18.3713**	–16.0199**	–1.8224**	–1.6823*	0.9119***	0.5030**
	(8.02)	(8.13)	(0.41)	(0.91)	(0.22)	(0.25)
Lower-order Interaction Terms	Yes	Yes	Yes	Yes	Yes	Yes
Borrower * Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Lender * Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes	Yes	Yes
Cross-border * Time FE	No	Yes	No	Yes	No	Yes
Cross-border * Term FE	No	Yes	No	Yes	No	Yes
Term * Time FE	No	Yes	No	Yes	No	Yes
Observations	192,868	192,868	8,807	8,807	8,807	8,807
R-squared	0.355	0.361	0.954	0.960	0.997	0.998

This table shows the cross-border differential in the extensive and intensive margin of term credit (relative to overnight credit) during the Lehman crisis (August 18, 2008, to November 9, 2008, daily frequency). In columns 1 and 2, the dependent variable equals one if lender bank i grants a loan (any maturity) to borrower bank j on day t, and zero if no loan is granted. In columns 3 and 4, the dependent variable equals the (log) amount of the loan lender bank i grants to borrower bank j on day t. In columns 3 and 6, the dependent variable equals the spread between the interest rate of the loan lender bank i grants to borrower bank j on day t and the interest rate paid on excess reserves (IOER) on day t. 'Cross-border' is a dummy variable that equals one if lender bank i and borrower bank j are headquartered in different countries, and zero otherwise. 'Crisis' refers to the Euribor-OIS spread (3M), which we scaled such that the lowest value equals zero, and the highest value equals one. In columns 1 and 2, 'Term Loan' is a dummy variable that equals one for any loan with a maturity longer than overnight, and zero otherwise. In columns 3 to 6, 'Term Loan' is a dummy variable that takes the value of one for any loan with a maturity longer than two weeks, and zero otherwise. The definition of our main variables can be found in the Appendix Table A1. Fixed effects are included ('Yes') or not ('No') as indicated. Where possible, a constant is included but its estimated value is not shown to avoid cluttering. Robust standard errors are presented in parentheses and are clustered at the bank-to-bank level. *** p<.01, ** p<0.05, * p<0.1.

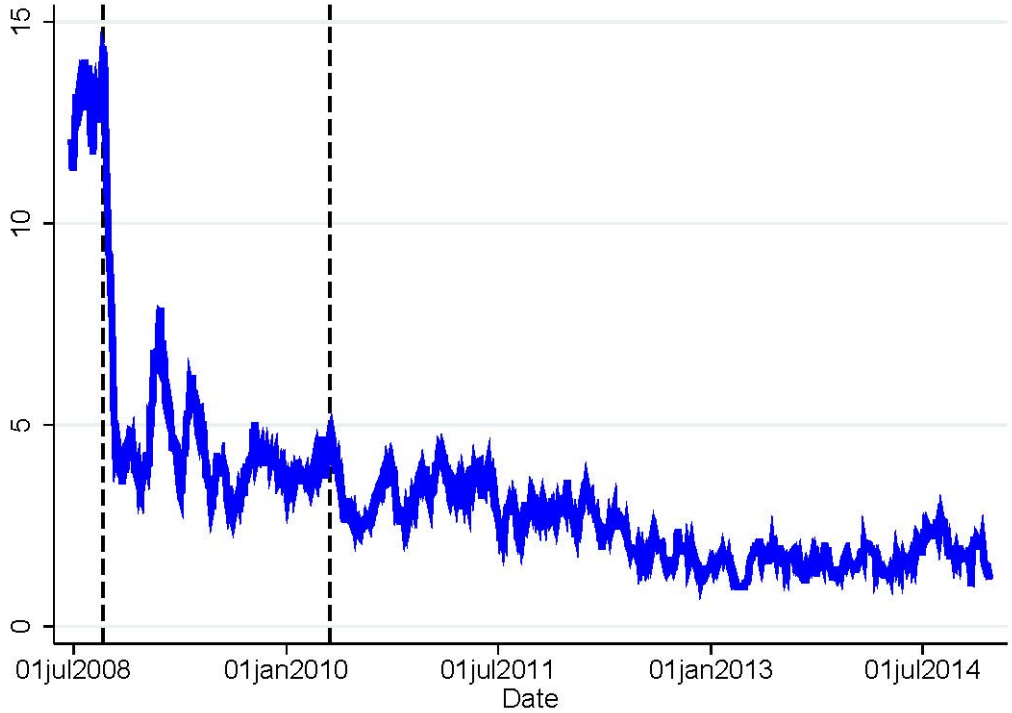
TABLE 7: MONETARY POLICY AND CROSS-BORDER LENDING

	Sample: +/– 1 Week Around Monetary Policy Event				
Monetary Policy Event:	**Full Allotment**	**First 3-Yr LTRO**	**Second 3-Yr LTRO**	**Draghi's Whatever-it-takes-speech**	**OMT Announcement**
	(October 15, 2008)	(December 21, 2011)	(February 29, 2012)	(July 26, 2012)	(August 2, 2012)
PANEL A - Dependent Variable: Access	(1)	(2)	(3)	(4)	(5)
Monetary Policy * Cross-border (foreign lender)	1.7163**	-0.7530	2.8273***	1.5403[a]	2.3278*
	(0.89)	(0.77)	(1.08)	(1.02)	(1.24)
Monetary Policy * Domestic (foreign lender)	0.7043	-0.8526	3.4705	-3.2278	-4.2335
	(1.52)	(1.20)	(2.51)	(2.45)	(4.05)
Borrower * Time FE	Yes	Yes	Yes	Yes	Yes
Lender * Time FE	Yes	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes	Yes
Observations	27,760	22,280	15,642	14,443	11,910
R-squared	0.551	0.550	0.509	0.619	0.631
PANEL B - Dependent Variable: Amount	(1)	(2)	(3)	(4)	(5)
Monetary Policy * Cross-border (foreign lender)	0.0747	-0.1265	-0.0668	-0.0270	0.0576
	(0.08)	(0.08)	(0.20)	(0.10)	(0.19)
Monetary Policy * Domestic (foreign lender)	0.0515	-0.0019	-0.0712	-0.2303	-0.1855
	(0.11)	(0.12)	(0.16)	(0.22)	(0.13)
Cross-border (foreign lender)	-0.4372***	-0.1889	-0.2107	0.2749	1.3029**
	(0.14)	(0.13)	(0.34)	(0.42)	(0.53)
Domestic (foreign lender)	-0.1040	-0.4440*	-0.7087**	0.1802	0.4030
	(0.21)	(0.24)	(0.28)	(0.49)	(0.65)
Borrower FE	Yes	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Observations	1,221	685	338	470	410
R-squared	0.856	0.886	0.891	0.892	0.879
PANEL C - Dependent Variable: Spread	(1)	(2)	(3)	(4)	(5)
Monetary Policy * Cross-border (foreign lender)	0.0144	0.0945***	0.0002	0.0159	-0.0021
	(0.03)	(0.03)	(0.02)	(0.01)	(0.02)
Monetary Policy * Domestic (foreign lender)	0.0169	0.0851***	0.0050	0.0114	0.0130*
	(0.03)	(0.03)	(0.02)	(0.01)	(0.01)
Cross-border (foreign lender)	-0.0966**	-0.0914***	-0.0178	0.1535	0.2321
	(0.04)	(0.03)	(0.01)	(0.14)	(0.15)
Domestic (foreign lender)	-0.0369	-0.0693*	-0.0032	-0.0487	-0.1202***
	(0.05)	(0.04)	(0.02)	(0.05)	(0.04)
Borrower FE	Yes	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Observations	1,221	685	338	470	410
R-squared	0.808	0.850	0.730	0.896	0.940

This table shows the impact of the Eurosystem's main monetary policy measures on the cross-border differential in the extensive and intensive margin of credit. For identification, we use a window of +/– 1 week around the respective monetary policy event. In Panel A, the dependent variable is a dummy variable that equals one if lender bank i grants an overnight loan to borrower bank j on day t, and zero otherwise. The dependent variable in Panel B is the (log) amount of the loan lender bank i grants to borrower bank j on day t. The dependent variable in Panel C is the spread (in percentage points) between the interest rate of the loan lender bank i grants to borrower bank j on day t and the interest rate paid on excess reserves (IOER) on day t. For a thorough description of the dependent variables, refer to Section 3. The independent variable 'Monetary Policy' is a dummy variable that equals one the week after the date of the respective monetary policy event that is provided in the table, and zero in the week before the given event. 'Cross-border' is a dummy variable that equals one if lender bank i and borrower bank j are headquartered in different countries, and zero otherwise. The definition of our main variables can be found in the Appendix Table A1. Fixed effects are included ('Yes'). Where possible a constant is included but its estimated value is not shown to avoid cluttering. Robust standard errors are presented in parentheses and are clustered at the bank-to-bank level. *** p<.01, ** p<0.05, * p<0.1.

APPENDIX

FIGURE A1: NUMBER OF CROSS-BORDER TERM LOANS



This figure shows the total number of cross-border trades per day (30-day moving average) over our sample from July 01, 2008 through December 31, 2014. The first dashed vertical line refers to September 15, 2008, i.e., the day on which Lehman Brothers filed for bankruptcy. The second dashed vertical line denotes April 23, 2010, the day the Greek government activated the financial support mechanism.

TABLE A1: DEFINITION OF MAIN VARIABLES

Variable	Defintion
Access(i,j,t)	Binary variable that equals the value one if lender bank i engages in at least one overnight interbank transaction with borrower bank j on day t, and zero otherwise.
Amount(i,j,t)	Logarithm of the aggregate overnight interbank lending amount (in EUR million) that lender i provides to borrower j on day t.
Spread(i,j,t)	Difference (in percentage points) between the (volume-weighted) interest rate that borrower j pays to lender i for overnight interbank transactions on day t and the interest rate paid on excess reserves (IEOR) on the same day t.
Access(j,t)	Binary variable that equals the value one if borrower j engages in at least one overnight interbank transaction on day t, and zero otherwise.
Amount(j,t)	Logarithm of the aggregate overnight interbank lending amount (in EUR million) that bank j borrows on day t.
Spread(j,t)	Difference (in percentage points) between the (volume-weighted) interest rates that borrower j pays for overnight interbank loans on day t and the interest rate paid on excess reserves on the same day t.
Euribor-OIS(t)	Difference (in percentage points) between the three-month Euribor rate and the correspondingly-dated overnight index swap (OIS) rate on any given day t. We scale the variable such that the lowest value in sample equals zero, and the highest value equals one.
Mean Periphery CDS(t)	Average of the logarithm of the five-year periphery country CDS spread (in basis points) on any given day t. We scale the variable such that the lowest value in sample equals zero, and the highest value equals one.
Cross-border(i,j)	Binary variable that equals the value one if lender i and borrower j are headquartered in different countries, and zero otherwise.
GIPS Bank(j)	Binary variable that equals the value one if the borrowing bank is headquartered in one of the GIPS countries, i.e., Greece, Ireland, Portugal, and Spain, and zero otherwise.
Creditor Rights(j)	Index from La Porta et al. (1998) and Djankov, McLiesh, and Shleifer (2007) that measures the protection of creditor rights in the borrower country.
Public Debt(j)	Borrower-country's public debt as a fraction of the country's GDP as of 2007 for the Lehman crisis period and as of 2009 for the sovereign crisis period.
Large Bank(j)	Binary varibale that equals the value one if the borrowing bank has total asset size above the cross-sectional median as at 2007 (2009) for the Lehman crisis period (sovereign crisis period), and zero otherwise.
High Leverage Bank(j)	Binary varibale that equals the value one if the borrowing bank has a leverage ratio above the cross-sectional median as at 2007 (2009) for the Lehman crisis period (sovereign crisis period), and zero otherwise.
Large GIPS Bank(j)	Binary varibale that equals the value one if the borrowing bank is a GIPS banks and has total asset size above the cross-sectional median as at 2007 (2009) for the Lehman crisis period (sovereign crisis period), and zero otherwise.
High Leverage GIPS Bank(j)	Binary varibale that equals the value one if the borrowing bank is a GIPS banks and has a leverage ratio above the cross-sectional median as at 2007 (2009) for the Lehman crisis period (sovereign crisis period), and zero otherwise.
Monetary Policy(t)	Binary variable that equals the value of one on any day after the respective monetary policy change, and zero in the week before. We consider the three main expansionary monetary policy enacted over our two crisis periods: during the Lehman crisis, (i) the fixed-rate full allotment (Full Allotment), and during the sovereign debt crisis, (ii) the two 3-year long-term refinancing operations (First 3-Yr LTRO), (iii) and Draghi's "whatever-it-takes" speech including the related outright monetary transactions (OMT announcement) program.
Full Allotment(t)	Binary variable that equals the value one as of October 15, 2008, when the Eurosystem implemented the fixed-rate full allotment policy and, zero on any other day.
First 3-Yr LTRO(t)	Binary variable that equals the value one as of October 21, 2011, when the Eurosystem implemented the first 3-year LTRO, and zero on any other day.
Second 3-Yr LTRO(t)	Binary variable that equals the value one as of February 29, 2012, when the Eurosystem implemented the second 3-year LTRO, and zero on any other day.
Draghi's Whatever-it-takes-speech(t)	Binary variable that equals the value one as of July 26, 2012, when the Draghi gave his "whatever it takes" speech, and zero on any other day.
OMT announcement(t)	Binary variable that equals the value one as of August 2, 2012, when the ECB announced the outright monetary transactions (OMT) program, and zero on any other day.

TABLE A2: SUMMARY STATISTICS DEPENDING ON CROSS-BORDER AND DOMESTIC

PANEL A: CROSS-BORDER

	Lehman Crisis						Sovereign Crisis					
Variable	**Mean**	**Median**	**Std**	**p(10)**	**p(90)**	**Obs**	**Mean**	**Median**	**Std**	**p(10)**	**p(90)**	**Obs**
Access	5.23	0.00	22.27	0.00	0.00	108,780	1.27	0.00	11.18	0.00	0.00	2,462,496
Loan Amount	198.19	100.00	235.17	24.48	500.00	3,610	268.05	150.00	370.61	45.00	600.00	14,626
Amount	4.72	4.61	1.13	3.20	6.21	3,610	5.00	5.01	1.08	3.81	6.40	14,626
Spread	0.88	1.01	0.32	0.25	1.10	3,611	0.22	0.14	0.22	0.02	0.55	14,626

PANEL B: DOMESTIC

	Lehman Crisis						Sovereign Crisis					
Variable	**Mean**	**Median**	**Std**	**p(10)**	**p(90)**	**Obs**	**Mean**	**Median**	**Std**	**p(10)**	**p(90)**	**Obs**
Access	8.37	0.00	27.70	0.00	0.00	79,380	3.41	0.00	18.16	0.00	0.00	1,789,920
Loan Amount	109.27	50.00	239.95	10.00	200.00	3,738	131.75	50.00	266.94	10.00	300.00	23,668
Amount	3.95	3.91	1.18	2.30	5.30	3,738	3.94	3.91	1.29	2.30	5.70	23,668
Spread	0.80	1.00	0.39	0.12	1.13	3,738	0.23	0.13	0.24	0.02	0.58	23,668

This table reports summary statistics of our dependent variables used in the paper conditional on cross-border and domestic trades, across two sub-periods. We define 'Lehman Crisis' (August 18, 2008, to November 9, 2008, daily frequency), and 'Sovereign Crisis' (July 1, 2009, to December 31, 2014, daily frequency). 'Access' denotes the extensive margin of credit. 'Loan Amount' reflects the loan volume (in EUR million), 'Amount' refers to the logarithm of 'Loan Amount'. 'Spread' reflects the difference (in percentage points) between the interest rate of a loan and the interest rate paid on excess reserves (IOER). For a thorough description of the dependent variables, refer to Section 3.

TABLE A3: UNOBSERVABLE BORROWER RISK AND FLIGHT TO QUALITY

	Lehman Crisis						Sovereign Crisis					
	Dependent Variable:											
	Access		Volume		Spread		Access		Volume		Spread	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Crisis * Cross-border	-2.8138***	-2.4846***	-0.0645	-0.1245**	-0.0712*	0.0697***	-1.1447***	-0.7925**	0.3718**	-0.1004**	-0.1292	0.1361***
	(0.80)	(0.83)	(0.18)	(0.06)	(0.04)	(0.02)	(0.38)	(0.40)	(0.18)	(0.05)	(0.09	(0.04)
Lower Order Terms	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes	Yes
Borrower * Time FE	No	Yes	No	No	No	No	No	Yes	No	No	No	No
Lender * Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pair FE	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	188,160	188,160	7,348	7,348	7,348	7,348	4,252,416	4,252,416	38,294	38,294	38,294	38,294
R-squared	0.154	0.360	0.750	0.919	0.610	0.630	0.158	0.306	0.812	0.862	0.750	0.947

This table replicates our main results from Tables 2 and 3, respectively, but excludes controls for observed and unobserved time-varying borrower heterogeneity (i.e., excluding borrower*time fixed effects and pair fixed effects). The results are presented in column 1, 3, 5, and 7, 9, and 11 for the 'Lehman Crisis" and the 'Sovereign Crisis', respectively. For the sake of comparison, we also report our main results with the full set of fixed effects from Table 2 and 3 in column 2, 4, 6, and 8, 10, and 12 for the 'Lehman Crisis" and the 'Sovereign Crisis', respectively. For more details, refer to Table 2 and 3. Robust standard errors are presented in parentheses and are clustered at the bank-to-bank level. *** p<.01, ** p<0.05, * p<0.1.

TABLE A4: MONETARY POLICY AND CROSS-BORDER LENDING

	Sample: +/– 1 Week Around Monetary Policy Event				
Monetary Policy Event:	**Full Allotment**	**First 3-Yr LTRO**	**Second 3-Yr LTRO**	**Draghi's Whatever-it-takes-speech**	**OMT Announcement**
	(October 15, 2008)	(December 21, 2011)	(February 29, 2012)	(July 26, 2012)	(August 2, 2012)
PANEL A - Dependent Variable: Access	(1)	(2)	(3)	(4)	(5)
Monetary Policy * Cross-border (foreign lender)	1.7163**	-0.7530	2.8273***	1.5403[a]	2.3278*
	(0.89)	(0.77)	(1.08)	(1.02)	(1.24)
Monetary Policy * Domestic (foreign lender)	0.7043	-0.8526	3.4705	-3.2278	-4.2335
	(1.52)	(1.20)	(2.51)	(2.45)	(4.05)
Borrower * Time FE	Yes	Yes	Yes	Yes	Yes
Lender * Time FE	Yes	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes	Yes
Observations	27,760	22,280	15,642	14,443	11,910
R-squared	0.551	0.550	0.509	0.619	0.631
PANEL B - Dependent Variable: Amount	(1)	(2)	(3)	(4)	(5)
Monetary Policy * Cross-border (foreign lender)	0.0753	-0.1369*	-0.0630	-0.0117	0.0663
	(0.08)	(0.08)	(0.21)	(0.10)	(0.18)
Monetary Policy * Domestic (foreign lender)	0.0520	-0.0075	-0.0854	-0.2257	-0.1746
	(0.11)	(0.12)	(0.18)	(0.22)	(0.13)
Monetary Policy	-0.0150	0.1385**	-0.0184	0.0154	0.0388
	(0.06)	(0.06)	(0.15)	(0.06)	(0.10)
Cross-border (foreign lender)	-0.4335***	-0.1969	-0.1593	0.2239	1.2523**
	(0.14)	(0.13)	(0.36)	(0.43)	(0.49)
Domestic (foreign lender)	-0.1069	-0.4605*	-0.6527**	0.1930	0.4376
	(0.21)	(0.24)	(0.30)	(0.50)	(0.66)
Borrower FE	Yes	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes	Yes
Observations	1,221	685	338	470	410
R-squared	0.855	0.884	0.885	0.890	0.876
PANEL C - Dependent Variable: Spread	(1)	(2)	(3)	(4)	(5)
Monetary Policy * Cross-border (foreign lender)	0.0360	0.0992***	-0.0021	0.0162	-0.0008
	(0.03)	(0.04)	(0.02)	(0.01)	(0.02)
Monetary Policy * Domestic (foreign lender)	0.0291	0.0811*	-0.0028	0.0123*	0.0138**
	(0.03)	(0.04)	(0.02)	(0.01)	(0.01)
Monetary Policy	-0.0299	-0.1511***	-0.0315***	-0.0098	-0.0125**
	(0.02)	(0.04)	(0.01)	(0.01)	(0.01)
Cross-border (foreign lender)	-0.1287***	-0.0883**	-0.0160	0.1594	0.2209
	(0.05)	(0.04)	(0.01)	(0.15)	(0.15)
Domestic (foreign lender)	-0.0953*	-0.0349	-0.0005	-0.0708	-0.1364***
	(0.06)	(0.05)	(0.02)	(0.05)	(0.04)
Borrower FE	Yes	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes	Yes
Observations	1,221	685	338	470	410
R-squared	0.709	0.764	0.720	0.884	0.929

This table shows the impact of the Eurosystem's main monetary policy measures on the cross-border differential in the extensive and intensive margin of credit. For identification, we use a window of +/– 1 week around the respective monetary policy event. In Panel A, the dependent variable is a dummy variable that equals one if lender bank i grants an overnight loan to borrower bank j on day t, and zero otherwise. The dependent variable in Panel B is the (log) amount of the loan lender bank i grants to borrower bank j on day t. The dependent variable in Panel C is the spread (in percentage points) between the interest rate of the loan lender bank i grants to borrower bank j on day t and the interest rate paid on excess reserves (IOER) on day t. For a thorough description of the dependent variables, refer to Section 3. The independent variable 'Monetary Policy' is a dummy variable that equals one the week after the date of the respective monetary policy event that is provided in the table, and zero in the week before the given event. 'Cross-border' is a dummy variable that equals one if lender bank i and borrower bank j are headquartered in different countries, and zero otherwise. The definition of our main variables can be found in the Appendix Table A1. Fixed effects are included ('Yes'). Where possible a constant is included but its estimated value is not shown to avoid cluttering. Robust standard errors are presented in parentheses and are clustered at the bank-to-bank level. *** p<.01, ** p<0.05, * p<0.1.