The Effect of Central Bank Liquidity Injections on Bank Credit Supply *

Luisa Carpinelli
Bank of Italy

Matteo Crosignani
Federal Reserve Board

January 2018

Abstract

We analyze central bank provisions of collateralized liquidity to banks following a wholesale funding dry-up. Combining firm-level data from the Italian loan credit registry with supervisory data on security-level holdings, we examine the European Central Bank's three-year Long Term Refinancing Operations. We find that (i) long-term, but not short-term, central bank liquidity helped banks hit by the dry-up restore their credit supply to firms; (ii) banks used most liquidity to buy government bonds; and (iii) a government guarantee, by granting banks hit by the dry-up access to central bank liquidity, was necessary for the transmission of liquidity to firms.

JEL: E50, E58, G21, H63

Keywords: Central Bank Liquidity, Wholesale Funding, Bank Credit, Government Bonds, Government Guarantees

*We are grateful to Viral Acharya, Philipp Schnabl, Alexi Savov, and Andres Liberman for many helpful comments. We thank our discussants Alessandro Barattieri, Michele Boldrin, Marco Di Maggio, Umit Gurun, Florian Heider, Sven Klinger, David Miles, Camelia Minoiu, and Matthew Plosser. We also thank Marcello Bofondi, Eduardo Dávila, Antonella Foglia, Xavier Gabaix, Gary Gorton, Valentina Michelangeli, Holger Mueller, Stefan Nagel, Stefano Neri, José-Luis Peydró, Matteo Piazza, Amiyatosh Purnanandam, Joao Santos, Johannes Stroebel, Toni Whited, Luigi Zingales, and seminar and conference participants at Bank of Italy, NYU Stern, McGill Desautels, European Central Bank, Boston Fed, UCLA Anderson, Michigan Ross, NY Fed, Fordham, Fed Board, AFA Meetings in Chicago, Fifth MoFiR Workshop on Banking, Fourth Workshop in Macro Banking and Finance, Third ECB Forum on Central Banking (Sintra), "Credit Solutions for the Real Economy" conference, "The Impact of Extraordinary Monetary Policy on the Financial Sector" (Atlanta Fed) conference, MFM Group Winter 2017 Meeting, Workshop on Empirical Monetary Economics (Sciences Po), RFS "Banks, Systemic Risk, Measurement and Mitigation" conference, BdP conference on Financial Intermediation, Yale "Fighting a Financial Crisis" conference, and Oxford-NY Fed Monetary Economics conference for valuable comments. We also thank Alberto Coco, Stefania De Mitri, Roberto Felici, and Nicola Pellegrini for helping us interpret the data and understand the institutional setting. Matteo Crosignani is grateful for the support of the Macro Financial Modeling Group (Becker Friedman Institute). The views expressed in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System, the European Central Bank, Bank of Italy, or anyone associated with these institutions. All results have been reviewed to ensure that no confidential information is disclosed. All errors are our own. First draft: December 2015. Emails: luisa.carpinelli@bancaditalia.it and matteo.crosignani@frb.gov.

1 Introduction

During the recent financial crises in the United States, the United Kingdom, and Europe, central banks provided liquidity to banks to counter ongoing credit contractions.[1] These interventions are based on the observation that banks hold fewer liquid assets than liquid liabilities and are therefore vulnerable to funding dry-ups, which can induce them to engage in costly fire sales, reducing their credit supply. By providing liquidity, central banks can help banks restore their credit supply. While intuitive and dating back to Bagehot (1873), this theory has been proven elusive to test.

We contribute to this seminal literature by analyzing how the European Central Bank (ECB) three-year Long-Term Refinancing Operations (LTRO) affected Italian banks' credit supply and holdings of securities. Through this operation, adopted at the peak of the eurozone crisis, the ECB extended the maturity of its liquidity provision from a few months to three years with the stated goal to "support bank lending and liquidity in the euro area money markets."[2] We analyze the transmission through Italian banks, which, having experienced a sharp reduction of their foreign wholesale funding before the intervention, provide a rare case of a dry-up followed by a liquidity injection.[3] In this context, we combine supervisory data on security-level holdings with the national credit registry, obtaining an unprecedented view of the two largest asset classes held by banks.

Our analysis provides three main findings. First, we find that the long maturity of central bank liquidity allowed banks hit by the dry-up to *restore* their credit supply to firms. Short-term liquidity provisions in place during the dry-up were indeed unable to stop the ongoing bank credit contraction.

[1] In the United States, the Term Asset-Backed Securities Loan Facility and the Term Auction Facility helped banks refinance their short-term debt. Outside the United States, the Bank of England's Funding for Lending Scheme and the European Central Bank's Long Term Refinancing Operations (LTROs) provided long-term funding to banks.

[2] The announcement is available at https://www.ecb.europa.eu/press/pr/date/2011/html/pr111208_1.en.html.

[3] We observe a stark contraction – equivalent to 3.6% of the aggregate size of our sample banks – of wholesale funding from June to December 2011, entirely driven by foreign deposits (mainly U.S.-held certificates of deposit and commercial paper) and eurozone centrally cleared repurchase agreements (see Chernenko and Sunderam (2014)).

Second, we find that banks used most central bank liquidity to buy domestic government bonds, an asset class usually overlooked in the literature on monetary policy transmission. In particular, banks not exposed to the dry-up did not increase their credit to firms and almost entirely used central bank liquidity to buy domestic government bonds. Third, we find that banks hit by the dry-up – having eroded their holdings of central bank eligible collateral during the dry-up – could access the central bank only because of a government guarantee program.

We proceed in two steps. First, we track the evolution of bank credit supply depending on banks' reliance on the foreign wholesale market. We disentangle demand and supply of credit, selecting firms that borrow from two or more banks and plugging firm fixed effects in our specifications.[4] More specifically, we compare the stock of credit granted to the same firm by banks differentially exposed to the dry-up during (i) the "normal" period (December 2010 to June 2011) when funding markets are well functioning, (ii) the "dry-up" period (June 2011 to December 2011) when we observe the dry-up, and (iii) the "intervention" period (December 2011 to June 2012) after the LTRO. High-exposure banks (top decile of the distribution) reduced their credit supply about 1 percentage point more than low-exposure banks (bottom decile) during the dry-up (on a baseline contraction of 2.2%) and restored it during the intervention period. Our results are robust to the inclusion of bank-firm fixed effects and time-varying bank balance sheet variables, which control for the non-random composition of funding (exposed banks are larger and more levered).

Second, we use a regulatory intervention by the Italian government to link the endogenous bank-level uptake of central bank liquidity (banks *choose* how much to borrow) to bank portfolio choice. In particular, we document that bank-level LTRO borrowing and bank exposure to the dry-up are uncorrelated, as the LTRO's attractive pricing induced banks to borrow at the ECB *regardless* of

[4]We confirm that this subsample (275,000 firms, equivalent to 28% of our sample) is comparable to the full sample.

their exposure to the dry-up. Right after the LTRO announcement, the Italian government offered banks a guarantee, against the payment of a fee, on securities *otherwise ineligible* at the ECB. As the ECB accepts all government-guaranteed assets as collateral, the program effectively allowed banks to increase their borrowing capacity at the central bank. The degree to which banks used this government guarantee – backing 57% of the total LTRO borrowing of our sample banks – depended on the dry-up. Banks that were relatively unaffected by the dry-up borrowed at the LTRO by pledging non-government-guaranteed collateral, thus avoiding the fee. Banks hit by the dry-up *self-selected* in the government guarantee program to access ECB liquidity, having eroded their holdings of ECB-eligible collateral during the dry-up.[5]

Consistent with the time-series evolution of bank credit supply to firms, we find that LTRO liquidity backed by government-guaranteed securities drove the restoration of private credit supply. However, banks used most central bank liquidity to buy domestic government bonds. Banks exposed to the dry-up invested, for every euro borrowed at the LTRO, €0.13 in private credit and €0.44 in (domestic) government bonds. Less-exposed banks did not use LTRO liquidity to increase private credit and invested, for every euro borrowed, €0.83 in (domestic) government bonds, which are more attractive than other high-yield securities because of their zero regulatory risk weight and collateral eligibility at the ECB.[6] Because it granted banks hit by the dry-up access to the LTRO, the government guarantee was necessary for the transmission of central bank liquidity to firms.

Overall, of the €181.5 billion borrowed, our sample banks invested €22.6 billion in private credit and €82.7 billion in government bonds. The effect on private credit supply is nevertheless sizable. In a counterfactual exercise, we find that without the LTRO, private credit would have contracted

[5]The goal of the government guarantee was exactly to "allow banks to restore their medium-long term funding."

[6]In addition, *domestic* government bonds can be used to satisfy government moral suasion (Ongena et al. (2016), Ivashina and Becker (forthcoming)) and risk-shift on insured depositors (Drechsler et al. (2016), Crosignani (2017)).

5.6% in the six months following the intervention instead of the observed 3.6%. In the cross section of banks, high-leverage banks drove the increase in credit supply. In the cross section of firms, credit was restored especially to those with low profitability. Once we collapse our data at the firm-level, we find that firms were unable to completely substitute missing credit from exposed banks with new credit from non-exposed banks during the dry-up and took advantage of the LTRO-induced credit supply expansion by increasing total borrowing after the intervention.

Our contribution is twofold. First, after documenting the well-established pass-through of bank negative funding shocks to credit supply (Khwaja and Mian (2008), Paravisini (2008), Chava and Purnanandam (2011), Schnabl (2012), Iyer et al. (2014)), we show that a subsequent central bank liquidity provision, *if long term*, allows banks to restore their credit supply during crises. In particular, this type of intervention – related to the seminal lender of last resort literature (Bagehot (1873)) – replenishes bank funding sources following a dry-up and is therefore inherently different from policies that affect the value of securities held by banks such as large scale asset purchases (Krishnamurthy and Vissing-Jorgensen (2013), Chodorow-Reich (2014a), Chakraborty et al. (2016), Di Maggio et al. (2016), Kandrac and Schlusche (2017), Darmouni and Rodnyansky (2017), Kurtzman et al. (2017)) and policies like yield curve flattening (Foley-Fisher et al. (2016)), indirect recapitalizations (Acharya et al. (2017)), and negative rates (Heider et al. (2017)).[7]

Second, we find that central bank liquidity is mainly used to buy domestic government bonds. Being the first to jointly analyze securities and loans to firms – the two largest asset classes held by banks – we add to the literature on the transmission of monetary policy through banks (Bernanke and Blinder (1992), Kashyap et al. (1994), Stein (1998), Kashyap and Stein (2000)), typically

[7]Large scale asset purchases operate through banks by increasing the value of some of their assets (e.g., Treasury securities or mortgage-backed securities), which, in turn, causes banks to rebalance their portfolios. Similarly, announcements like Draghi's OMT speech can lead to indirect recapitalizations of weak banks (Acharya et al. (2017)).

focused on credit to firms (Jimenez et al. (2012), Jimenez et al. (2014), Williams (2016), Drechsler et al. (forthcoming)) or households (Agarwal et al. (forthcoming), Di Maggio et al. (forthcoming)).[8]

Our analysis also informs policy regarding the design and side effects of central bank liquidity provisions during crises. The government guarantee suggests that central bank collateral eligibility plays a key role for the transmission of liquidity to bank credit (Choi and Santos (2017), Van Bekkum et al. (forthcoming), Cahn et al. (2017)). The transmission to purchases of domestic government bonds suggests that central bank liquidity might exacerbate the "doom loop" between banks and sovereigns (Farhi and Tirole (forthcoming), Brunnermeier (2015)).

Our findings also relate to the literature on the eurozone crisis. In particular, the ECB's extraordinary policies are analyzed by Krishnamurthy et al. (2017), Garcia-de-Andoain et al. (2016), Heider et al. (2017), Grosse-Rueschkamp et al. (2017), Casiraghi et al. (2013), Crosignani et al. (2017), van der Kwaak (2017), Daetz et al. (2016), Alves et al. (2016), Andrade et al. (2017), and Garcia-Posada and Marchetti (2016).[9] While the last four papers analyze the effect of the LTRO and bank credit, we contribute by (i) jointly examining credit to firms and holdings of securities, (ii) analyzing a setting with an ongoing bank credit contraction caused by a funding dry-up, and (iii) exploiting a government program unique to our setting to identify the transmission channel.[10]

The rest of the paper is structured as follows. Section 2 describes the empirical setting. Section 3 documents the evolution of bank credit supply. Section 4 analyzes the effect of central bank liquidity on bank credit supply and holdings of securities. Section 5 examines the heterogeneity of

[8] Crosignani et al. (2017) and Peydró et al. (2017) use security-level data to analyze banks' holdings of eligible collateral during the LTRO and the role of bank capital for the risk-taking channel of monetary policy, respectively.

[9] The pass-through of sovereign risk is analyzed by Bocola (2016), Popov and van Horen (2015), Gennaioli et al. (2016), De Marco (forthcoming), Bottero et al. (2017), Cingano et al. (2016), Bofondi et al. (forthcoming), Acharya et al. (2016), and Beltratti and Stulz (2017). In the United States, the effect of the crisis on credit supply is analyzed by Chodorow-Reich (2014b), Ivashina and Scharfstein (2010), Benmelech et al. (2017), and Puri et al. (2011).

[10] Alves et al. (2016), Andrade et al. (2017), and Garcia-Posada and Marchetti (2016) use credit registry data from Portugal, France, and Spain, respectively. Daetz et al. (2016) use eurozone syndicated loan data.

the effects across banks and firms. Section 6 analyzes firms' borrowing. Section 7 concludes.

2 Setting and Data

Our laboratory is Italy from December 2010 to June 2012. In this section, we describe the Italian macroeconomic environment during this period, show that Italian banks are hit by a wholesale funding dry-up in the six months before the LTRO, and describe our data set.

2.1 Macroeconomic Picture

Sovereign yields of core and "peripheral" (Greece, Italy, Ireland, Portugal, Spain) eurozone countries first diverged in 2009, driven by concerns about public debt sustainability of peripheral countries.

The crisis in Italy started in 2009 and can be divided into two phases. During the first phase, from 2009 to June 2011, Italian government bond prices fell 25% and sovereign CDS spreads doubled to reach 200 basis points as investors became concerned that the crisis affecting Greece and Portugal was going to spread to Italy. Political uncertainty, large government debt, and the long-standing slack in GDP growth made, and still make, Italy very vulnerable to shocks. Investors' concerns materialized in June 2011 when S&P downgraded the Greek debt to CCC and announcements of involving the private sector in Greek debt restructuring led to contagion in Italy.

During the second phase, from June to December 2011, sovereign CDS spreads and bond yields started increasing very sharply, reaching record highs in November 2011.[11] As concerns about the solvency of the sovereign and its financial sector mounted, Italian banks experienced a dry-up of

[11] Greece was downgraded five times by the three main credit rating agencies in June and July. As documented in Bofondi et al. (forthcoming), sovereign yields then also abruptly rose in Italy, as investors feared that Italy might have also been unable to repay its public debt. With sovereign yields rising, support for the Italian government fell, forcing Prime Minister Silvio Berlusconi to resign in favor of the technocratic government led by Mario Monti. In the Online Appendix, we show the time series evolution of various macroeconomic variables around this time.

their wholesale funding driven by withdrawals of foreign investors.

2.2 Bank Funding during the Crisis

During the first phase of the crisis, from January 2009 to June 2011, retail funding slightly increased, whereas wholesale funding dropped by 3 percentage points of total assets. Short-term central bank liquidity partially substituted for this drop, reaching 2.2% of total assets in June 2011. During the second phase, in the six months from June to December 2011, wholesale funding declined 5 percentage points. This drain in funds was offset by short-term central bank liquidity, which, at the end of 2011, represented 5.7% of total assets.

This dry-up in wholesale funds, also called a "quiet run" by Chernenko and Sunderam (2014), was driven by a sharp reduction in *foreign* funding, mainly certificates of deposits and commercial paper held by U.S. money market funds and eurozone centrally cleared repurchase agreements. In Figure 1, we illustrate the €97 billion drop in aggregate wholesale funding driven by foreign withdrawals between June and December 2011, equivalent to 3.6% of the aggregate size of our sample banks. In December 2011, the ECB announced the LTRO and the dry-up stopped.[12]

The ECB started providing extraordinary liquidity to banks as early as October 2008, when it switched to a "fixed-rate full-allotment" mode for its refinancing operations. In this new regime – still ongoing – eurozone banks can obtain unlimited *short-term* liquidity from the central bank at a fixed rate if they pledge sufficient collateral. The ECB applies a haircut that depends on the asset class, residual maturity, rating, and coupon structure of the pledged security. There is no limit on how much a bank can borrow, provided that it pledges sufficient collateral.[13]

[12] In Figure A.1 in the Appendix, we illustrate the time series evolution of household deposits, firm deposits, domestic interbank funding, and bond financing. The foreign wholesale dry-up is also described by Chernenko and Sunderam (2014), Ivashina et al. (2015), and Giannone et al. (2012).

[13] Eligible collateral includes government and regional bonds, covered bonds, corporate bonds, asset-backed securi-

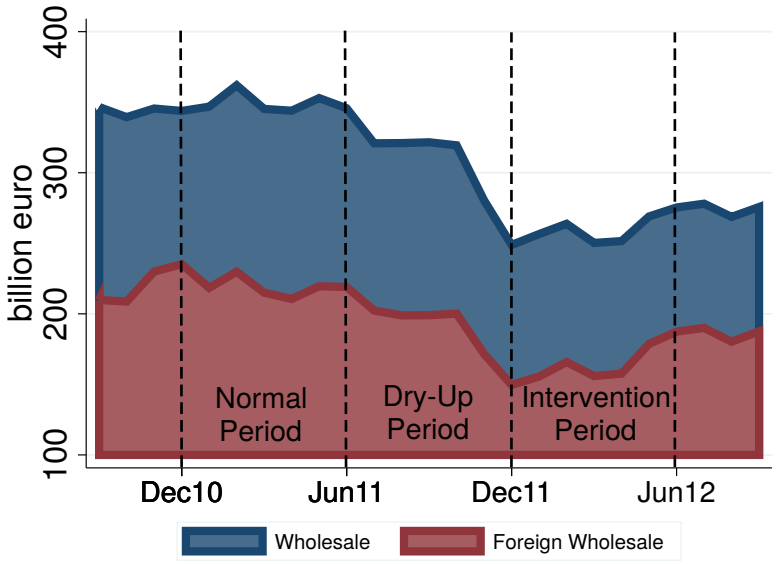

Figure 1: Foreign Wholesale Funding Dry-Up. This plot shows the total wholesale market funding (foreign and domestic wholesale, excluding bond financing) and the foreign wholesale market funding of our sample banks. The total wholesale funding corresponds to the sum of the blue and red areas. See Figure A.1 in the Appendix for the time series evolution of additional funding sources. Quantities are in billion euro. Source: Bank of Italy.

The LTRO On December 8, 2011, the ECB increased its support to the eurozone banking sector even further, announcing the provision of two three-year maturity loans, the three-year LTRO, allotted on December 21, 2011 (LTRO1) and February 29, 2012 (LTRO2), with the stated goal "to support bank lending and liquidity in the euro area." The distinctive feature of the LTRO, compared with pre-existing liquidity facilities, is the long three-year maturity. The interest rate and haircut did not change from previous standing operations.[14]

In a frictionless world with no uncertainty, the LTRO is a redundant tool that should not attract

ties, and other uncovered credit debt instruments. The haircut schedule is publicly available on the ECB website. In the Online Appendix, we discuss the ECB collateral framework in greater detail.

[14]The interest rate on the two LTRO loans is the average rate of the regular main refinancing operations over the life of the operation, to be neutral compared with pre-existing short-term loans. The regulatory treatment of long-term and short-term collateralized loans from the ECB is also equivalent. No major changes were made on the haircuts or eligibility of collateral securities, with the exception of selected asset-backed securities (ABS). In December 2011, the ECB started accepting ABS with a second-best rating of at least "single A" (see Van Bekkum et al. (forthcoming)). The ECB also allowed national central banks to temporarily accept selected bank loans ("additional credit claims") in addition to those eligible before the intervention, but this change was implemented only in July 2013 by the Bank of Italy. Banks had the option to repay the LTRO loans early, after one year.

banks, as they would be indifferent between borrowing at the central bank at a three-year maturity and borrowing at, say, a two-week maturity and then rolling over every two weeks for three years. However, the two strategies are not equivalent if there is uncertainty about the ECB's role as a liquidity provider in the next three years, which was likely the case at the end of 2011, as the continuation of the unlimited feature of the ECB liquidity provision and the future of the euro were unclear.[15]

Almost all Italian banks that are usually counterparties of the ECB open market operations tapped the LTRO. Our sample banks obtained €181.5 billion, consisting of €88.4 billion at LTRO1 and €93.1 billion at LTRO2. It is an economically large quantity, as the mean uptake was 10.9% of total assets.[16] This large uptake is not surprising: the LTRO was an opportunity not to be missed for banks, as its interest rate and haircuts were generally more attractive – especially in peripheral countries like Italy – than the private market.[17]

2.3 Data

In this section, we describe the data set construction and empirical work. The unit of observation is at the (i, j, s, t) level, where i is a firm, j is a bank, s is a security, and t is a date. Data on banks refer to the banking group level, consolidated at the national level.

We combine information from various sources. First, at the (i, j, t) firm-bank-period level,

[15] More specifically, there was uncertainty about whether the full-allotment procedure would have been in place during the three years of the LTRO. Crucially, the LTRO was not protecting banks against changes in collateral eligibility or haircuts, as the central bank makes margin calls if the value of collateral drops (or the haircuts increase) during the loan period. Marketable assets used as collateral are marked to market daily.

[16] The median uptake was 9.7% of total assets. More than 95% of banks that are usually counterparties of the ECB's open market operations borrowed at the LTRO. For more descriptive statistics, see Bank of Italy (2012).

[17] Consistent with ECB liquidity being particularly attractive in the eurozone periphery, approximately two-thirds of the total LTRO liquidity was allotted to Italian and Spanish banks. Banks located in core countries could, in general, obtain cheaper funding in private markets. See Drechsler et al. (2016) for a discussion of the ECB subsidy.

Bank-Level		**Jun10**	**Dec10**	**Jun11**	**Dec11**	**Jun12**	**Dec12**
Total Assets	€billions	37.3	36.7	36.6	36.4	37.5	37.7
Leverage	Units	11.9	12.3	12.2	12.2	13.2	13.5
Tier 1 Ratio	Units	19.0	15.2	14.3	13.9	13.8	13.4
Risk-Weighted Assets	%Assets	69.3	69.0	68.3	67.8	62.2	60.5
Non-performing Loans	%Loans	8.2	8.5	9.1	9.9	11.7	12.7
Private Credit	%Assets	59.5	62.8	65.2	66.8	67.6	69.4
- Credit to Households	%Assets	16.3	17.5	18.2	18.7	19.2	19.9
- Credit to Firms	%Assets	38.4	40.5	42.2	43.4	43.6	44.6
Securities	%Assets	17.4	16.9	16.3	17.3	24.2	23.7
- Government Bonds	%Assets	5.6	6.5	8.0	9.1	16.6	19.6
Cash Reserves	%Assets	0.4	0.5	0.5	0.5	0.4	0.5
ROA	Profits/Assets	0.1	0.3	0.1	0.0	0.1	0.1
Central Bank Borrowing	%Assets	0.9	2.0	2.2	5.7	12.5	13.5
Household Deposits	%Assets	33.0	32.0	30.8	30.3	29.3	29.8
Wholesale Funding	%Assets	8.1	8.5	8.4	7.7	8.0	8.5
Bond Financing	%Assets	18.6	18.5	19.2	18.0	16.3	14.8

		Normal Period	*Dry-Up Period*	*Intervention Period*
Loan-Level	**Loan Type**	**Dec10-Jun11**	**Jun11-Dec11**	**Dec11-Jun12**
ΔCreditDrawn	All Types	6.2%	-2.1%	-3.1%
ΔCreditGranted	All Types	4.7%	-2.2%	-3.6%

Table 1: Summary Statistics: Bank Characteristics and Credit Growth. The top panel shows cross-sectional means of selected balance sheet characteristics from June 2010 to December 2012. The bottom panel shows bank firm credit growth during the December 2010 - June 2011 period, the June 2011 - December 2011 period, and the December 2011 - June 2012 period. The table shows changes (difference in log stocks) in (i) total credit on term loans and drawn from revolving credit lines and loans backed by account receivables and (ii) total credit on term loans and committed on revolving credit lines and loans backed by account receivables. Source: Bank of Italy.

we obtain data on all outstanding loans with a balance above €30,000 from the Italian Credit Registry. We have information on term loans, revolving credit lines, and loans backed by account receivables. For each firm-bank pair, we observe the type of credit as well as the amounts granted and drawn. The quality of this data set is extremely high, as banks are required by law to disclose this information to the Bank of Italy.

Second, at the (j, t) bank-period level, we observe standard balance sheet characteristics (most of them biannually), detailed funding sources, and the LTRO uptake from the Supervisory and Statistical Reports submitted by intermediaries to the Bank of Italy.

Third, at the (s, j, t) security-bank-period level, we observe holdings of each marketable security held by Italian banks from the Supervisory Reports. We also observe time-invariant information

(e.g., issuer) from Datastream, whether the security is ECB-eligible collateral and its haircut at LTRO from the ECB, and whether it is pledged (at the ECB or in the private market) or available.

Fourth, at the (i, t) firm-period level, we have information on firms' characteristics from end-of-year balance sheet data and profitability ratios from official firm reports deposited to the Italian Chamber of Commerce (Cebi-Cerved database).

Our final data set is obtained by merging all data sources and excluding some banks. First, we exclude foreign banks (branches and subsidiaries) operating in Italy, as we only observe the liquidity injections that banks obtained from the ECB through the Bank of Italy and not their total ECB borrowing, which is likely to be much larger. Second, we exclude banks involved in extraordinary administration procedures around the time of the LTRO, as their credit policies are likely to have very small discretion margins. Third, we exclude mutual banks and their central institutes, as in most cases the latter tapped the ECB liquidity and then redistributed funds among the former, but we do not observe the allocation of liquidity among affiliated banks. Fourth, we exclude banks that specialize in specific activities such as wealth or nonperforming loans management. Finally, given our focus on the LTRO, we restrict our analysis to banks that were counterparties of the Bank of Italy at least once in the sample period. Our final sample consists of 74 banks.

In the top panel of Table 1, we show bank-level summary statistics at six dates around the introduction of the LTRO. Two features stand out: (i) a stark increase in holdings of securities, driven by government bonds, between December 2011 and June 2012, and (ii) two jumps in central bank borrowing around the two LTRO allotments (December 2011 and February 2012). In the bottom panel, we show changes in credit to firms. Total credit is the sum of term loans, revolving credit lines, and loans backed by account receivables. For each type of credit, we observe credit drawn and credit granted (committed). Changes in both credit granted and drawn are large and negative after June 2011, when Italian banks were hit by the dry-up.

3 Bank Credit Supply during the Dry-Up and the LTRO

In this section, we document the evolution of bank credit supply for banks differentially exposed to the foreign wholesale dry-up. We isolate bank credit supply by restricting our sample to the large number of firms that borrow, in any given period, from two or more banks and then comparing changes in credit from different banks *within* firms (Khwaja and Mian (2008)).[18] In this subsample, we can control for firm observed and unobserved heterogeneity using firm fixed effects, effectively comparing how the same firm's loan growth from one exposed bank changes relative to the loan growth from another, less-exposed bank. In Section 3.1, we present our measure of bank exposure to the dry-up. In Section 3.2, we show that more-exposed banks reduced their credit supply during the dry-up and restored it after the ECB extended the maturity of its liquidity provision with the LTRO.

3.1 Exposure to the Wholesale Funding Dry-Up

We use banks' reliance on the foreign wholesale funding in June 2011 as a measure of bank exposure to the June–December 2011 dry-up. The intuition, confirmed by our data, is that banks with high exposure to the foreign wholesale funding are more affected by the dry-up than less-exposed banks.[19] We define bank j's exposure as the foreign wholesale funding normalized by total assets in June

[18] Our sample includes approximately 1.4 million observations at any given date. In most of our analysis we focus on firms with multiple relationships. We make sure that this subsample, which includes approximately 0.7 million observations (275,000 unique firms) at any given time, is comparable to the full sample. Approximately 170,000 firms have two relationships at any given date, 60,000 have three relationships, 24,000 have four relationships, and 21,000 have five or more relationships. See Ongena and Smith (2000) for a discussion of multiple relationships in Italy.

[19] In the Online Appendix, we show that the exposure to the foreign wholesale market in June 2011 explains the June–December 2011 dry-up (in foreign and total wholesale funding), controlling for other bank characteristics.

2011, just before the dry-up:

$$Exposure_{j,Jun11} = \frac{ForeignWholesale_{j,Jun11}}{TotalAssets_{j,Jun11}} \tag{1}$$

where $ForeignWholesale_{Jun11}$ is the sum of foreign deposits (mainly commercial paper and certificates of deposit held by U.S. money market funds) and eurozone centrally cleared repurchase agreements. Approximately half of our sample banks have a small exposure, below 1%. However, banks with exposure above 5% are quantitatively important, as they hold 75% of total credit to firms.[20]

Of course, banks' funding mix in June 2011 is correlated with other observable and unobservable characteristics of banks. In Table 2, we show bank summary statistics for "exposed" (above median exposure) and "non-exposed" (below median exposure) banks in June 2011. Exposed banks tend to be larger, more levered, and less reliant on household deposits than non-exposed banks. The reasoning is intuitive. On the one hand, large banks obtain a sizable amount of funding through wholesale markets and have a non-negligible share of total funding coming from foreigners. On the other hand, small banks are usually present in local markets, where they have a large and stable household deposit base. As will become clear from our main specification, we include bank balance sheet controls as well as stringent fixed effects to tackle the potential omitted variable bias originating from these differences in observables.

Our choice to use banks' exposure to (foreign) wholesale funding as a source of heterogeneity also closely follows the theory of wholesale market dry-ups. Dry-ups are the result of asymmetric

[20] The 10th, 30th, 50th, 70th, and 90th percentiles of the distribution of the exposure variable are 0.0%, 0.1%, 0.8%, 2.7%, and 7.6%, respectively. In the Online Appendix, we show the distribution of banks' exposure to the dry-up.

Balance-Sheet Item	Unit	Exposed Banks	Non-Exposed Banks
Total Assets	€billions	11.0	1.3
Leverage	Units	13.2	10.8
Tier 1 Ratio	Units	9.1	11.4
Risk-Weighted Assets	%Assets	71.2	68.0
Nonperforming Loans	%Loans	8.6	8.7
Private Credit	%Assets	68.9	70.1
- Credit to Households	%Assets	17.1	20.0
- Credit to Firms	%Assets	43.7	47.0
Securities	%Assets	14.2	14.0
- Government Bonds	%Assets	7.1	6.2
Cash Reserves	%Assets	0.4	0.5
ROA	Profits/Assets	0.2	0.1
Central Bank Borrowing	%Assets	1.8	0.0
Household Deposits	%Assets	24.7	34.9
Wholesale Funding	%Assets	12.2	1.6
Bond Financing	%Assets	22.8	20.2

Table 2: Summary Statistics for Exposed and Non-Exposed Banks. This table shows June 2011 bank summary statistics (subsample medians) for exposed and non-exposed banks. Exposed (non-exposed) banks have exposure to the foreign wholesale market above (below) the median in June 2011. Source: Bank of Italy.

information, as borrowers know more about their own financial health than lenders. In an economy populated by only uninformed lenders, following a shock, lenders become concerned about the quality of borrowers and interest rates go up for *all* borrowers. High-quality borrowers then self-select out of the market, causing uninformed lenders to stop lending to *all* borrowers (Akerlof (1970)). However, if there are some informed lenders in the economy, they will stop lending to low-quality borrowers (Gorton and Pennacchi (1990), Calomiris and Kahn (1991)). To isolate the correlation between the exposure to the dry-up and bank credit supply, we include a set of control variables that capture bank vulnerability (leverage, tier 1 ratio, nonperforming loans ratio, ROA), therefore controlling for the potential selective withdrawals of informed lenders.[21]

[21] Perignon et al. (forthcoming) show that in the European market from 2008 to 2014 dry-ups are consistent with theories featuring informed and uninformed lenders reacting to a deterioration in the quality of borrowers.

3.2 Funding Dry-Ups and the Evolution of Bank Credit Supply

Following the timing suggested by Figure 1, we compare three periods: (i) the *normal* period, from December 2010 to June 2011, when funding markets are well functioning; (ii) the *dry-up* period, from June 2011 to December 2011, when we observe a dry-up in the foreign wholesale market; and (iii) the *intervention* period, from December 2011 to June 2012, after the LTRO.[22]

We use a three-period difference-in-differences specification to document the evolution of bank credit supply during the dry-up and intervention periods. In particular, we (i) compare the stock of credit granted by bank j to firm i in the dry-up period to the same (i, j) stock of credit granted in the normal period, and (ii) compare the stock of credit granted by bank j to firm i in the intervention period to the same (i, j) stock of credit granted in the dry-up period.[23] More specifically, we estimate the following model:

$$\begin{aligned}\Delta CreditGranted_{ijt} = \alpha + \beta_1 Exposure_{j,Jun11} \times \mathbb{I}_{DU,LTRO} + \beta_2 Exposure_{j,Jun11} \times \mathbb{I}_{LTRO} \\ + \mu_{it} + \gamma_{ij} + \phi' X_{ijt} + \epsilon_{ijt} \qquad (2)\end{aligned}$$

where observations are at the (i, j, t) firm-bank-period level. We use the four dates that delimit the normal period, the dry-up period, and the intervention period – December 2010, June 2011, December 2011, and June 2012. The dependent variable is the change in log (stock of) credit granted by bank j to firm i at time t.[24] $Exposure_{Jun11}$ is bank j's exposure to the foreign wholesale market in June 2011 defined in (1). $\mathbb{I}_{DU,LTRO}$ is a dummy equal to one in the dry-up and the intervention

[22] We decide to end the sample in June 2012 to avoid overlapping with the July 2012 Draghi OMT announcement.

[23] By "stacking" two difference-in-differences specifications, we estimate the time-invariant fixed effects on the entire sample period.

[24] Credit granted includes drawn and undrawn credit. In line with empirical studies that use credit registry data, we choose to use credit granted as our dependent variable, as credit drawn is likely driven by firm demand.

periods, and $\mathbb{I}_{LTRO}$ is a dummy equal to one in the intervention period only. We add bank-firm fixed effects to absorb any bank-firm time-invariant characteristics, including any time-invariant bank characteristic. We also plug in firm-time fixed effects to control for both observable and unobservable firm heterogeneity, crucially capturing firm demand for credit at time t.

Intuitively, as in a standard difference-in-differences setting, β_1 captures the difference in credit growth between more-exposed and less-exposed banks during the dry-up period relative to the normal period. Similarly, β_2 captures the difference in credit growth between more-exposed and less-exposed banks during the intervention period relative to the dry-up period.[25] We rely on two identification assumptions: (i) exposed banks would have behaved like non-exposed banks during the dry-up period in the absence of the dry-up, and (ii) exposed banks would have behaved like non-exposed banks during the intervention period in the absence of the LTRO.[26] Because bank exposure is not randomly assigned to banks, we ensure that our results are robust to the inclusion of key balance sheet characteristics *interacted* with the two time dummies. These characteristics are leverage, return on assets, tier 1 ratio, nonperforming loans ratio, and a dummy equal to one if a bank belongs to the large and internationally diversified banking groups.[27]

Finally, we add firm-bank relationship variables (vector X) to control for specific characteristics of the bank-firm credit relationships that might change over time. These variables are (i) the share of total firm i credit obtained from bank j (measuring the strength of the relationship), (ii) the ratio of drawn to committed credit (measuring how close firm i is from exhausting its borrowing capacity from bank j), and (iii) the share of overdraft credit by firm i with respect to bank j

[25] In the Online Appendix, we prove this claim analytically.

[26] In Figure A.2 in the Appendix, we show the evolution of our outcome variable for exposed (exposure above median) and non-exposed (exposure below median) banks.

[27] In the Online Appendix, we show the evolution of several bank balance sheet variables, including pre-trends starting in June 2010, for exposed and non-exposed banks.

(measuring the extent of an eventual over-borrowing).

In Table 3, we show the estimation results, progressively saturating our specification with fixed effects and controls. In columns (1) and (2), we include time and bank fixed effects. The sample is the only difference between the two columns, as column (1) covers the full sample and column (2) only includes firms that have multiple relationships. In column (3), we substitute time fixed effects with firm-time fixed effects in order to control for firm time-varying credit demand. These estimation results show a negative effect of the dry-up and a positive effect of the intervention on bank credit supply. The estimated coefficients are stable, suggesting that (i) the subsample of firms with multiple relationships is comparable with the full sample, and (ii) firms borrowing from exposed banks do not systematically demand more or less credit during the dry-up and more or less credit during the intervention period compared with less-exposed banks. In other words, firm demand does not seem to be a major identification concern in this setting.

In column (4), we include three relationship control variables ($Share$, $Drawn/Granted$, $Overdraft$) to account for time-varying bank-firm relationship characteristics. In column (5) we substitute bank fixed effects with the more stringent bank-firm fixed effects to exploit the variation within the same firm-bank pair over time, thereby controlling for any time-invariant relationship characteristics. Again, affected banks' credit supply contraction during the dry-up relative to unaffected banks is offset by an approximately equivalent increase during the intervention period.[28]

In column (6), we saturate the specification with June 2011 bank balance sheet characteristics *interacted* with the two time dummies. Again, we confirm that banks with a large exposure to foreign wholesale market reduce their credit supply during the dry-up and restore it during the

[28] When we include bank-firm fixed effects, the number of observations shrinks from approximately 2.32 million to 2.17 million. While, with bank fixed effects, the sample includes firms that have multiple relationships at each date t, with bank-firm fixed effects the sample includes only observations about the *same* bank-firm relationship over time.

	$\Delta CreditGranted$					
	(1)	(2)	(3)	(4)	(5)	(6)
$Exposure_{Jun11} \times \mathbb{I}_{DU,LTRO}$	-0.092**	-0.127***	-0.129***	-0.128***	-0.132***	-0.114***
	(0.041)	(0.045)	(0.037)	(0.037)	(0.040)	(0.031)
$Exposure_{Jun11} \times \mathbb{I}_{LTRO}$	0.212***	0.247***	0.251***	0.245***	0.172***	0.115**
	(0.054)	(0.061)	(0.044)	(0.043)	(0.043)	(0.053)
$Share$				-0.002***	-0.026***	-0.026***
				(0.000)	(0.001)	(0.001)
$Overdraft$				0.068***	0.251***	0.249***
				(0.003)	(0.027)	(0.026)
$Drawn/Granted$				0.052	0.252	0.250
				(0.032)	(0.223)	(0.220)
$LEV_{Jun11} \times \mathbb{I}_{DU,LTRO}$						0.141
						(0.207)
$LEV_{Jun11} \times \mathbb{I}_{LTRO}$						0.244
						(0.158)
$ROA_{Jun11} \times \mathbb{I}_{DU,LTRO}$						-0.038*
						(0.020)
$ROA_{Jun11} \times \mathbb{I}_{LTRO}$						0.027
						(0.044)
$T1R_{Jun11} \times \mathbb{I}_{DU,LTRO}$						0.396**
						(0.155)
$T1R_{Jun11} \times \mathbb{I}_{LTRO}$						0.362***
						(0.127)
$NPL_{Jun11} \times \mathbb{I}_{DU,LTRO}$						-0.321*
						(0.185)
$NPL_{Jun11} \times \mathbb{I}_{LTRO}$						0.222**
						(0.101)
$Large \times \mathbb{I}_{DU,LTRO}$						-0.647
						(0.943)
$Large \times \mathbb{I}_{LTRO}$						0.615
						(1.518)
Time FE	✓	✓				
Bank FE	✓	✓	✓	✓		
Firm-Time FE			✓	✓	✓	✓
Bank-Firm FE					✓	✓
Sample	Full	Multiple Lenders	Multiple Lenders	Multiple Lenders	Multiple Lenders	Multiple Lenders
Observations	4,434,431	2,322,142	2,322,142	2,322,142	2,171,749	2,171,749
R-squared	0.004	0.005	0.380	0.394	0.700	0.701

Table 3: Bank Credit Supply During the Dry-Up and the Intervention Periods. This table presents the results from specification (2). The dependent variable is the difference in log (stock of) credit granted. $Exposure_{Jun11}$ is the exposure to the foreign wholesale market, divided by assets, in June 2011. $\mathbb{I}_{DU,LTRO}$ is a dummy equal to one in the dry-up and intervention periods. $\mathbb{I}_{LTRO}$ is a dummy equal to one in the intervention period. The normal period runs from December 2010 to June 2011. The dry-up period runs from June 2011 to December 2011. The intervention period runs from December 2011 to June 2012. *Share* is the share of total firm i credit obtained from bank j, *Drawn/Granted* is the ratio of drawn credit over committed credit between bank j and firm i, *Overdraft* is the share of overdraft credit between firm i and bank j, *LEV* is leverage, *ROA* is return on assets, $T1R$ is the Tier 1 Ratio, NPL is nonperforming loans ratio, and *Large* is a dummy equal to one if the bank has assets above €500 billion. Standard errors double clustered at the bank and firm level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Bank of Italy.

intervention period. The estimates of the balance sheet controls suggest that the intervention might have also helped banks holding low-quality assets that likely experienced withdrawals from informed lenders during the dry-up.[29] During the dry-up, banks with low regulatory capital and high nonperforming loans ratios reduce their credit supply compared with other banks. During the intervention period, banks with high nonperforming loans ratios increase their credit supply compared with banks with low nonperforming loans ratios.

The effects captured by the dry-up exposure are economically significant. During the dry-up, on a baseline credit contraction of 2.2%, credit granted by high-exposure banks (top decile of the exposure distribution) grew about 1 percentage point less than credit granted by banks with low-exposure (bottom decile of the exposure distribution). However, during the intervention period, we observe an offsetting credit supply expansion by high-exposure banks that undoes the contraction during the dry-up period.[30]

4 Transmission of Central Bank Liquidity

We have documented that banks that are more exposed to the foreign wholesale market reduce their credit supply during the dry-up and restore it after the central bank intervention, compared with less exposed banks. In Section 4.1, we present our strategy to link the actual bank-level uptake of ECB liquidity to banks' portfolio choice and show that banks that are relatively more exposed to the dry-up could access the central bank only because of a government guarantee program. In Section 4.2, we show that relatively more-exposed banks use LTRO liquidity to restore their credit

[29] Whether the central bank liquidity was allotted to temporary illiquid or insolvent banks is beyond the scope of this paper.

[30] In Section 5.2, we aggregate these within firm-bank estimation results to quantify the aggregate effects.

supply. In Section 4.3, we show that relatively less-exposed banks use LTRO liquidity to buy high-yield domestic government bonds and not to increase their credit supply.

4.1 Government Guarantee and Uptake of Central Bank Liquidity

We now analyze the actual bank-level uptake of central bank liquidity. Note that banks can *choose* how much to borrow at the LTRO. Hence, were we to use the heterogeneity of banks' LTRO borrowing as a source of variation, we would likely capture other bank characteristics and our results would suffer from an omitted variable bias.[31]

Indeed, bank uptake of LTRO liquidity and bank exposure to the dry-up are uncorrelated: banks tap liquidity for approximately 10% of total assets, *regardless* of their exposure to the dry-up. In Figure 2, we divide banks in quartiles according to their exposure to the dry-up (x-axis) and show their LTRO uptake normalized by total assets (y-axis). We find that bank exposure to the dry-up and bank LTRO uptake are uncorrelated, raising the possibility that the restoration of bank credit supply is unrelated to the central bank liquidity injection.

To reconcile this observation with the observation that exposed banks restored their credit supply after the LTRO, we exploit a regulatory intervention by the Italian government. Right after the announcement of the LTRO, the Italian government offered banks a guarantee on securities *otherwise ineligible* at the ECB by paying a fee. As the ECB accepts all government-guaranteed assets as collateral, the program effectively gave banks a technology to "manufacture" ECB-eligible collateral and therefore increase their borrowing capacity at the central bank.[32]

[31] The existing papers on the transmission of the LTRO simply use banks' endogenous uptake of ECB liquidity as a source of variation (Andrade et al. (2017), Daetz et al. (2016), Garcia-Posada and Marchetti (2016)).

[32] Banks could obtain the government guarantee on zero-coupon, senior, unsecured, euro-denominated bank bonds. In the period between the two LTRO allotments, banks took advantage of this law by issuing *and retaining* unsecured bank bonds. A retained issuance is effectively a self-issuance, as banks do not allow the bonds to go to the market or to investors, but keep them on the asset side of the balance sheet. Paying a fee to the Treasury, banks could

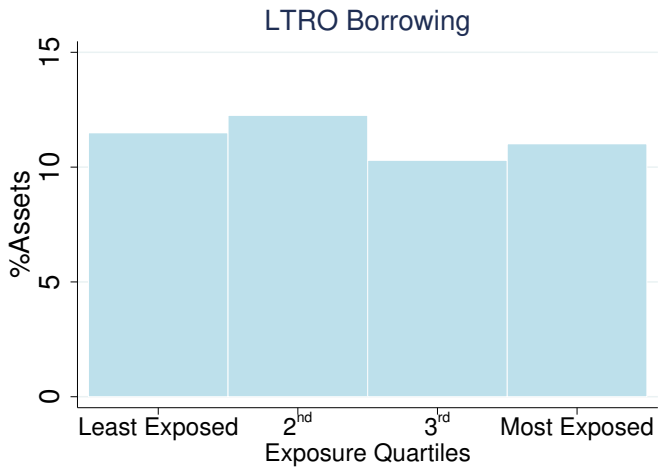

Figure 2: LTRO Uptakes by Bank Exposure Quartile. This histogram shows, for each dry-up exposure quartile, mean LTRO uptakes, normalized by assets in June 2011. Banks are divided in quartiles according to their exposure to the foreign wholesale market in June 2011. Source: Bank of Italy.

The use of the government program was sizable, as 28 banks created haircut-adjusted collateral worth €102.8 billion, equivalent to 57% of the total LTRO borrowing. The government program – explicitly intended to help banks with scarce collateral access ECB liquidity – was mainly used by banks hit by the dry-up. Government-guaranteed collateral backed 68% of LTRO liquidity for banks in the top quartile of the dry-up exposure distribution and only 17% of LTRO liquidity for banks in the bottom quartile of the dry-up exposure distribution.

Our interpretation is intuitive. During the dry-up, between June and December 2011, banks affected by the funding contraction eroded their available collateral by pledging it either in the private market or at the central bank to obtain (short-term) funding.[33] As a result, the Italian government intervened, effectively allowing banks to create eligible collateral by paying a fee. Banks hit by the dry-up *self-selected* in the government guarantee program to increase their borrowing

then obtain a government guarantee on these newly created bonds (called Government Guaranteed Bank Bonds) so that they became eligible to be pledged at the LTRO. In the Online Appendix, we provide a detailed description of this government guarantee program as well as anecdotal evidence on its rationale and use by banks. Using our security-level data set, we confirm that these government-guaranteed securities are used as collateral at the ECB.

[33] In Figure A.3 in the Appendix, we show that banks exposed to the foreign wholesale market eroded their ECB-eligible collateral during the dry-up.

	$Uptake^{Total}$	$Uptake^{GovtGuarantee}$
$Exposure_{Jun11}$	-0.164	0.236**
	(0.197)	(0.101)
LEV_{Jun11}	0.901***	-0.000
	(0.284)	(0.146)
ROA_{Jun11}	0.093**	-0.024
	(0.041)	(0.021)
$T1R_{Jun11}$	0.636***	-0.191*
	(0.220)	(0.113)
NPL_{Jun11}	0.071	0.066
	(0.247)	(0.127)
$Large_{Jun11}$	-7.628*	0.042
	(4.312)	(2.215)
Observations	48	48
R-squared	0.395	0.228

Table 4: Use of the Government Guarantee Program. This table presents the results from specification (3). The dependent variable in column (1) is the total LTRO uptake. The dependent variable in column (2) is the LTRO uptake backed by government guaranteed collateral. The independent variables are the exposure to the dry-up defined in (1), leverage, return on assets, tier 1 ratio, nonperforming loans ratio, and a dummy equal to one if a bank has assets above €500 billion. Sample banks have non-zero borrowing at the ECB in November 2011, before the LTRO. All variables are measured in June 2011. *** p<0.01, ** p<0.05, * p<0.1. Source: Bank of Italy.

capacity at the LTRO. Banks that were relatively unaffected by the dry-up borrowed at the LTRO with their own collateral, thus avoiding the fee.[34]

More formally, we check whether this observation is robust by running, in the sample of banks that borrowed at the ECB before the LTRO, the following cross-sectional regression:

$$Uptake_j = \alpha + \beta Exposure_{j,Jun11} + \mu X_{j,Jun11} + \epsilon_j \tag{3}$$

where $Uptake$ is the bank-level uptake of LTRO liquidity normalized by total assets and the independent variables are the exposure to the dry-up defined in (1) and the usual set of bank characteristics measured in June 2011 (vector X_{Jun11}).

[34]Our findings suggest that, absent the fee, all banks would have chosen to secure additional collateral using the government guarantee program. In the Online Appendix we provide anecdotal evidence, from banks' annual reports, that the fee was high enough to discourage relatively unaffected banks from using the government program.

We show estimation results in Table 4. In column (1), the dependent variable is bank total borrowing at the LTRO ($Uptake^{Total}$). Consistent with the non-parametric evidence in Figure 2, we find that the bank exposure to the dry-up is uncorrelated with the uptake of LTRO liquidity, even after controlling for bank balance sheet characteristics. In column (2), the dependent variable is bank LTRO borrowing collateralized by government-guaranteed securities ($Uptake^{GovtGuarantee}$). The estimation result confirms that bank LTRO borrowing backed by government-guaranteed collateral is positively correlated with exposure to the dry-up. Taken together, these findings suggest that exposed banks could only access the central bank liquidity because of the government guarantee program.

4.2 Effect on Private Credit Supply

Having provided evidence suggesting that banks hit by the dry-up used the government program to access LTRO liquidity, we next estimate a standard difference-in-differences specification where we compare the dry-up period and the intervention period, using banks' LTRO uptake as a source of variation. We separately consider (i) bank total LTRO uptake, (ii) bank LTRO uptake backed by government-guaranteed collateral, and (iii) bank LTRO uptake backed by standard (i.e., not guaranteed by the government) collateral. More formally, we estimate the following model:

$$\Delta CreditGranted_{ijt} = \alpha + \beta_1 Uptake_j \times \mathbb{I}_{LTRO} + \mu_{it} + \gamma_{ij} + \phi' \Gamma_{jt} + \epsilon_{ijt} \tag{4}$$

where the dependent variable is the change in log (stock of) credit granted by bank j to firm i at time t. Following our baseline specification (2), we compare the dry-up period (June 2011–December 2011) and the intervention period (December 2011–June 2012), using a dummy $\mathbb{I}_{LTRO}$ equal to one in the intervention period. Again, we saturate the regression with firm-time fixed effects, bank-firm fixed effects, and bank-level control variables interacted with the time dummy

	$\Delta CreditGranted$					
	(1)	(2)	(3)	(4)	(5)	(6)
$Uptake^{Total} \times \mathbb{I}_{LTRO}$	-0.066	-0.042				
	(0.131)	(0.144)				
$Uptake^{GovtGuarantee} \times \mathbb{I}_{LTRO}$			0.228**	0.249**		
			(0.111)	(0.122)		
$Uptake^{StandardCollateral} \times \mathbb{I}_{LTRO}$					-0.275**	-0.269*
					(0.131)	(0.142)
$LEV \times \mathbb{I}_{LTRO}$	0.538***	0.618***	0.520***	0.596***	0.498***	0.576***
	(0.184)	(0.200)	(0.164)	(0.179)	(0.181)	(0.197)
$ROA \times \mathbb{I}_{LTRO}$	0.029	0.031	0.057	0.061	0.054	0.054
	(0.063)	(0.070)	(0.063)	(0.070)	(0.063)	(0.070)
$T1R \times \mathbb{I}_{LTRO}$	0.720**	0.805**	0.564**	0.633**	0.557*	0.644*
	(0.338)	(0.362)	(0.274)	(0.296)	(0.305)	(0.329)
$NPL \times \mathbb{I}_{LTRO}$	0.474***	0.547***	0.435***	0.497***	0.355**	0.425**
	(0.158)	(0.168)	(0.139)	(0.152)	(0.155)	(0.164)
$Large \times \mathbb{I}_{LTRO}$	1.022	0.959	1.449	1.279	0.098	-0.054
	(2.235)	(2.459)	(2.062)	(2.277)	(2.359)	(2.605)
Firm-Time FE	✓	✓	✓	✓	✓	✓
Bank FE	✓		✓		✓	
Bank-Firm FE		✓		✓		✓
Observations	1,512,104	1,381,420	1,512,104	1,381,420	1,512,104	1,381,420
R-squared	0.385	0.655	0.385	0.655	0.385	0.655

Table 5: Bank LTRO Liquidity Uptake and Credit Supply. This table presents the results from specification (4). The dependent variable is the difference in log (stock of) credit granted. $Uptake^{Total}$ is the total LTRO uptake, $Uptake^{StandardCollateral}$ is the LTRO uptake backed by standard collateral, and $Uptake^{GovtGuarantee}$ is the LTRO uptake backed by the government guarantee program. All independent variables are divided by assets in June 2011. $\mathbb{I}_{LTRO}$ is a dummy equal to one in the intervention period, LEV is leverage, ROA is return on assets, $T1R$ is the tier 1 ratio, NPL is nonperforming loans ratio, and $Large$ is a dummy equal to one if the bank has assets above €500 billion. The sample period runs from June 2011 to June 2012. The sample includes only firms with multiple relationships at any time t. Standard errors double clustered at the bank and firm level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Bank of Italy.

(vector Γ).

Table 5 shows the estimation results. In columns (1) and (2), $Uptake$ is total bank LTRO uptake ($Uptake^{Total}$). In column (1) we include bank fixed effects, and in column (2) we include the more restrictive bank-firm fixed effects. The coefficient on the interaction term between $Uptake^{Total}$ and the time dummy is close to zero and not significant, suggesting that banks that tapped more LTRO liquidity did *not* increase their credit supply during the intervention period compared with banks that tapped less LTRO liquidity, relative to the dry-up period.

In columns (3) and (4), $Uptake$ is bank LTRO uptake backed by government-guaranteed collateral ($Uptake^{GovtGuarantee}$). In columns (5) and (6), $Uptake$ is bank LTRO uptake backed by

standard collateral ($Uptake^{StandardCollateral}$). We find that banks that borrowed more at the LTRO using government-guaranteed collateral increased their credit supply more during the intervention period than banks that borrowed less using the government-guaranteed collateral, relative to the dry-up period. The opposite is true for banks that used standard collateral to borrow at the ECB.[35] Taken together, these results show that LTRO liquidity backed by the government guarantee explains the increase of credit supply, consistent with banks hit by the dry-up *self-selecting* in the costly government guarantee program to restore credit to their clients.

These results suggest that the government guarantee was *necessary* for the transmission of central bank liquidity to firms, as it granted banks that experienced the dry-up access to the LTRO.[36] However, the time-series evidence suggests that the government guarantee was *not sufficient* for the transmission to firms. In fact, during the dry-up, banks reduced their credit supply even if they were borrowing short-term freely from the central bank, thus eroding their holdings of eligible collateral. In sum, the short-term central liquidity provision during the dry-up was likely countered by the uncertainty about the ECB's role as a liquidity provider in the future. By allowing banks to secure three-year funding from the ECB, the LTRO maturity extension reduced that uncertainty.

4.3 Effect on Government Bond Holdings

Our analysis of the transmission of central bank liquidity leaves one open question. While all banks borrow at the LTRO, only banks exposed to the dry-up restore their credit supply to firms. How do *less*-exposed banks use the central bank liquidity? And, more in general, did banks use LTRO

[35]The total uptake is the sum of the uptake backed by government-guaranteed collateral and the uptake backed by standard collateral. The coefficients of interest in columns (3)-(4) and (5)-(6) are therefore mechanically symmetric.

[36]By allowing banks with scarce eligible collateral to access the central bank liquidity, the government guarantee likely had a cost in terms of ex ante moral hazard. The quantification of this cost is beyond the scope of this paper.

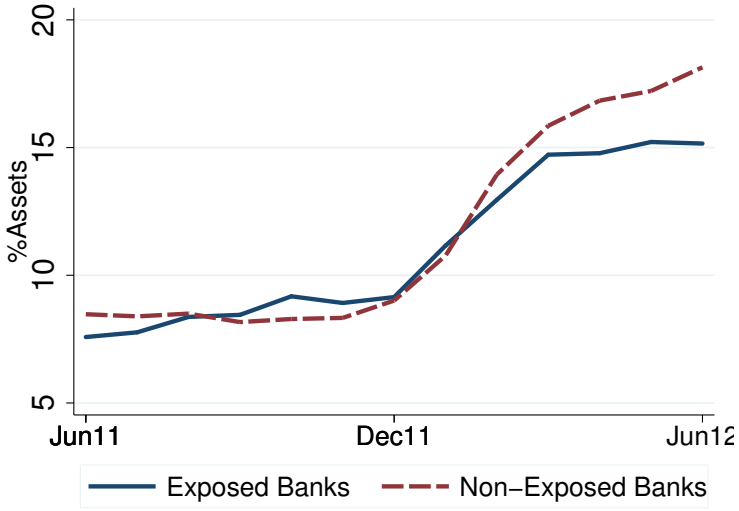

Figure 3: Government Bond Holdings and Exposure to the Dry-up. This figure shows government bond holdings, normalized by total assets in June 2011, by exposed and non-exposed banks (subsample means). Exposed (Non-exposed) banks have dry-up exposure, defined in (1), above (below) median. Source: Bank of Italy, Datastream.

liquidity to also increase their holdings of other assets?

As shown in Table 1, the time-series evolution of government bond holdings around the LTRO stands out: holdings increase from 9.1% to 16.6% of total assets between December 2011 and June 2012, whereas we observe almost no changes before December 2011 and after June 2012. In Figure 3, we document the evolution of government bond holdings for exposed (above median exposure) and non-exposed (below median exposure) banks. We observe that this increase in holdings corresponds to the LTRO announcement and is more pronounced for non-exposed banks.

This non-parametric evidence is consistent with our previous findings, as exposed banks use LTRO liquidity to increase their credit supply more compared with less exposed banks. More formally, we estimate the following model in the dry-up and intervention periods:

$$Govt_{jt} = \alpha + \beta Exposure_{j,Jun11} \times \mathbb{I}_{LTRO} + \Gamma_{jt} + \eta_t + \gamma_j + \epsilon_{j,t} \tag{5}$$

where the unit of observation is at the bank-month level and the dependent variable is holdings of

	$Govt$	$Govt^{Domestic}$	$Govt^{GIPS}$	$Govt^{Core}$
$Exposure_{Jun11} \times \mathbb{I}_{LTRO}$	-0.169**	-0.169**	-0.001	-0.004
	(0.072)	(0.077)	(0.004)	(0.004)
$LEV_{Jun11} \times \mathbb{I}_{LTRO}$	0.033	0.036	-0.005	0.006*
	(0.111)	(0.114)	(0.003)	(0.003)
$ROA_{Jun11} \times \mathbb{I}_{LTRO}$	-1.583	-1.532	-0.108	0.012
	(1.724)	(1.756)	(0.097)	(0.054)
$T1R_{Jun11} \times \mathbb{I}_{LTRO}$	0.087***	0.088***	-0.001	0.001
	(0.027)	(0.027)	(0.001)	(0.002)
$NPL_{Jun11} \times \mathbb{I}_{LTRO}$	2.839	3.088	-0.066	-0.112
	(7.574)	(7.560)	(0.083)	(0.117)
$Large_{Jun11} \times \mathbb{I}_{LTRO}$	-0.655	-0.623	0.034	-0.017
	(0.827)	(0.877)	(0.055)	(0.019)
Observations	949	949	949	949
R-squared	0.866	0.860	0.606	0.645

Table 6: Effect on Holdings of Government Bonds. This table presents the results from specification (5). The dependent variable in column (1) is the total holdings of government bonds. The dependent variables in columns (2) through (4) are holdings of domestic, GIPS (Greece, Ireland, Portugal, Spain), and core (U.S., Germany, France) government bonds, respectively. All dependent variables are normalized by total assets in June 2011. The independent variables are the exposure to the dry-up defined in (1), a time dummy $\mathbb{I}_{LTRO}$ equal to one in the intervention period, leverage, return on assets, tier 1 ratio, nonperforming loans ratio, and a dummy equal to one if a bank has assets above €500 billion. All dependent variables are measured in June 2011. The sample includes only securities matched with Bloomberg or Datastream issuer county variable and runs from June 2011 to June 2012. *** p<0.01, ** p<0.05, * p<0.1. Source: Bank of Italy, Bloomberg, Datastream.

government bonds by bank j in month t normalized by total assets in June 2011.[37] The independent variables include time fixed effects, bank fixed effects, the exposure to the dry-up defined in (1) interacted with the time dummy $\mathbb{I}_{LTRO}$ equal to one in the intervention period, and balance sheet characteristics also interacted with the same time dummy (vector Γ).

We show the estimation results in Table 6. In the first column, the dependent variable is total holdings of government bonds, normalized by assets. We find that the increase in holdings of government bonds between the dry-up and the intervention period was larger for relatively less-exposed banks than relatively more-exposed ones. In columns (2) through (4), the dependent variables are holdings of domestic; peripheral non-domestic (Greece, Ireland, Portugal, Spain); and

[37] We observe bank total assets at a biannual frequency.

core (United States, Germany, France) government bonds normalized by total assets, respectively. We find that *domestic* government bonds drive the increase in total high-yield sovereign bond holdings.[38] These securities are particularly attractive during this period, as they carry a zero regulatory risk weight, have a high yield, and, compared with other (non-domestic) high-yield eurozone bonds, can be used to risk-shift and satisfy eventual government moral suasion.[39] Taken together, these results suggest that LTRO liquidity induced banks to buy domestic high-yield government bonds, consistent with the recent literature on monetary policy and bank reach-for-yield behavior (Peydró et al. (2017), Acharya and Plantin (2017)). Finally, the transmission of LTRO liquidity to purchases of government bonds likely sustained government bond prices and helped the domestic sovereign refinance its debt (Crosignani et al. (2017)).

In sum, in the previous two subsections we find that (i) banks exposed to the dry-up drive the restoration of private credit supply, and (ii) all banks – but especially those relative less exposed to the dry-up – use the attractive central bank liquidity to buy high-yield securities in the form of domestic government bonds. In particular, exposed banks invested, for every euro borrowed at the LTRO, €0.13 in private credit and €0.44 in government bonds. Banks that were relatively less exposed purchased almost exclusively public debt, investing €0.83 in government bonds for every euro borrowed at the LTRO. Overall, we find that the banks in our sample, of the €181.5 billion they borrowed at the LTRO, invested €22.6 billion in credit to firms and €82.7 billion in government bonds.[40]

[38] Our sample banks display a large home bias in their government bond portfolio, even before the LTRO. In June 2011, the share of domestic securities in banks' government bond portfolio was 94%.

[39] A large literature attributes the increased government bond holdings to risk-shifting (Acharya and Steffen (2015), Drechsler et al. (2016)); moral suasion (Ivashina and Becker (forthcoming), Ongena et al. (2016), De Marco and Macchiavelli (2015)); a combination of two (Altavilla et al. (forthcoming), Horvath et al. (2015)); precautionary motives (Angelini et al. (2014)); or the interplay between a regulator and a common central bank (Uhlig (2013)).

[40] In the Online Appendix, we show the estimation results that back these quantitative claims.

5 Credit Supply across Banks and Firms

In this section, we check whether the effect of the dry-up and the effect of the central bank intervention on bank credit supply vary across banks and firms and discuss the channels at work.

5.1 Credit Supply across Banks

To determine whether our effects on bank credit supply vary across bank fundamentals, we interact our two interaction terms in (2) with bank balance sheet characteristics measured in June 2011. For example, we interact them with leverage to check whether, holding constant the exposure to the dry-up, high-leverage banks (i) reduced their credit supply more compared with low-leverage banks during the dry-up relative to the normal period and (ii) restored their credit supply more compared with low-leverage banks during the intervention relative to the dry-up period.

We show the estimation results in Table 7. In column (1), we report our most conservative baseline specification of column (6) in Table 3. We then augment the specification with triple interactions in columns (2) through (6). During the dry-up, less-profitable banks and banks with larger ratios of nonperforming loans reduced credit supply more than healthier banks, holding the exposure to the dry-up constant. During the intervention period, high-leverage banks increased their credit supply more than low-leverage banks, holding the exposure to the dry-up constant. These findings are consistent with the literature, showing that the transmission of monetary policy is driven by financially constrained institutions (Kashyap and Stein (1995)).

5.2 Credit Supply across Firms

We now ask to which firms banks reduced and restored their credit supply the most. To this end, we exploit firm-level information on profitability (EBITDA), size, leverage, and credit risk (Z-score). We re-run our most conservative baseline specification, interacting our two key interaction terms

	$\Delta CreditGranted$					
	(1)	(2)	(3)	(4)	(5)	(6)
$Exposure_{Jun11} \times \mathbb{I}_{DU,LTRO}$	-0.114***	-0.741	-0.099***	-0.475***	0.019	0.846**
	(0.031)	(0.667)	(0.035)	(0.135)	(0.437)	(0.335)
$Exposure_{Jun11} \times \mathbb{I}_{LTRO}$	0.115**	-1.306***	0.090	0.374**	-0.163	-0.358
	(0.053)	(0.444)	(0.065)	(0.186)	(0.608)	(0.513)
$Exposure_{Jun11} \times \mathbb{I}_{DU,LTRO} \times LEV_{Jun11}$		0.039				
		(0.042)				
$Exposure_{Jun11} \times \mathbb{I}_{LTRO} \times LEV_{Jun11}$		0.088***				
		(0.027)				
$Exposure_{Jun11} \times \mathbb{I}_{DU,LTRO} \times ROA_{Jun11}$			2.853***			
			(1.073)			
$Exposure_{Jun11} \times \mathbb{I}_{LTRO} \times ROA_{Jun11}$			-2.056			
			(1.626)			
$Exposure_{Jun11} \times \mathbb{I}_{DU,LTRO} \times T1R_{Jun11}$				-0.014		
				(0.046)		
$Exposure_{Jun11} \times \mathbb{I}_{LTRO} \times T1R_{Jun11}$				0.030		
				(0.064)		
$Exposure_{Jun11} \times \mathbb{I}_{DU,LTRO} \times NPL_{Jun11}$					-0.078***	
					(0.027)	
$Exposure_{Jun11} \times \mathbb{I}_{LTRO} \times NPL_{Jun11}$					0.038	
					(0.040)	
$Exposure_{Jun11} \times \mathbb{I}_{DU,LTRO} \times Large$						-0.523
						(0.323)
$Exposure_{Jun11} \times \mathbb{I}_{LTRO} \times Large$						0.799
						(0.745)
Relationship Controls	✓	✓	✓	✓	✓	✓
Firm-Time FE	✓	✓	✓	✓	✓	✓
Bank-Firm FE	✓	✓	✓	✓	✓	✓
Double Bank-Time Interactions	✓	✓	✓	✓	✓	✓
Observations	2,171,749	2,171,749	2,171,749	2,171,749	2,171,749	2,171,749
R-squared	0.701	0.701	0.701	0.701	0.701	0.701

Table 7: Bank Credit Supply Across Banks. This table presents results from specification (2) augmented to include triple interactions with bank characteristics measured in June 2011. The dependent variable is the difference in log (stock of) credit granted. $Exposure_{Jun11}$ is the exposure to the foreign wholesale market defined in (1). $\mathbb{I}_{DU,LTRO}$ is a dummy equal to one in the dry-up and intervention periods. $\mathbb{I}_{LTRO}$ is a dummy equal to one in the intervention period. The normal period runs from December 2010 to June 2011. The dry-up period runs from June 2011 to December 2011. The intervention period runs from December 2011 to June 2012. The regression includes time-varying relationship controls (the share of total firm i credit coming from bank j, the ratio of drawn credit over committed credit, and the share of overdraft credit by firm i with respect to bank j), bank characteristics in June 2011 (leverage, return on assets, tier 1 ratio, nonperforming loans ratio, and a dummy equal to one if the bank has assets above €500 billion), interacted with the two time dummies. LEV is leverage, ROA is return on assets, $T1R$ is the tier 1 ratio, NPL is nonperforming loans ratio, and $Large$ is a dummy equal to one if the bank has assets above €500 billion. Standard errors double clustered at the bank and firm level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Bank of Italy.

	$\Delta CreditGranted$				
	(1)	(2)	(3)	(4)	(5)
$Exposure_{Jun11} \times \mathbb{I}_{DU,LTRO}$	-0.114***	-0.117	-0.122***	-0.117***	-0.082*
	(0.031)	(0.268)	(0.041)	(0.038)	(0.045)
$Exposure_{Jun11} \times \mathbb{I}_{LTRO}$	0.115**	-0.424***	0.144**	0.121**	0.075
	(0.053)	(0.148)	(0.059)	(0.056)	(0.048)
$Exposure_{Jun11} \times \mathbb{I}_{DU,LTRO} \times FirmSize_{Dec10}$		-0.000			
		(0.019)			
$Exposure_{Jun11} \times \mathbb{I}_{LTRO} \times FirmSize_{Dec10}$		0.036***			
		(0.011)			
$Exposure_{Jun11} \times \mathbb{I}_{DU,LTRO} \times FirmProfitability_{Dec10}$			0.058		
			(0.202)		
$Exposure_{Jun11} \times \mathbb{I}_{LTRO} \times FirmProfitability_{Dec10}$			-0.339***		
			(0.112)		
$Exposure_{Jun11} \times \mathbb{I}_{DU,LTRO} \times FirmLeverage_{Dec10}$				-0.018	
				(0.024)	
$Exposure_{Jun11} \times \mathbb{I}_{LTRO} \times FirmLeverage_{Dec10}$				0.012	
				(0.036)	
$Exposure_{Jun11} \times \mathbb{I}_{DU,LTRO} \times FirmRisky_{Dec10}$					-0.055**
					(0.027)
$Exposure_{Jun11} \times \mathbb{I}_{LTRO} \times FirmRisky_{Dec10}$					0.072***
					(0.026)
Firm-Time FE	✓	✓	✓	✓	✓
Bank-Firm FE	✓	✓	✓	✓	✓
Bank Controls (interacted with time dummies)	✓	✓	✓	✓	✓
Relationship Controls	✓	✓	✓	✓	✓
Observations	2,171,749	1,389,799	1,414,211	1,414,211	1,386,784
R-squared	0.701	0.686	0.688	0.688	0.686

Table 8: Bank Credit Supply Across Firms. This table presents results from specification (2) augmented to include triple interactions with firm balance sheet characteristics. The dependent variable is the difference in log (stock of) credit granted. $Exposure_{Jun11}$ is the exposure to the foreign wholesale market defined in (1). $\mathbb{I}_{DU,LTRO}$ is a dummy equal to one in the dry-up and intervention periods. $\mathbb{I}_{LTRO}$ is a dummy equal to one in the intervention period. The normal period runs from December 2010 to June 2011. The dry-up period runs from June 2011 to December 2011. The intervention period runs from December 2011 to June 2012. The regression includes time-varying relationship controls (the share of total firm i credit coming from bank j, the ratio of drawn credit over committed credit, and the share of overdraft credit by firm i with respect to bank j), bank characteristics in June 2011 (leverage, return on assets, tier 1 ratio, nonperforming loans ratio, and a dummy equal to one if the bank has assets above €500 billion), interacted with the two time dummies. Firm characteristics are measured in December 2010 and defined as follows: $FirmSize$ is log of total assets; $FirmProfitability$ is EBITDA; $FirmLeverage$ is firm leverage; $FirmRisky$ is a dummy equal to one if the firm is considered risky based on the Z-score greater or equal than 5 (range 1-9). We do not observe the continuous Z-score variable and are therefore forced to use a dummy variable to measure firm risk. Standard errors double clustered at the bank and firm level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Bank of Italy Cebi-Cerved Database.

with firm characteristics, measured in December 2010.[41]

We show the estimation results in Table 8. Again, we report our baseline specification in column (1), as a reference. In columns (2) through (5), we include the triple interaction terms. For example, in column (2), we ask whether the effect of the dry-up and the effect of the intervention on credit supply change depending on firm size, where the variable $FirmSize_{Dec10}$ is the log of firm total assets in December 2010. Similarly, the last three columns include triple interactions with firm profitability, firm leverage, and a firm riskiness dummy. Note that the firm-bank and the time-firm double interactions are absorbed by the fixed effects.

We find that, holding the exposure to the dry-up constant, the effect of the dry-up is stable across different firm characteristics, with the exception of risky clients, to which affected banks reduced their credit supply more compared with safer clients. However, holding the exposure to the dry-up constant, during the intervention period, more-exposed banks increased their credit supply especially to large, low-profitability, and risky firms, compared with less-exposed banks.[42]

6 Effect on Firm Borrowing

In this section, we analyze total firm borrowing, collapsing our bank-firm-time data set at the firm-time level. In Section 6.1, we examine the effect of the dry-up and the effect of the intervention on firm borrowing behavior. In Section 6.2, we compute aggregate effects.

For each firm, we compute the *indirect* exposure to the dry-up based on its banking relationships.

[41] We lose 45% of observations by merging the firm-level data set from Cebi-Cerved with bank-firm observations from the comprehensive national credit registry. However, we can still count on more than 1 million observations at any given date. As firm-level characteristics are available at an annual frequency, we use firm characteristics measured in December 2010 (last observation before the dry-up). We present firm summary statistics in the Online Appendix.

[42] These findings relate to the literature on monetary policy and bank risk-taking (Peydró et al. (2017), Jimenez et al. (2014), Paligorova and Santos (2017), Morais et al. (forthcoming)).

Formally, the indirect exposure of firm i is the weighted average of its banks' exposures to the dry-up, where the weights are given by the total credit drawn from each bank in June 2011:

$$\widetilde{Exposure}_{i,Jun11} = \frac{\sum_j Drawn_{ij,Jun11} Exposure_{j,Jun11}}{\sum_j Drawn_{ij,Jun11}} \tag{6}$$

where $Exposure_{Jun11}$ is defined in (1).

6.1 Do Firms Switch Lenders?

We now ask (i) whether firms are able to avoid the credit contraction during the dry-up by substituting the reduction in credit from affected banks with more credit from less-affected banks, and, similarly, (ii) whether firms expand their *total* borrowing following the increased credit supply by affected banks during the intervention period. To this end, we estimate the following model:

$$\begin{aligned}\Delta CreditDrawn_{it} = \alpha + \beta_1 \widetilde{Exposure}_{i,Jun11} \times \mathbb{I}_{DU,LTRO} + \beta_2 \widetilde{Exposure}_{i,Jun11} \times \mathbb{I}_{LTRO} \\ + \psi' \Lambda_{it} + \phi' \Gamma_{it} + \eta_t + \chi_i + \epsilon_{it}\end{aligned} \tag{7}$$

where observations are at the (i,t) firm-period level. We use the four dates that delimit the normal period, the dry-up period, and the intervention period (December 2010, June 2011, December 2011, and June 2012). The dependent variable is the change in log (stock of) total firm i credit drawn at time t, and $\widetilde{Exposure}_i$ is the indirect exposure of firm i to the dry-up defined in (6).[43] $\mathbb{I}_{DU,LTRO}$ and $\mathbb{I}_{LTRO}$ are the usual time dummies, η are time fixed effects, and χ are firm fixed effects.

We saturate the regression with bank- and firm-level controls. Bank characteristics (vector

[43] We now use credit drawn – and not granted – as a dependent variable. This choice is motivated by our goal to find whether firms reacted to the credit contraction/expansion by changing their (potentially bank-specific) demand.

Λ) include the indirect exposure of firm i to each balance sheet control used in our baseline regression, following the definition illustrated in (6), interacted with the two time dummies. Firm characteristics (vector Γ) include the interaction between the two time dummies and a series of firm characteristics, namely size, profitability, leverage, and credit risk. As firm variables are available at an annual frequency, we use observations in December 2010.

Similar to the baseline regression, β_1 captures the extent to which the difference in bank credit growth between more- and less-exposed firms varies during the dry-up relative to the normal period, and β_2 captures the extent to which the difference in bank credit growth between more- and less-exposed firms varies during the intervention period relative to the dry-up period.

We show the estimation results in Table 9. In the first column, we find that the firms more exposed to the dry-up reduced borrowing from banks during the dry-up and restored it during the intervention period compared with firms less exposed to the dry-up. These results suggest that (i) firms were unable to completely undo the credit contraction and were therefore affected by the wholesale funding dry-up, and (ii) the intervention helped firms re-access bank credit. The inability to substitute sources of funding during the credit contraction is consistent with two strands of literature. In the literature on "slow moving" capital, keeping capital in liquid form in anticipation of possible fire sales is costly (Duffie and Strulovici (2012)). In the literature on information frictions, lenders have private information about their borrowers, and borrowers left looking for a new lender are adversely selected, preventing a full reallocation of credit (Darmouni (2016)).

In columns (2) through (5), we include triple interaction terms to ask which firms were able to at least partially undo the credit crunch and which types of firms benefited the most from the intervention. We find that the decline in credit the exposed firms experienced during the dry-up (relative to the normal period) was milder for risky firms; risky firms also benefited less from the increase in credit during the intervention period. Our findings are consistent with Ippolito et al.

	$\Delta CreditDrawn$				
	(1)	(2)	(3)	(4)	(5)
$\mathbb{I}_{DU,LTRO} \times \widetilde{Exposure}_{Jun11}$	-0.701***	-0.435	-0.671***	-0.707***	-1.060***
	(0.159)	(0.953)	(0.172)	(0.158)	(0.164)
$\mathbb{I}_{LTRO} \times \widetilde{Exposure}_{Jun11}$	0.812***	1.152	0.781***	0.812***	0.994***
	(0.190)	(1.085)	(0.202)	(0.196)	(0.188)
$\mathbb{I}_{DU,LTRO} \times \widetilde{Exposure}_{Jun11} \times FirmSize_{Dec10}$		-0.019			
		(0.068)			
$\mathbb{I}_{LTRO} \times \widetilde{Exposure}_{Jun11} \times FirmSize_{Dec10}$		-0.024			
		(0.076)			
$\mathbb{I}_{DU,LTRO} \times \widetilde{Exposure}_{Jun11} \times FirmProfitability_{Dec10}$			-0.492		
			(0.382)		
$\mathbb{I}_{LTRO} \times \widetilde{Exposure}_{Jun11} \times FirmProfitability_{Dec10}$			0.492		
			(0.331)		
$\mathbb{I}_{DU,LTRO} \times \widetilde{Exposure}_{Jun11} \times FirmLeverage_{Dec10}$				0.097	
				(0.123)	
$\mathbb{I}_{LTRO} \times \widetilde{Exposure}_{Jun11} \times FirmLeverage_{Dec10}$				-0.012	
				(0.251)	
$\mathbb{I}_{DU,LTRO} \times \widetilde{Exposure}_{Jun11} \times FirmRisky_{Dec10}$					0.552***
					(0.191)
$\mathbb{I}_{LTRO} \times \widetilde{Exposure}_{Jun11} \times FirmRisky_{Dec10}$					-0.283**
					(0.137)
Time FE	✓	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓	✓
Bank-level Controls Λ	✓	✓	✓	✓	✓
Firm-level Controls Γ	✓	✓	✓	✓	✓
Observations	625,509	625,509	625,509	625,509	625,509
R-squared	0.260	0.260	0.260	0.260	0.260

Table 9: Effect on Firm Borrowing. This table presents the results from specification (7). The dependent variable is the difference in log (stock of) total credit. Total credit includes drawn credit from revolving credit lines and loans backed by account receivables and term loans. $\widetilde{Exposure}$ is the firm indirect exposure to the foreign wholesale defined in (6). $\mathbb{I}_{DU,LTRO}$ is a dummy equal to one in the *dry-up* and *intervention* periods. $\mathbb{I}_{LTRO}$ is a dummy equal to one in the *intervention* period. The *normal* period runs from December 2010 to June 2011. The *dry-up* period runs from June 2011 to December 2011. The *intervention* period runs from December 2011 to June 2012. Firm characteristics are measured in December 2010 and defined as follows: $FirmSize$ is log of total assets; $FirmProfitability$ is EBITDA; $FirmLEV$ is firm leverage; $FirmRisky$ is a dummy equal to one if the firm is considered risky based on the Z-score greater or equal than 5 (range 1-9). We do not observe the continuous Z-score variable and are therefore forced to use a dummy variable to measure firm risk. Estimated coefficients on double firm-time interactions and double bank-time interactions (with exception of the exposure-time term) are included in the estimation, but omitted in this table. The firms in the sample have at least two credit lines with two separate banks at any given time t. Standard errors double clustered at the main bank level (calculated as of June 2011) in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Bank of Italy, Cebi-Cerved Database.

(2016), who show that financially constrained firms increase the drawdown on their credit lines more than the average firm following a negative shock hitting their lender bank, as financially constrained firms might face tougher consequences if they run out of credit compared with less constrained firms.

6.2 Aggregate Effect

We next examine the aggregate effect of the intervention on bank credit supply to firms. We use a counterfactual exercise (Chodorow-Reich (2014b)) to estimate the drop in credit that would have occurred from December 2011 to June 2012 if the ECB had not offered LTRO liquidity.

We proceed in five steps. First, we estimate the firm-time fixed effects $\hat{\mu}_{it}$ from our baseline specification (2). By capturing firm time-varying heterogeneity, these fixed effects effectively capture borrowers' credit demand. Second, we compute the firm-level *indirect* exposure to the dry-up using (6). Third, having obtained firm demand and firm exposure to the wholesale funding shock, we plug the stored firm-time fixed effects $\hat{\mu}$ into the firm-level equation and estimate

$$\begin{aligned}\Delta CreditGranted_{it} = \alpha + \beta_1 \widetilde{Exposure}_{i,Jun11} \times \mathbb{I}_{DU,LTRO} + \beta_2 \widetilde{Exposure}_{i,Jun11} \times \mathbb{I}_{LTRO} \\ + \hat{\mu}_{it} + \psi' \Lambda_{it} + \phi' \Gamma_{it} + \eta_t + \chi_i + \epsilon_{it} \end{aligned} \tag{8}$$

where the only differences from (7) are the dependent variable (we now use credit *granted*) and the inclusion of the fixed effects $\hat{\mu}$ as an independent variable. Fourth step, we use the coefficients estimated in (8) and average exposures to the dry-up to predict the change in firm loan growth. In the last step, we aggregate at the period-level using a weighted average of firm-level loan growth, where the weights are given by firm-level granted credit in December 2011.

We then compare the world with no LTRO intervention with the world with LTRO intervention.

We obtain the former by simply setting $\beta_2 = 0$ in the last predictive regression. Of course, this analysis is subject to all caveats associated with a partial equilibrium exercise. In particular, the underlying assumption is that, absent the ECB intervention, during the intervention period the supply of credit granted would have decreased at the same rate of the dry-up period. We find that the LTRO had a positive effect on credit supply, increasing it 2%. The effect is quantitatively large: without the intervention, bank credit would have contracted 5.6% in the intervention period instead of the observed 3.6%. The intervention does not, however, fully restore bank credit supply, given that the dry-up caused a credit contraction of 3.7%.

7 Conclusion

There is substantial agreement that central banks should act as liquidity providers during crises. In this paper, we analyze the transmission of the largest liquidity provision in history, the 2011–12 ECB three-year LTRO, on credit to firms and holdings of securities by Italian banks. In this setting, which provides a rare case of a bank funding dry-up followed by a liquidity provision, we combine firm-level data from the national credit registry with supervisory data on bank security-level holdings, thus obtaining an unprecedented view of the two largest asset classes held by banks.

Our three main findings can be summarized as follows. First, by providing *long-term* collateralized loans, central banks help banks restore their private credit supply. Second, banks – especially those that do not experience a dry-up before the liquidity provision – use a large portion of liquidity to buy high-yield securities that, in the context of the eurozone crisis, are mostly domestic government bonds. Third, given that banks hit by the funding shock erode their eligible collateral during the dry-up, a government intervention, by granting banks access to the central bank loans, is necessary for the transmission of liquidity to firms.

More broadly, our results inform the theory and practice of central bank liquidity provisions

during crises. We show that the design of the liquidity provision matters for its transmission. In particular, the maturity at which the central bank lends to banks and the eligibility of collateral, usually overlooked features of liquidity provisions, play a key role. Of course, the benefits of a longer maturity and the relaxation of collateral eligibility rules should be weighed against the costs in terms of ex-ante moral hazard. We believe these are promising areas for future research.

References

Acharya, V. V., T. Eisert, C. Eufinger, and C. Hirsch (2016): "Real Effects of the Sovereign Debt Crisis in Europe: Evidence from Syndicated Loans," *Working Paper*.

——— (2017): "Whatever it takes: The Real Effects of Uncoventional Monetary Policy," *Working Paper*.

Acharya, V. V. and G. Plantin (2017): "Monetary Easing and Financial Stability," *Working Paper*.

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

Agarwal, S., S. Chomsisengphet, N. Mahoney, and J. Stroebel (forthcoming): "Do Banks Pass Through Credit Expansions? The Marginal Profitability of Consumer Lending During the Great Recession," *Quarterly Journal of Economics*.

Akerlof, G. A. (1970): "The Market for Lemons: Quality Uncertainty and the Market Mechanism," *Quarterly Journal of Economics*, 84, 488500.

Altavilla, C., M. Pagano, and S. Simonelli (forthcoming): "Bank Exposures and Sovereign Stress Transmission," *Review of Finance*.

Alves, N., D. Bonfim, and C. Soares (2016): "Surviving the Perfect Storm: the Role of the Lender of Last Resort," *Working Paper*.

Andrade, P., C. Cahn, H. Fraisse, and J.-S. Mesonnier (2017): "Can the Provision of Long-Term Liquidity Help to Avoid a Credit Crunch? Evidence from the Eurosystem's LTRO," *Working Paper*.

Angelini, P., G. Grande, and F. Panetta (2014): "The Negative Feedback Loop Between Banks and Sovereigns," *Working Paper*.

Bagehot, W. (1873): "Lombard Street," *H.S. King, London*.

Bank of Italy (2012): "Financial Stability Report," .

Beltratti, A. and R. M. Stulz (2017): "How Important Was Contagion Through Banks During the European Sovereign Crisis?" *Working Paper*.

Benmelech, E., R. R. Meisenzahl, and R. Ramcharan (2017): "The Real Effects of Liquidity During the Financial Crisis: Evidence From Automobiles," *Quarterly Journal of Economics*, 132, 317–365.

Bernanke, B. S. and A. S. Blinder (1992): "The Federal Funds Rate and the Channels of Monetary Transmission," *American Economic Review*, 82, 901–21.

Bocola, L. (2016): "The Pass-Through of Sovereign Risk," *Journal of Political Economy*, 124, 879–926.

Bofondi, M., L. Carpinelli, and E. Sette (forthcoming): "Credit Supply During a Sovereign Debt Crisis," *Journal of the European Economic Association*.

Bottero, M., S. Lenzu, and F. Mezzanotti (2017): "Sovereign Debt Exposure and the Bank Lending Channel: Impact on Credit Supply and the Real Economy," *Working Paper*.

Brunnermeier, M. K. (2015): "Diabolic Loop between Sovereign and Banking Risk," *G7 Bundesbank and BMF Panel Discussion*.

Cahn, C., A. Duquerroy, and W. Mullins (2017): "Unconventional Monetary Policy and Bank Lending Relationships," *Working Paper*.

Calomiris, C. W. and C. M. Kahn (1991): "The Role of Demandable Debt in Structuring Optimal Banking Arrangements," *American Economic Review*, 81, 497–513.

Casiraghi, M., E. Gaiotti, L. Rodano, and A. Secchi (2013): "The Impact of Unconventional Monetary Policy on the Italian Economy During the Sovereign Debt Crisis," *Questioni di Economia e Finanza*, 203.

Chakraborty, I., I. Goldstein, and A. MacKinlay (2016): "Monetary Stimulus and Bank Lending," *Working Paper*.

Chava, S. and A. Purnanandam (2011): "The Effect of Banking Crisis on Bank-Dependent Borrowers," *Journal of Financial Economics*, 99, 116–135.

Chernenko, S. and A. Sunderam (2014): "Frictions in Shadow Banking: Evidence from the Lending Behavior of Money Market Funds," *Review of Financial Studies*, 27, 1717–1750.

Chodorow-Reich, G. (2014a): "Effects of Unconventional Monetary Policy on Financial Institutions," *Brookings Papers on Economic Activity*, Spring, 155–204.

——— (2014b): "The Employment Effects of Credit Market Disruptions: Firm-level Evidence from the 2008-09 Financial Crisis," *Quarterly Journal of Economics*, 129, 1–59.

Choi, D. B. and J. Santos (2017): "A Theory of Collateral for the Lender of Last Resort," *Working Paper*.

Cingano, F., F. Manaresi, and E. Sette (2016): "Does Credit Crunch Investments Down? New Evidence on the Real Effects of the Bank-Lending Channel," *Review of Financial Studies*, 29, 2737–2773.

Crosignani, M. (2017): "Why Are Banks Not Recapitalized During Crises?" *Working Paper*.

Crosignani, M., M. Faria-e Castro, and L. Fonseca (2017): "The (Unintended?) Consequences of the Largest Liquidity Injection Ever," *Working Paper*.

Daetz, S. L., M. G. Subrahmanyam, D. Yongjun Tang, and S. Q. Wang (2016): "Did ECB Liquidity Injections Help The Real Economy," *Working Paper*.

Darmouni, O. (2016): "Estimating Informational Frictions in Sticky Relationships," *Working Paper*.

Darmouni, O. and A. Rodnyansky (2017): "The Effects of Quantitative Easing on Bank Lending Behavior," *Review of Financial Studies*, 30, 38583887.

De Marco, F. (forthcoming): "Bank Lending and the Sovereign Debt Crisis," *Journal of Financial and Quantitative Analysis*.

De Marco, F. and M. Macchiavelli (2015): "The Political Origin of Home Bias: The Case of Europe," *Working Paper*.

Di Maggio, M., A. Kermani, B. Keys, T. Piskorski, R. Ramcharan, A. Seru, and V. Yao (forthcoming): "Monetary Policy Pass-Through: Mortgage Rates, Household Consumption and Voluntary Deleveraging," *American Economic Review*.

Di Maggio, M., A. Kermani, and C. Palmer (2016): "How Quantitative Easing Works: Evidence on the Refinancing Channel," *Working Paper*.

Drechsler, I., T. Drechsel, D. Marques, and P. Schnabl (2016): "Who Borrows from the Lender of Last Resort," *Journal of Finance*, 71, 1933–1974.

Drechsler, I., A. Savov, and P. Schnabl (forthcoming): "The Deposit Channel of Monetary Policy," *Quarterly Journal of Economics*.

Duffie, D. and B. Strulovici (2012): "Capital Mobility and Asset Pricing," *Econometrica*, 80, 2469–2509.

Farhi, E. and J. Tirole (forthcoming): "Deadly Embrace: Sovereign and Financial Balance Sheets Doom Loops," *Review of Economics Studies*.

Foley-Fisher, N., R. Ramcharan, and E. Yu (2016): "The Impact of Unconventional Monetary Policy on Firm Financing Constraints: Evidence from the Maturity Extension Program," *Journal of Financial Economics*, 122, 409–429.

Garcia-de-Andoain, C., F. Heider, , M. Hoerova, and S. Manganelli (2016): "Lending-of-last-resort is as Lending-of-last-resort Does: Central Bank liquidity Provision and Interbank Market Functioning in the Euro Area," *Journal of Financial Intermediation*, 28, 32–47.

Garcia-Posada, M. and M. Marchetti (2016): "The Bank Lending Channel of Unconventional Monetary Policy: the Impact of the VLTROS on Credit Supply in Spain," *Economic Modelling*, 58, 427–441.

Gennaioli, N., A. Martin, and S. Rossi (2016): "Banks, Government Bonds, and Default: What do the Data Say?" *Working Paper*.

Giannone, D., M. Lenza, H. Pill, and L. Reichlin (2012): "The ECB and the Interbank Market," *The Economic Journal*, 122, F467F486.

Gorton, G. and G. Pennacchi (1990): "Financial Intermediaries and Liquidity Creation," *Journal of Finance*, 45, 1540–6261.

Grosse-Rueschkamp, B., S. Steffen, and D. Streitz (2017): "Cutting Out the Middleman — The ECB as Corporate Bond Investor," *Working Paper*.

Heider, F., F. Saidi, and G. Schepens (2017): "Life Below Zero: Bank Lending Under Negative Policy Rates," *Working Paper*.

Horvath, B. L., H. Huizinga, and V. Ioannidou (2015): "Determinants and Valuation Effects of the Home Bias in European Banks Sovereign Debt Portfolios," *Working Paper*.

Ippolito, F., J.-L. Peydró, A. Polo, and E. Sette (2016): "Double Bank Runs and Liquidity Risk Management," *Journal of Financial Economics*, 122, 135–154.

Ivashina, V. and B. Becker (forthcoming): "Financial Repression in the European Sovereign Debt Crisis," *Review of Finance*.

Ivashina, V. and D. S. Scharfstein (2010): "Bank Lending During the Financial Crisis of 2008," *Journal of Financial Economics*, 97, 319–338.

Ivashina, V., D. S. Scharfstein, and J. C. Stein (2015): "Dollar Funding and the Lending Behavior of Global Banks," *Quarterly Journal of Economics*, 130, 1241–1281.

Iyer, R., J.-L. Peydró, S. da Rocha-Lopes, and A. Schoar (2014): "Interbank Liquidity Crunch and the Firm Credit Crunch: Evidence from the 2007-2009 Crisis," *Review of Financial Studies*, 27, 347–72.

Jimenez, 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, 2301–2326.

——— (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, 463–505.

Kandrac, J. and B. Schlusche (2017): "Quantitative Easing and Bank Risk Taking: Evidence from Lending," *Working Paper*.

Kashyap, A. K., O. A. Lamont, and J. C. Stein (1994): "Credit Conditions and the Cyclical Behavior of Inventories," *Quarterly Journal of Economics*, 109, 565–92.

Kashyap, A. K. and J. C. Stein (1995): "The Impact of Monetary Policy on Bank Balance Sheets," *Carnegie-Rochester Conference Series on Public Policy*, 42, 151–195.

——— (2000): "What do a Million Observations on Banks Say About the Transmission of Monetary Policy?" *American Economic Review*, 90, 407–428.

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

Krishnamurthy, A., S. Nagel, and A. Vissing-Jorgensen (2017): "ECB Policies involving Government Bond Purchases: Impact and Channels," *Working Paper*.

Krishnamurthy, A. and A. Vissing-Jorgensen (2013): "The Ins and Outs of Large Scale Asset Purchases," *Kansas City Federal Reserve Symposium on Global Dimensions of Unconventional Monetary Policy*.

Kurtzman, R., S. Luck, and T. Zimmermann (2017): "Did QE Lead to Lax Bank Lending Standards? Evidence from the Federal Reserves LSAPs," *Working Paper*.

Morais, B., J.-L. Peydró, and C. Ruiz (forthcoming): "The International Bank Lending Channel of Monetary Policy Rates and QE: Credit Supply, Reach-for-Yield, and Real Effects," *Journal of Finance*.

Ongena, S., A. A. Popov, and N. van Horen (2016): "The Invisible Hand of the Government: Moral Suasion During the European Sovereign Debt Crisis," *Working Paper*.

Ongena, S. and D. C. Smith (2000): "What Determines the Number of Bank Relationships? Cross-Country Evidence," *Journal of Financial Intermediation*, 9, 26–56.

Paligorova, T. and J. Santos (2017): "Monetary Policy and Bank Risk-Taking: Evidence from the Corporate Loan Market," *Journal of Financial Intermediation*, 30, 35–49.

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

Perignon, C., D. Thesmar, and G. Vuillemey (forthcoming): "Wholesale Funding Dry-Ups," *Journal of Finance*.

Peydró, J. L., A. Polo, and E. Sette (2017): "Monetary Policy at Work: Security and Credit Application Registers Evidence," *Working Paper*.

Popov, A. A. and N. van Horen (2015): "Exporting Sovereign Stress: Evidence from Syndicated Bank Lending During the Euro Area Sovereign Debt Crisis," *Review of Finance*, 19, 1825–1866.

Puri, M., J. Rocholl, and S. Steffen (2011): "Global Retail Lending in the Aftermath of the US Financial Crisis: Distinguishing Between Supply and Demand Effects," *Journal of Financial Economics*, 100, 319–338.

Schnabl, P. (2012): "The International Transmission of Bank Liquidity Shocks: Evidence from an Emerging Market," *Journal of Finance*, 67, 897–932.

Stein, J. (1998): "An Adverse-Selection Model of Bank Asset and Liability Management with Implications for the Transmission of Monetary Policy," *RAND Journal of Economics*, 29, 466–86.

Uhlig, H. (2013): "Sovereign Default Risk and Banks in a Monetary Union," *German Economic Review*, 15, 23–41.

Van Bekkum, S., R. M. Irani, and M. Gabarro (forthcoming): "Does a Larger Menu Increase Appetite? Collateral Eligibility and Credit Supply," *Review of Financial Studies*.

van der Kwaak, C. (2017): "Financial Fragility and Unconventional Central Bank Lending Operations," *Working Paper*.

Williams, E. (2016): "Monetary Policy and the Funding Structure of Banks," *Working Paper*.

Appendix A Additional Figures

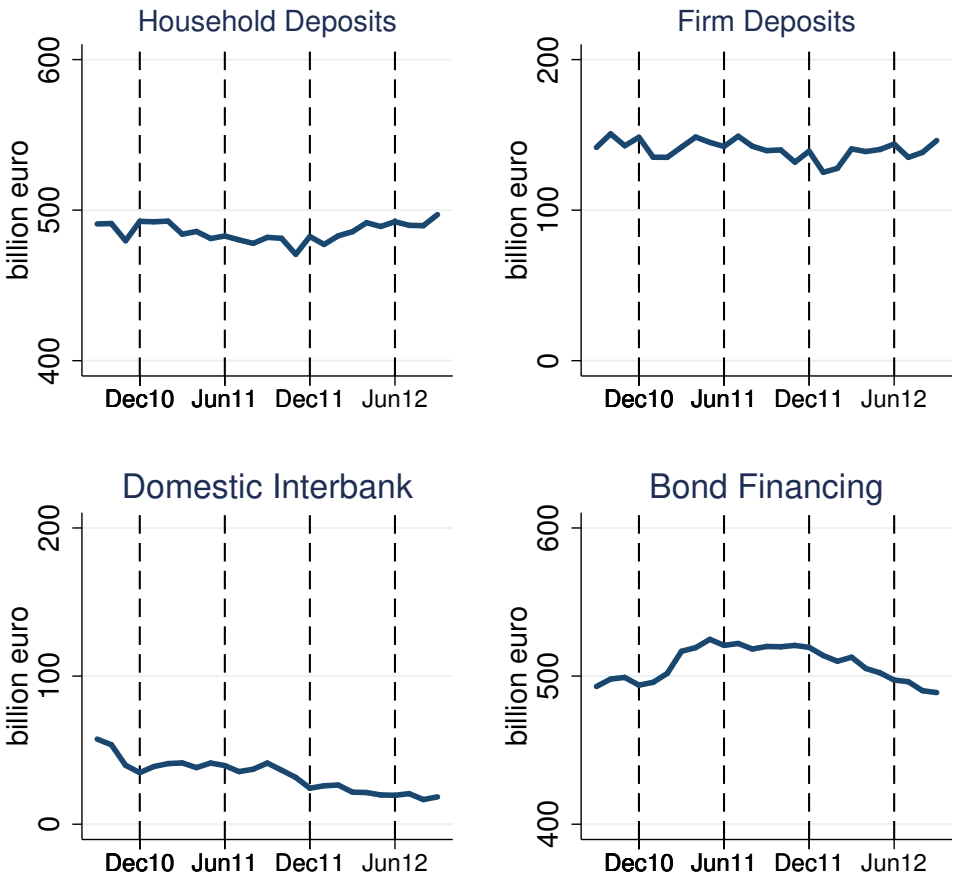

Figure A.1: Bank Funding Sources. This figure shows the time series evolution of various sources of bank funding during our sample period. The dashed vertical lines correspond to December 2010, June 2011, December 2011, and June 2012. They delimit the normal, dry-up, and intervention periods. The four panels show household deposits, firm deposits, domestic interbank funding, and bond financing, respectively. Quantities are in billion euro. Source: Bank of Italy.

Figure A.2: Outcome Variable: Time-Series Evolution. This figure shows the time-series evolution of our outcome variable during the normal period, dry-up period, and intervention period. Source: Bank of Italy.

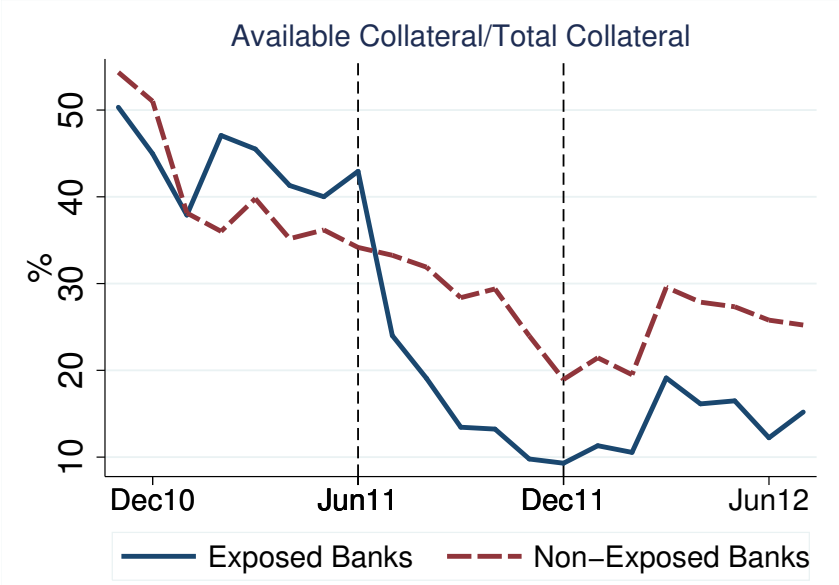

Figure A.3: Erosion of ECB-Eligible Collateral During the Dry-Up. This plot shows the time-series evolution of available (not pledged) ECB-eligible collateral divided by total ECB-eligible collateral. The solid (dashed) line shows the share of available ECB-eligible collateral from December 2010 to June 2012 for exposed (non-exposed) banks. Exposed (non-exposed) banks have exposure to the dry-up above (below) median. The two vertical dashed lines delimit the dry-up period. Collateral is haircut adjusted. Source: Bank of Italy.

Online Appendix[1]

OA.1 Specification

Consider the following simplified version of (2):

$$y_{jt} = \beta_0 + \beta_1 T_j + \beta_2 \mathbb{I}_{DU,LTRO} + \beta_3 T_j \times \mathbb{I}_{DU,LTRO} + \beta_4 \mathbb{I}_{LTRO} + \beta_5 T_j \times \mathbb{I}_{LTRO} + \epsilon_{it} \tag{OA.1}$$

where j is a bank and t is a date. T_j is a treatment dummy. There are three periods: the dummy $\mathbb{I}_{DU,LTRO}$ is equal to one in the second and third period. The dummy $\mathbb{I}_{LTRO}$ is equal to one in the last period.
Claim. The coefficient β_3 (β_5) captures the difference in y_{jt} for the treated group during the second (third) period relative to control group during the first (second) period.

$$\begin{aligned}
\beta_3 =& E(y_{jt}|\mathbb{I}_{DU,LTRO}=1,\mathbb{I}_{LTRO}=0,T_j=1) - E(y_{jt}|\mathbb{I}_{DU,LTRO}=0,\mathbb{I}_{LTRO}=0,T_j=1) \\
&- \big(E(y_{jt}|\mathbb{I}_{DU,LTRO}=1,\mathbb{I}_{LTRO}=0,T_j=0) - E(y_{jt}|\mathbb{I}_{DU,LTRO}=0,\mathbb{I}_{LTRO}=0,T_j=0)\big) \\
\beta_5 =& E(y_{jt}|\mathbb{I}_{DU,LTRO}=1,\mathbb{I}_{LTRO}=1,T_j=1) - E(y_{jt}|\mathbb{I}_{DU,LTRO}=1,\mathbb{I}_{LTRO}=0,T_j=1) \\
&- \big(E(y_{jt}|\mathbb{I}_{DU,LTRO}=1,\mathbb{I}_{LTRO}=1,T_j=0) - E(y_{jt}|\mathbb{I}_{DU,LTRO}=1,\mathbb{I}_{LTRO}=0,T_j=0)\big)
\end{aligned}$$

Proof. Using (OA.1), we can compute the following conditional expectations:

$$\begin{aligned}
&E(y_{jt}|\mathbb{I}_{DU,LTRO}=0,\mathbb{I}_{LTRO}=0,T_j=0) = \beta_0 \\
&E(y_{jt}|\mathbb{I}_{DU,LTRO}=0,\mathbb{I}_{LTRO}=0,T_j=1) = \beta_0 + \beta_1 \\
&E(y_{jt}|\mathbb{I}_{DU,LTRO}=1,\mathbb{I}_{LTRO}=0,T_j=0) = \beta_0 + \beta_2 \\
&E(y_{jt}|\mathbb{I}_{DU,LTRO}=0,\mathbb{I}_{LTRO}=0,T_j=1) = \beta_0 + \beta_1 + \beta_2 + \beta_3 \\
&E(y_{jt}|\mathbb{I}_{DU,LTRO}=1,\mathbb{I}_{LTRO}=1,T_j=0) = \beta_0 + \beta_2 + \beta_4 \\
&E(y_{jt}|\mathbb{I}_{DU,LTRO}=1,\mathbb{I}_{LTRO}=1,T_j=1) = \beta_0 + \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 \\
&\Rightarrow (y_{jt}|\mathbb{I}_{DU,LTRO}=1,\mathbb{I}_{LTRO}=0,T_j=1) - E(y_{jt}|\mathbb{I}_{DU,LTRO}=0,\mathbb{I}_{LTRO}=0,T_j=1) \\
&- \big(E(y_{jt}|\mathbb{I}_{DU,LTRO}=1,\mathbb{I}_{LTRO}=0,T_j=0) - E(y_{jt}|\mathbb{I}_{DU,LTRO}=0,\mathbb{I}_{LTRO}=0,T_j=0)\big) = \beta_3 \\
&\Rightarrow E(y_{jt}|\mathbb{I}_{DU,LTRO}=1,\mathbb{I}_{LTRO}=1,T_j=1) - E(y_{jt}|\mathbb{I}_{DU,LTRO}=1,\mathbb{I}_{LTRO}=0,T_j=1) \\
&- \big(E(y_{jt}|\mathbb{I}_{DU,LTRO}=1,\mathbb{I}_{LTRO}=1,T_j=0) - E(y_{jt}|\mathbb{I}_{DU,LTRO}=1,\mathbb{I}_{LTRO}=0,T_j=0)\big) = \beta_5
\end{aligned}$$

□

[1]Date: January 2018. Not for publication. The opinions expressed are those of the author and do not necessarily reflect the views of the Board of Governors of the Federal Reserve System, the Bank of Italy, the European Central Bank or anyone associated with these institutions. All results have been reviewed to ensure that no confidential information is disclosed. All errors are our own. Emails: luisa.carpinelli@bancaditalia.it and matteo.crosignani@frb.gov.

OA.2 Additional Figures

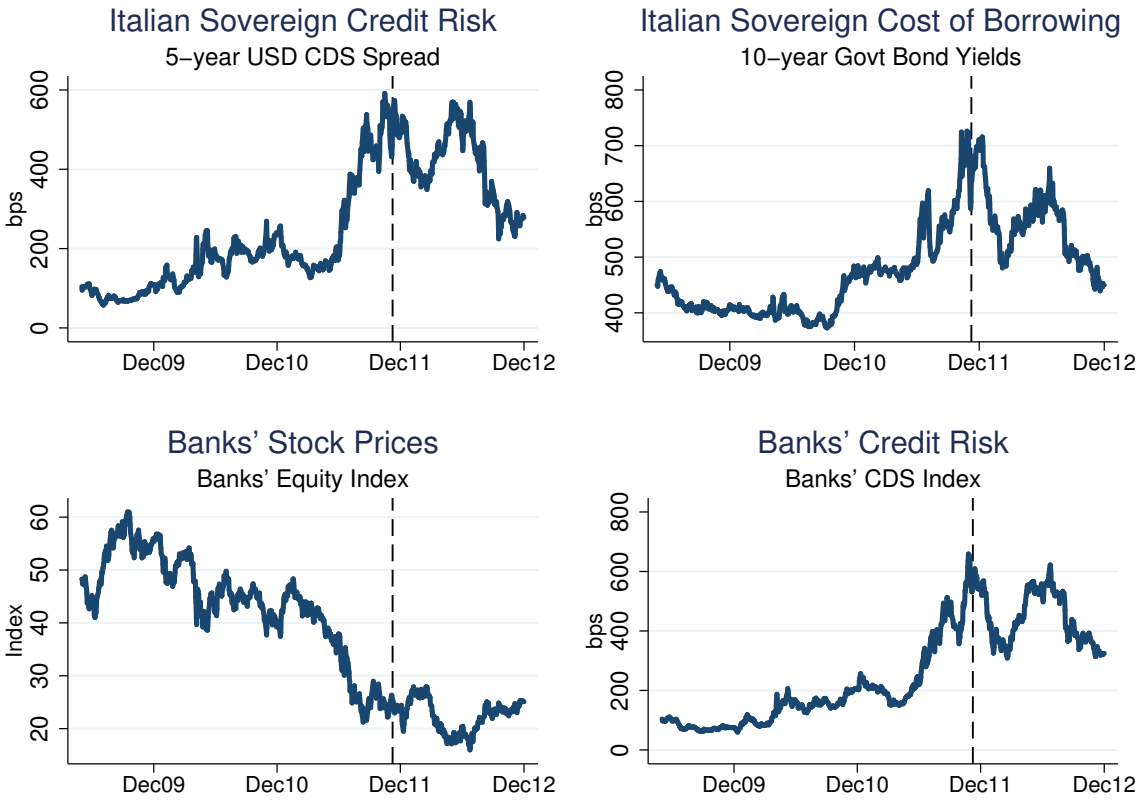

Figure OA.1: Italian Bank and Sovereign Credit Risk. The top left figure shows the Italian sovereign 5-year USD-denominated CDS spread. The top right figure shows the Italian 10-year government bond yield. The bottom left figure shows Italian banks' equity prices (MSCI Italian Financials Index). The bottom right figure shows Italian banks' CDS spread using data on the six major banks with CDS spreads available on Bloomberg for the entire sample. The vertical dashed line corresponds to the LTRO announcement on December 8, 2011. Source: Bloomberg.

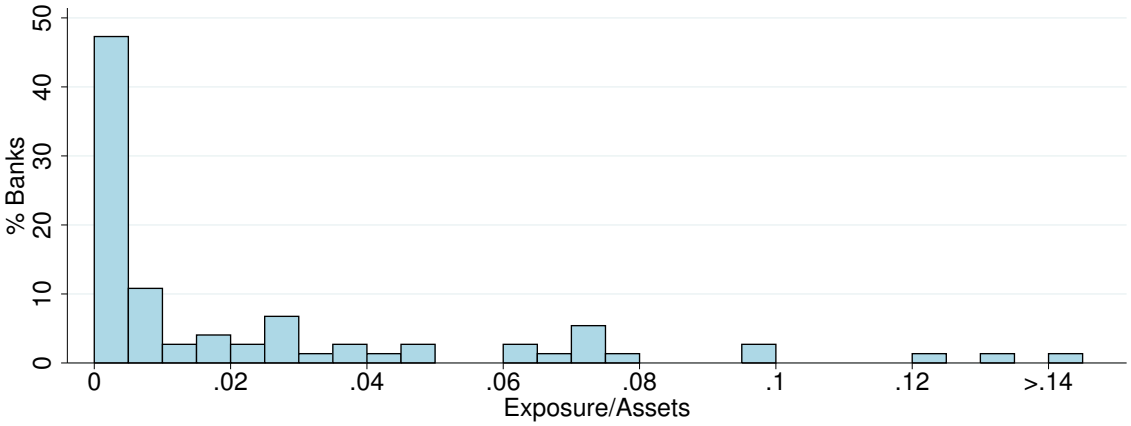

Figure OA.2: Bank Exposure to the Wholesale Funding Dry-Up. This histogram shows bank-level exposure to the foreign wholesale funding market defined in (1). The y-axis is the share of sample banks. Source: Bank of Italy.

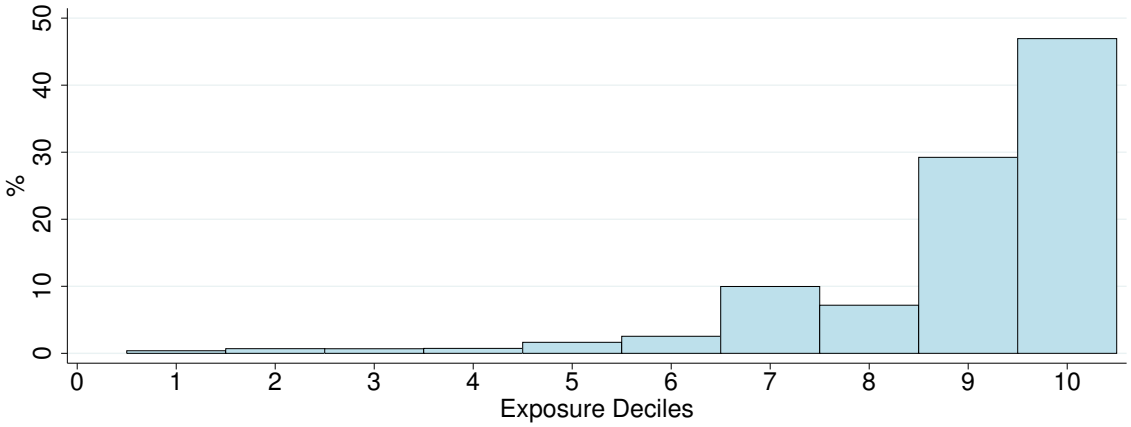

Figure OA.3: Bank Dry-Up Exposure and Loans to Firms. This bar chart shows the correlation between banks' total loans to firms and banks' exposure to the foreign wholesale market. The x-axis groups banks in ten deciles according to their exposure to the foreign wholesale market in June 2011. Each bar measures the share of total credit to firms funded by banks in each decile. Exposure deciles are delimited by p(10)=0.00%, p(20)=0.03%, p(30)=0.11%, p(40)=0.21%, p(50)=0.75%, p(60)=1.48%, p(70)=2.74%, p(80)=4.56%, and p(90)=7.57%. Source: Bank of Italy.

OA.3 Additional Tables

Panel A	Wholesale Funding Dry-Up					
$Exposure_{Jun11}$	-0.439***	-0.425***	-0.403***	-0.400***	-0.411***	-0.405***
	(0.116)	(0.117)	(0.121)	(0.122)	(0.120)	(0.124)
LEV_{Jun11}		-0.097	-0.068	-0.091	-0.092	-0.093
		(0.101)	(0.108)	(0.118)	(0.116)	(0.117)
ROA_{Jun11}			-0.011	-0.014	-0.025	-0.024
			(0.014)	(0.016)	(0.016)	(0.017)
$T1R_{Jun11}$				-0.018	-0.043	-0.042
				(0.018)	(0.020)	(0.020)
NPL_{Jun11}					-0.147*	-0.145*
					(0.078)	(0.080)
$Large_{Jun11}$						-0.576
						(2.850)
Observations	73	73	73	73	73	73
R-squared	0.168	0.178	0.185	0.188	0.229	0.229

Panel B	Foreign Funding Wholesale Dry-Up					
$Exposure_{Jun11}$	-0.283***	-0.291***	-0.278***	-0.277***	-0.277***	-0.263***
	(0.062)	(0.063)	(0.065)	(0.065)	(0.066)	(0.068)
LEV_{Jun11}		0.055	0.072	0.062	0.062	0.059
		(0.054)	(0.058)	(0.063)	(0.064)	(0.064)
ROA_{Jun11}			-0.006	-0.008	-0.008	-0.007
			(0.008)	(0.008)	(0.009)	(0.009)
$T1R_{Jun11}$				-0.007	-0.009	-0.008
				(0.018)	(0.020)	(0.020)
NPL_{Jun11}					-0.009	-0.003
					(0.043)	(0.044)
$Large_{Jun11}$						-1.303
						(1.556)
Observations	73	73	73	73	73	73
R-squared	0.226	0.237	0.245	0.247	0.247	0.255

Table OA.1: Wholesale Market Exposure and Dry-Up. These two panels present the results from two cross-sectional regressions. In the top panel, the dependent variable is the change in wholesale market funding between June 2011 and December 2011 (normalized by total assets in June 2011). In the bottom top panel, the dependent variable is the change in foreign wholesale market funding between June 2011 and December 2011 (normalized by total assets in June 2011). In both panels, the independent variables are the exposure to the foreign wholesale market defined in (1), leverage, return on assets, tier 1 ratio, nonperforming loans ratio, and a dummy equal to one if the bank has assets above €500 billion. Only 73 of our 74 sample banks are alive in this period. All independent variables are measured in June 2011. *** p<0.01, ** p<0.05, * p<0.1. Source: Bank of Italy.

Panel A Exposed Banks		Jun10	Dec10	Jun11	Dec11	Jun12	Dec12
Total Assets	€billions	10.2	10.5	11.0	11.4	12.9	12.9
Leverage	Units	13.5	14.2	13.2	13.4	14.0	13.9
Tier 1 Ratio	Units	8.9	8.7	9.1	9.4	10.4	10.8
Risk-Weighted Assets	%Assets	71.7	70.6	71.2	69.3	64.3	60.8
Non-performing Loans	%Liabilities	8.1	8.0	8.6	8.9	10.8	11.7
Private Credit	%Assets	64.7	66.8	68.9	69.1	69.4	69.4
- Credit to Households	%Assets	15.9	16.6	17.1	17.7	17.5	18.0
- Credit to Firms	%Assets	40.5	42.3	43.7	44.7	44.1	42.8
Securities	%Assets	13.9	13.6	14.2	14.9	20.0	18.5
- Government Bonds	%Assets	3.3	5.1	7.1	7.7	12.3	15.0
Cash Reserves	%Assets	0.4	0.4	0.4	0.4	0.4	0.5
ROA	Profits/Assets	0.2	0.3	0.2	0.2	0.2	0.1
Central Bank Borrowing	%Assets	0.4	3.1	1.8	7.2	11.0	10.8
Household Deposits	%Assets	27.4	26.6	24.7	25.5	24.5	25.0
Wholesale Funding	%Assets	11.0	10.9	12.2	11.5	11.7	10.9
Bond Financing	%Assets	19.3	20.6	22.8	19.3	16.9	16.5

Panel B Non-Exposed Banks		Jun10	Dec10	Jun11	Dec11	Jun12	Dec12
Total Assets	€billions	1.2	1.1	1.3	1.1	1.4	1.6
Leverage	Units	10.8	10.9	10.8	10.4	11.4	11.6
Tier 1 Ratio	Units	12.5	11.7	11.4	12.3	12.8	12.5
Risk-Weighted Assets	%Assets	68.4	70.1	68.0	69.8	65.7	64.3
Non-performing Loans	%Liabilities	8.3	8.5	8.7	9.2	10.9	11.9
Private Credit	%Assets	64.1	67.5	70.1	71.1	71.5	76.1
- Credit to Households	%Assets	18.8	19.3	20.0	19.7	19.6	20.2
- Credit to Firms	%Assets	42.4	45.0	47.0	49.1	48.8	51.2
Securities	%Assets	15.4	14.5	14.0	16.1	23.4	20.6
- Government Bonds	%Assets	4.7	5.6	6.2	7.9	15.8	15.5
Cash Reserves	%Assets	0.5	0.6	0.5	0.6	0.5	0.6
ROA	Profits/Assets	0.1	0.2	0.1	0.2	0.1	0.2
Central Bank Borrowing	%Assets	0.0	0.0	0.0	2.1	12.2	12.5
Household Deposits	%Assets	38.1	35.7	34.9	33.8	33.8	34.6
Wholesale Funding	%Assets	1.6	1.6	1.6	1.6	1.7	1.5
Bond Financing	%Assets	20.5	20.1	20.2	17.0	14.4	13.9

Table OA.2: Exposed and Non-Exposed Banks: Time-Series Evolution. This table shows cross-sectional medians of selected balance sheet items during the period from June 2010 to December 2012. The top panel (bottom panel) shows medians for the subsample of exposed (non-exposed) banks. Exposed (Non-exposed) banks have a June 2011 exposure to the foreign wholesale market above (below) median. This table extends Table 2 to capture the time-series dimension. Source: Bank of Italy.

	Private Credit	Government Bonds	Private Credit	Government Bonds
$Uptake^{Total} \times \mathbb{I}_{LTRO}$	0.129**	0.442*	0.001	0.829***
	(0.054)	(0.244)	(0.127)	(0.089)
$LEV_{Jun11} \times \mathbb{I}_{LTRO}$	-0.101	-0.159	0.372	-0.433**
	(0.139)	(0.323)	(0.255)	(0.180)
$ROA_{Jun11} \times \mathbb{I}_{LTRO}$	-2.209	16.849**	-1.496	-3.269*
	(2.013)	(6.586)	(2.537)	(1.614)
$T1R_{Jun11} \times \mathbb{I}_{LTRO}$	0.050	-0.074	0.083**	-0.049*
	(0.082)	(0.295)	(0.038)	(0.025)
$NPL_{Jun11} \times \mathbb{I}_{LTRO}$	-29.796*	43.839	-9.423	-10.380**
	(15.659)	(34.931)	(11.085)	(5.033)
$Large_{Jun11} \times \mathbb{I}_{LTRO}$	1.903	-6.617		
	(1.192)	(4.069)		
Time FE	✓	✓	✓	✓
Bank FE	✓	✓	✓	✓
Sample	Exposed Banks	Exposed Banks	Non-Exposed Banks	Non-Exposed Banks
Observations	468	481	468	468
R-squared	0.994	0.875	0.954	0.937

Table OA.3: Transmission of LTRO Liquidity by Exposed and Non-Exposed Banks. This table shows the results from a difference-in-differences regression during the period from June 2011 to June 2012. The unit of observation is at the bank-month level. $\mathbb{I}_{LTRO}$ is a dummy equal to one in the intervention period from January 2012 to June 2012. The independent variable in columns (1) and (3) is the total private credit normalized by total assets in June 2011. The independent variable in columns (2) and (4) is the holdings of government bonds normalized by total assets in June 2011. In columns (1) and (2) the sample includes banks with an exposure to the dry-up above median. In columns (3) and (4) the sample includes banks with an exposure to the dry-up below median. $Uptake^{Total}$ is the total LTRO uptake divided by assets in June 2011, LEV is leverage, ROA is return on assets, $T1R$ is the Tier 1 Ratio, NPL is nonperforming loans ratio, and $Large$ is a dummy equal to one if the bank has assets above €500 billion. Standard errors clustered at the bank level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Bank of Italy.

Firm Characteristics		**Dec10**	**Dec11**	**Dec12**
Q1				
Risky	Dummy	0	0	0
Firm Profitability	EBITDA	2.2	1.8	0.9
Leverage	%	37.9	38.5	35.4
Total Assets	€billions	652.0	665.0	650.0
Median				
Risky	Dummy	1	1	1
Firm Profitability	EBITDA	6.2	5.9	5.3
Leverage	%	67.8	68.6	66.8
Total Assets	€billions	1,533.0	1,553.0	1,523.0
Q3				
Risky	Dummy	1	1	1
Firm Profitability	EBITDA	11.4	11.1	10.4
Leverage	%	87.3	87.9	87.5
Total Assets	€billions	4,058.0	4,099.0	4,025.0
Mean				
Risky	Dummy	0.491	0.487	0.486
Firm Profitability	EBITDA	6.8	5.1	3.0
Leverage	%	61.0	62.1	61.8
Total Assets	€billions	9,226.4	9,299.0	9,311.5

Table OA.4: Summary Statistics, Firms. This table shows firm summary statistics at December 2010, December 2011, and December 2012. The four panels show the first quartile, the median, the third quartile, and the mean, respectively. Firm characteristics include a risk dummy equal to one if the firm has a Z-score greater or equal than 5 (range 1-9), profitability (EBITDA), leverage, and total assets. Source: Cebi-Cerved Database.

OA.4 Institutional Details

This section documents, in great detail, the institutional setting. In Appendix OA.4.1, we present the ECB collateral framework. In Appendix OA.4.2, we present (i) the legislative framework behind government guaranteed bonds and (ii) present anecdotal evidence confirming that the program was designed to allow banks to expand their eligible collateral in order to access LTRO2.

OA.4.1 ECB Collateral Framework

In this Appendix, we discuss the ECB collateral framework and describe the evolution of holdings of available (non-pledged) collateral securities during the period June 2011–November 2011.

Every bank has access to ECB liquidity and, in particular, to the 3-Year LTRO. To be able to borrow at ECB, banks are required to post eligible collateral. The list of eligible collateral securities is posted and constantly updated on ECB website. There, intermediaries can check which securities are pledgeable and what is the haircut that the central bank applies to each asset. The haircut depends mainly on the asset class, rating, coupon structure, and residual maturity. Table OA.5 and Table OA.6 provide examples of valuation haircuts, taken on a specific day, from the ECB website.

Haircuts are applied at the market value of the security. If the market value drops before the ECB loan matures, banks might receive a margin call from ECB asking to post additional collateral. Haircuts are not changed often and, crucially, are unchanged around the allotment of the 3-Year LTRO.

OA.4.2 Government Guaranteed Bank Bonds (GGBBs)

After the 2008 financial crisis, the European Commission temporarily relaxes the standard restrictions on financial sector government support. As the sovereign crisis deteriorates even further in the summer of 2011, the European Commission extends the temporary framework to allow peripheral eurozone governments to back their weak domestic banking sectors (see European Commission (2011)). On 6 December, the Italian government implements the European Commission guideline (see Italian Government (2011)) allocating a government budget of million €200 to bank liabilities guarantees for the 2012-2016 period. Under these scheme Italian banks can apply, not later than June 30, 2012, to receive a government guarantee on specific debt instruments (principal and interests).

The guarantee has a maturity between three months and five years (or seven years in the case of covered bonds). The Bank of Italy is in charge of evaluating the capitalization of the applicant bank in order to ensure that the entity is not insolvent. The guarantee is irrevocable, cannot be conditioned on other obligations, and it might be granted only to banks with Italian legal residence. Banks can obtain government guarantees up to what is "necessary to reactivate their medium- and long-term financing capacity". However, individual bank's guarantees cannot exceed the regulatory capital. The Bank of Italy monitors that these limits are respected. After having determined that the issuer eligible to receive the guarantee, the Bank of Italy communicates the positive response to the Italian Treasury. Within five days, the Treasury then confidentially communicates the approval of the guarantee to the bank.

Eligible financial debt instruments must be senior, euro denominated, plain vanilla, and issued after 22 December 2011. The also need to have fixed coupon and a unique principal payment at maturity. For each bank, the share of financial instruments with maturity greater than three years cannot exceed one third of the total nominal value of guaranteed instruments. The bank needs to pay a fee that is the sum of a

Levels of valuation haircuts applied to eligible marketable assets										
		Liquidity categories								
Credit quality	*Residual maturity (years)*	Category I		Category II		Category III		Category IV		Category V
		fixed coupon	zero coupon	fixed coupon	zero coupon	fixed coupon	zero coupon	fixed coupon	zero coupon	
Steps 1 and 2 (AAA to A-)	0-1	0.5	0.5	1.0	1.0	1.5	1.5	6.5	6.5	
	1-3	1.5	1.5	2.5	2.5	3.0	3.0	8.5	9.0	
	3-5	2.5	3.0	3.5	4.0	5.0	5.5	11.0	11.5	
	5-7	3.0	3.5	4.5	5.0	6.5	7.5	12.5	13.5	16
	7-10	4.0	4.5	5.5	6.5	8.5	9.5	14.0	15.5	
	>10	5.5	8.5	7.5	12.0	11.0	16.5	17.0	22.5	
		Liquidity categories								
Credit quality	*Residual maturity (years)*	Category I		Category II		Category III		Category IV		Category V
		fixed coupon	zero coupon	fixed coupon	zero coupon	fixed coupon	zero coupon	fixed coupon	zero coupon	
Step 3 (BBB+ to BBB-)	0-1	5.5	5.5	6.0	6.0	8.0	8.0	15.0	15.0	
	1-3	6.5	6.5	10.5	11.5	18.0	19.5	27.5	29.5	
	3-5	7.5	8.0	15.5	17.0	25.5	28.0	36.5	39.5	Not eligible
	5-7	8.0	8.5	18.0	20.5	28.0	31.5	38.5	43.0	
	7-10	9.0	9.5	19.5	22.5	29.0	33.5	39.0	44.5	
	>10	10.5	13.5	20.0	29.0	29.5	38.0	39.5	46.0	

Table OA.5: ECB Collateral Schedule at LTRO (marketable assets). This table shows the haircuts applied by the European Central Bank for each eligible collateral type pledged during open market operations after 28 July 2010, including longer term LTROs. The liquidity categories are (i) government bonds and debt instrument issued by central banks; (ii) local and regional government debt instruments, Jumpo covered bonds, agency debt instruments, and supranational debt instruments; (iii) traditional and structured covered bank bonds and corporate debt instruments; (iv) uncovered credit institutions debt instruments; (v) ABSs. Standard floaters belong to maturity category 0-1 years and another (unreported) table is applied to inverse floaters. This table is publicly available and directly taken from the ECB website `www.ecb.europa.eu` and has been published on 28 July 2010. Source: ECB website.

fixed commission and a variable part based on the riskiness of the issuer. The cost of the guarantee is approximately one percent of the guaranteed amount.

OA.4.3.1 GGBBs and LTRO: Anecdotal Evidence

In this subsection, we document anecdotal evidence confirming that (i) self-issued government guaranteed bonds were entirely used to tap the second LTRO allotment and (ii) the cost of the guarantee was non negligible implying that only banks with scarce available collateral had the incentive to pay the government guarantee.

Use of Government Guaranteed Bank Bonds UBI Banca, in the 2012 Annual Financial Financial statement documents that "The increase in the assets [eligible at ECB] is the result of a series of actions undertaken in the first quarter of the year (+€13 billion) [...] The principal strategic initiatives implemented during 2012 were the issuance by UBI Banca, of bonds with a government guarantee for a total nominal amount of €6 billion (€5.8 billion net of haircuts) [...]". In its 2012 annual statement, Banco Popolare di Milano states that "the following are the own bonds issued and repurchased as part of the refinancing operations with the European Central Bank [...] and provided as collateral for the advances received from central banks (OMO Open Market Operations): (i)"BPM 23.03.2012-2017 5.90%" bonds guaranteed by the

Levels of valuation haircuts applied to eligible non-marketable assets				
		Asset categories		
Credit quality	*Residual maturity (years)*	Credit claims		Non-marketable RMB debt
		Fixed interest payment and a valuation based on a theoretical price assigned by the NCB	Fixed interest payment and a valuation according to the outstanding amount assigned by the NCB	
Steps 1 and 2 (AAA to A-)	0-1	8.0	10.0	24
	1-3	11.5	17.5	
	3-5	15.0	24.0	
	5-7	17.0	29.0	
	7-10	18.5	34.5	
	>10	20.5	44.5	
Credit quality	*Residual maturity (years)*	Credit claims		Non-marketable RMB debt
		Fixed interest payment and a valuation based on a theoretical price assigned by the NCB	Fixed interest payment and a valuation according to the outstanding amount assigned by the NCB	
Step 3 (BBB+ to BBB-)	0-1	15.5	17.5	Not eligible
	1-3	28.0	34.0	
	3-5	37.0	46.0	
	5-7	39.0	51.0	
	7-10	39.5	55.5	
	>10	40.5	64.5	

Table OA.6: ECB Collateral Schedule at LTRO (non-marketable assets). This table shows the haircuts applied by the European Central Bank for each eligible collateral type pledged during open market operations after 28 July 2010, including longer term LTROs. The liquidity categories are (i) government bonds and debt instrument issued by central banks; (ii) local and regional government debt instruments, Jumbo covered bonds, agency debt instruments, and supranational debt instruments; (iii) traditional and structured covered bank bonds and corporate debt instruments; (iv) uncovered credit institutions debt instruments; (v) ABSs. Standard floaters belong to maturity category 0-1 years and another (unreported) table is applied to inverse floaters. This table is publicly available and directly taken from the ECB website `www.ecb.europa.eu` and has been published on 28 July 2010. Source: ECB website.

Government, for a nominal value of €0.5 billion; (ii) "BPM 23.03.2012-2015 4.90%" bonds guaranteed by the Government, for a nominal value of €1.0 billion." In its 2012 annual financial statement, Banca Carige states that "assets held to guarantee own liabilities include [...] own debt securities, irrevocably and unconditionally guaranteed by the Italian Government pursuant to Art. 8 of Law Decree 201/2011, amounting to €2,000 million, pledged as a guarantee to the European Central Bank for Long Term Refinancing Operations (LTRO)."

Rationale for the Italian Government GGBBs Law Fitch Ratings (2012) notes that "The Italian government was quick to establish a government-guaranteed bond scheme to enable the banks to create collateral by issuing selfretained bonds. Fitch understands that the LTRO funds to date have been used primarily to replace short-term interbank and institutional funding or wholesale maturities, with very

little invested in government debt so far. The Bank of Italy expects the banks to use LTRO funding to sustain loan availability to the real economy. Measures taken by the Italian government and the central bank have enabled the banking sector to increase available ECB-eligible collateral substantially. This additional collateral has eased pressure on funding, which had intensified during Q411. According to the Bank of Italy, at end-January 2012 the Italian banking sector had about €150 billion unencumbered eligible collateral. The recent decision to allow additional assets (rated loans) as collateral could increase available collateral by about €70–€90 billion. This puts the total of potential unutilised available collateral prior to February's LTRO at around €250 billion." Similarly, Unicredit Credit Research (2014) illustrates that the government law was "carried out in order to stabilize the Italian credit system and to provide Italian banks with state guarantees on their bonds, which could then be posted as ECB collateral for much needed liquidity: 3Y LTROs."

Cost of the Government Guarantee Intesa Sanpaolo, in its 2012Q1 financial statement, reports that "compared to the fourth quarter of 2011, net fee and commission income for the first quarter of 2012 fell slightly by 1.6%, entirely due to the impact of the cost for the government guarantee on the banks bonds [...]." Similarly. in its 2012 annual financial statement, Banco Popolare states that "net fee and commission income was negative, corresponding to €-37.4 million, insofar as it includes the cost of bonds guaranteed by the government". Monte dei Paschi Siena, in its 2012 annual report, states that "net fees and commissions were impacted by the cost of the Government guarantee required to gain access to ECB LTROs, as against a slight growth in retail and corporate components [...] The downtrend as compared to 2011 was mainly accounted for by institutional funding charges (particularly commissions on the Government guarantee required to gain access to ECB LTROs)."

References

European Commission (2011): "On the Application, from 1 January 2012, of State Aid Rules to Support Measures in Favour of Banks in the Context of the Financial Crisis," *Communication from the Commission*, C(2011) 8744.

Fitch Ratings (2012): "European Banks' Use of LTRO: A Stabilising Influence," *Special Report*.

Italian Government (2011): "Decreto Legge, Disposizioni Urgenti per la Crescita, L'Equita e il Consolidamento dei Conti Pubblici," *GU*, 284.

Unicredit Credit Research (2014): "Italian Government Guaranteed Bonds (3Y LTROs) and Italian Banks."