CAN THE PROVISION OF LONG-TERM LIQUIDITY HELP TO AVOID A CREDIT CRUNCH? EVIDENCE FROM THE EUROSYSTEM'S LTRO

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ABSTRACT. We exploit the Eurosystem's longer-term refinancing operations (LTROs) of 2011–2012 to assess whether a large provision of central bank liquidity to banks during a financial crisis has a positive impact on banks' credit supply to firms. We control for credit demand by examining firms that borrow from several banks, in addition to controlling for confounding factors at the level of banks. We find that the LTROs enhanced loan supply: according to our baseline estimate, banks borrowing 1 billion euros from the facility increased their loan supply by 186 million euros over one year. We also find that the transmission mostly took place with the first operation of December 2011, in which banks that were more capital constrained bid more. Moreover, we show that the opportunity to substitute long-term central bank liquidity for short-term liquidity enhanced this transmission. Lastly, the operations benefited larger borrowers more and did not lead banks to increase their lending to riskier firms.

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1. Introduction

Over the recent years, many central banks injected very large amounts of liquidity into the financial system in an attempt to mitigate the effects of the financial crisis that started in 2007–08. The Eurosystem's 3-year longer-term refinancing operations (LTROs) of 2011–12 are a distinctive example of this type of policy. One trillion euros were allotted to banks through this program, inducing a unprecedented net increase by some 12% of the total size of the Eurosystem's balance sheet, allotted at a maturity well above the ones of the previous Eurosystem's liquidity programs. These operations aimed at limiting a credit crunch that was threatening the euro area's economy at the time, in particular due to the sovereign debt crisis. As Mario Draghi stated then[1] "[...] this decision has at least prevented a credit contraction that would have been more serious, far more serious."

The rationale behind such interventions is strikingly at odds with the pre-crisis consensus epitomized by, e.g., Wallace (1981) or Eggertsson and Woodford (2003) according to which central bank balance sheet policies should have no significant macroeconomic impact. Yet, more recent contributions by, e.g., Cúrdia and Woodford (2011), Gertler and Karadi (2011), Gertler and Kiyotaki (2011), or Del Negro et al. (2017) argue that such central bank injections of liquidity are effective as they alleviate financial frictions that impede banks' access to external financing in crisis times, and hence their ability to supply loans at a reasonable cost.[2] Most of the papers assessing the effects of central banks liquidity injections implemented during the crisis use aggregate data. In this paper, we rely on a large sample of disaggregated bank-firm data to bring new empirical evidence consistent with the view that such liquidity injections sustained banks' supply of loans.

More precisely, we build and exploit a unique and very disaggregated dataset covering more than 1.390 million bank-firm credit linkages as well as bank and firm balance sheet information for France.[3] We obtain two main new results. First, in line with macroeconomic models featuring financial frictions, we find that liquidity injections resulting from the LTROs were associated with a positive increase in banks credit supply to firms. Banks that bid more in the LTROs did use (at least a part of) this cheap funding source to lend more to non-financial corporations than they would have otherwise. Second, we

[1] ECB Press conference, January 12, 2012.

[2] See also Cùrdia and Woodford (2009), Benmelech and Bergman (2012), Chen et al. (2012), Gagnon et al. (2011), Gertler and Karadi (2013), Krishnamurthy and Vissing-Jorgensen (2011), and Swansson and Williams (2014) for related contributions.

[3] Our database covers firms operating in France, which is a case of interest as this is the second biggest economy in the euro area and the financing of French firms relies mostly on banks.

take advantage of the unique feature of this operation, namely the 3-year maturity at which the central bank liquidity was lent, to show that such a policy is more likely to succeed when the central bank lends at longer horizons.

Identifying the impact of the LTROs on loan supply requires to tackle two important issues. To start with, the LTROs were implemented against the backdrop of the escalating sovereign debt crisis in the euro area which dragged down the economic outlook, thereby depressed credit demand and increased firms credit risk. As a result, the LTROs were coincident with several confounding factors potentially leading to a decrease in the amount of loans issued. Moreover, commercial banks chose the amount of central bank liquidity they borrowed from the Eurosystem. A bank bidding large amounts in the LTROs may be more stressed than the average bank and might therefore plan to de-leverage more aggressively than others. Conversely, a more aggressive bidding may reveal better credit opportunities. In other words, banks' bidding behavior was likely to be correlated with some bank specific factors affecting their loan supply. We use our dataset to address these two problems and to estimate a counterfactual of what credit supply would have been absent LTROs by controlling adequately for firms' loan demand and risk as well for a large set of relevant banks' characteristics.

More precisely, we exploit the information contained in the Banque de France credit register which provides a quasi-exhaustive sample of bank-firm credit relationships in France. Following the now standard methodology of Khwaja and Mian (2008), we control for firm-specific characteristics that may affect their demand for credit or their intrinsic level of risk by including firm fixed effects in our regressions. We also control for a large set of banks' characteristics that are likely to both impinge on banks' credit supply to firms and to affect banks' bid for central bank liquidity. These include variables such as, among others, banks' leverage, the liquidity of their assets, the credit quality of their loan portfolios.[4]

Our first main result is that the LTROs had overall a positive impact on the provision of credit to firms. According to our baseline estimate, each EUR 1 billion of central bank money lent to the average bank holding company was associated with a EUR 186 million increase in the credit made

[4]Absent any instrument to banks' LTRO take-ups, we cannot completely rule out that we uncover correlation rather than causality. However, in a robustness exercise, we show that the set of explanatory variables considered in our baseline regression is larger than the one resulting from a statistical procedure selecting covariates as the ones that provide the best fit of (i) banks credit supply before the 3-year LTROs were implemented and (ii) banks LTRO take-ups. We can therefore be reasonably confident that our baseline regression controls for the main potential sources of endogeneity.

available to the average firm over the 12-month period from September 2011 to September 2012. We obtain similar results for a large set of robustness checks. Importantly, we also find that this effect is weaker for the second round of the LTROs, for which bidding banks were on average better capitalized and more generally that banks' capital-ratio was an important determinant of banks bidding behavior at the facility. This confirms that the positive bank funding shock has a lower impact on bank lending for banks that were *ex-ante* less financially constrained.

Second, we show that increasing the horizon at which central bank liquidity was provided had a positive impact on banks' credit supply. Before December 2011, the Eurosystem had been mainly lending liquidity to banks at shorter maturities than 3 years, namely in between 1 week and 1 year. We exploit the fact that some banks substituted long-term for short-term ECB borrowing to disentangle the effects of the *maturity swap* associated with the LTROs from the one of net increase in liquidity. According to our estimates, a EUR 1 billion of liquidity swaped to 3-year maturity keeping the quantity of central bank liquidity constant would increase loan supply by EUR 398 million. In comparison, a net injection of EUR 1 billion of liquidity keeping the maturity constant would increase loan supply by only EUR 140 million.

Third, we document that the LTROs did not benefit all borrowing firms the same. An often debated question is whether non-standard monetary policy measures helped to limit credit restrictions to smaller firms during the crisis since they are more dependent on banks for their funding.[5] Looking at the impact of the LTROs across firms of different sizes, we find that the program benefited also small borrowing firms. However, the impact was roughly two times larger for large individual firms.

Fourth and finally, we investigate whether the program led banks to ever-green bad loans or to take excessive risks. We find that banking groups that borrowed in the LTROs tended to increase their lending more to firms with whom they had a relatively short relationship (defined as a credit link that is less than three years old), suggesting that the measure did not predominantly favor ever-greening. We also use several measure of firms' credit risk and show that banks did not grant more loans to riskier firms.

Our paper belongs to the literature that relies on microeconomic data to study the bank lending channel of monetary policy. Kashyap and Stein (1995), Kashyap and Stein (2000), and Jiménez et al. (2012) show that credit supply is affected by monetary policy. Khwaja and Mian (2008), Paravisini

[5]See, e.g., Chodorow-Reich (2014b) for recent evidence in the US.

(2008) and Schnabl (2012) find similar results when looking at other types of liquidity shocks. Cornett et al. (2011), Chodorow-Reich (2014b), Iyer et al. (2014), and Puri et al. (2011) document that the negative liquidity shock consecutive to the freeze of the US interbank markets in 2007–08 triggered a substantial credit contraction. Bofondi et al. (2016) show that the Italian sovereign debt crisis sharply reduced credit supply of Italian banks. Most existing studies look at the negative effects of a tighter policy or of episodes of funding stress. Our results rather emphasize the positive side of the bank lending channel and point to the fact that central banks liquidity injections conducted during the recent crisis had a positive impact on credit supplied to the economy.[6]

Our paper also contributes to the recent literature assessing the impact of unconventional monetary policies that resort on changes in the central bank balance-sheet. In addition to the aforementioned references which study the effect of policies conducted by the Fed, several recent contributions study the impact of measures implemented in euro-area. Ghysels et al. (2017), Altavilla et al. (2015), and Andrade et al. (2016) study the impact of various Eurosystem's asset purchase programmes. Darracq Pariès and De Santis (2015) use a panel VAR to show that the LTRO helped to boost growth and lift inflation. Cahn et al. (2017) achieve similar conclusions in an estimated dynamic stochastic general equilibrium (DSGE) model with financial frictions for the euro area. Moreover, they emphasize the key role played by the extended maturity of such programs. Bocola (2016) develops a DSGE with both credit frictions and sovereign default risk and emphasizes that banks might partly hoard liquidity injections to hedge against the funding constraints resulting from a devaluation of their sovereign assets. When calibrated on Italian data the model predicts that such mechanism strongly mitigated the positive effect of LTROs on credit supply that we identify.

These studies rely on financial and aggregate data to assess the effectiveness of central bank balance sheet policies. By contrast, we provide micro based evidence consistent with such policies having a positive impact on banks credit supply as in macro-models featuring financial frictions. Subsequent works by Garcia-Posada and Marchetti (2016), Carpinelli and Crosignani (2017) and Crosignani et al. (2016) also find micro-data evidence that the 3-year LTROs sustained credit growth in, respectively, Spain, Italy and Portugal. Our results show that the policy also had a positive impact in France, an economy that was not directly affected by such strains on public debt markets. Acharya and Steffen (2015)

[6]Paravisini (2008), who studies an Argentinian liquidity program designed to support bank lending to Small and Medium sized Enterprises (SME), is another example of a successful stimulation of bank credit by a public liquidity injection.

and Drechsler et al. (2016) further argue that the Eurosystem's liquidity operations encouraged risky and opportunistic "carry trade" government bond purchases by the weakest European banks. While we do not assess the whole extent of potential risk induced by the program, we do not however find any evidence in support of the risk-shifting hypothesis as regards loans offered to firms.

The rest of the paper is organized as follows. In Section 3, we describe the Eurosystem's LTROs in greater depth and detail our identification strategy. Section 4 presents the data. We discuss our main results on the bank lending channel and several robustness checks in Section 5. Additional results regarding the heterogeneous effect of the policy across firms and the overall firm-level impact are discussed in Section 6. Finally, Section 7 concludes.

2. The Eurosystem's LTROs of 2011–2012 and its economic background

The Governing Council of the ECB announced on 8 December 2011 its decision to implement two so-called longer-term refinancing operations (LTROs) with a maturity of three years, with the option of early repayment after one year.[7] The operations were conducted as fixed rate tender procedures with full allotment. The interest rate in these operations was fixed at the average rate of the ECB's main refinancing operations (the repo rate) over the life of each operation. Considering the level of the ECB's repo rate (1%) and of expectations of its future level up to three years (from EONIA swaps), this pricing made the LTROs very much cheapier than any funding alternative available for banks.[8] The first LTRO operation, which took place on 21 December 2011, provided EUR 489.2 billion to 523 credit institutions in the euro area. The second operation took place on 29 February 2012 and saw the allotment of EUR 529.5 billion to 800 credit institutions. Part of this liquidity was substituted for the liquidity the Eurosystem already provided at that time through its 3-month and regular weekly operations. When taking into account other liquidity operations conducted the same weeks and operations maturing at these dates, the first round of LTROs amounted to a net injection of EUR 210 billion while the second amounted to a net injection of EUR 311 billion. Overall, this "quantitative easing" policy led to a

[7]The LTROs were the most salient measure in a larger policy package which also included a reduction of the compulsory reserve ratio from 2 to 1 percent of banks' deposits as well as an extension of the pool of eligible collateral. The latter was obtained by a reduction of the rating threshold for certain types of Asset-Backed Securities (ABS) and the decision to allow national central banks to accept as collateral Additional Credit Claims (ACC), which include bank loans to firms of intermediate credit quality. Measures on collateral took effect only in February 2012.

[8]Note that interest had therefore to be paid *ex post*, i.e., when the respective operation matures.

substantial increase, by some 12%, of the size of the Eurosystem's balance sheet. To give an idea of the order of magnitudes involved, the gross amount of liquidity lent equaled 80 percent of the monetary base in the euro area and 20 percent of total bank credit to euro area firms. Overall, the quantity of liquidity provision (in gross terms) amounted to almost 11 percent of the area's nominal GDP.

The policy was announced against the backdrop of an intensification of the euro area sovereign debt crisis in the second half of 2011. Banks in the Eurozone were under heightened funding stress due to their exposure to such sovereigns and prospects for credit and growth were rapidly deteriorating. Figure 1 illustrates that European banks faced unprecedented levels of funding pressures in the second half of 2011. For each of the four largest economies of the Eurozone, it displays the average spread of bonds issued by domestic large banks, as compared to the German government bond, since the inception of the euro.[9] The figure reveals that the funding stress faced by European banks in the fall of 2011 was even greater than the one they experienced after the failure of Lehman Brothers. Banks decided to participate or not in the LTRO program and they determined freely the amount they bid. Reports in the ECB Monthly Bulletins of January and March 2012 suggest that funding considerations played a major role in banks' bidding behavior in the 3-year LTROs. Liquidity-constrained banks were likely to bid more in this new facility than the average bank. At the same time, these stressed banks were probably contracting their loan supply more than the average.

Moreover, while bank spreads shot higher in peripheral countries mired in the sovereign debt crisis, spreads paid by French banks also reached historical highs, although these banks were much less exposed to sovereign risk in periphery countries (Greece, Ireland, Italy, Portugal, and Spain). The Eurosystem's Bank Lending Survey (BLS) of bank loan officers[10] provides evidence suggesting that this negative funding shock translated into tighter credit conditions offered to bank customers. Figure 2 shows how credit conditions for non-financial firms evolved in France in 2011 and 2012. The increase in the BLS credit tightening index over the last quarter of the year 2011 points to a rapid contraction in the supply of credit, which the implementation of the LTROs seems effective in undoing over the first two quarters of 2012. Interestingly, the BLS questionnaire also asks reporting banks about the

[9]This measure of bank bond spreads is taken from Gilchrist and Mojon (2017). Country-aggregates are computed as weighted averages of individual bond spreads, where the weights are relative to the outstanding amounts of each issue. Individual spreads compared to the German Bund are computed so as to match corporate and government bonds of similar maturities. See Gilchrist and Mojon (2017) for more details.

[10]The euro area's equivalent for the Fed's Senior Loan Officier Opinion Survey (SLOOS).

specific reasons underlying changes to their credit supply. More specifically, the figure shows a sub-index which tracks the role of constrained access to liquidity in explaining credit tightening, as reporting banks self-assess it. We note that the liquidity stress sub-index closely follows the total index of credit conditions to firms over the winter of 2011-2012, suggesting that liquidity stress acted as a major driver of the contraction in credit supply towards the end of 2011. In contrast, the LTROs were associated with alleviated liquidity constraints over the Spring of 2012, which in turn dampened the risk of a credit crunch. Last but not least, the figure also confirms that, at least according to the loan officers' reports, demand for credit from non-financial firms receded sharply over the course of 2012, which obviously calls for carefully controlling for credit demand in our regressions.

The goal of this measure was actually to "ensure enhanced access of the banking sector to liquidity" and to "support the provision of credit to households and non-financial corporations." In rest of the paper, we assess whether this credit policy was indeed effective and sustained credit supply. As the previous paragraphs highlight, to identify such an impact of LTRO on credit supply, one needs to control for firms' and banks' specific factors that jointly affect the amount of credit to firms and of LTRO take-up by banks namely (i) banks' characteristics, and notably those determining their funding stress and their lending opportunity and (ii) demand effects and firms' risk. In the next section, we describe the methodology that we implement in order to overcome such challenges.

3. Identifying the impact of the LTROs on credit supply

Estimating the causal impact of a given bank i LTRO take-up on their supply of credit to a given firm j raises two main identification issues. To clarify them consider the following regression:

$$\Delta L_{ij} = \beta_0 + \beta_1 LTRO_i + u_{ij},$$

where ΔL_{ij} is the (log) change of loans that firm j gets from bank i after the LTRO policy, $LTRO_i$ is the amount LTRO taken by bank i (expressed as a fraction of its total assets) and u_{ij} are other factors affecting the amount of loans firm j gets from bank i over the same period.

The first identification issue is that banks' LTRO uptakes may be correlated with firms' loan demand. The program was launched in times of depressed economic activity hence low loan demand. The other way around, once launched the program could have increase firms' incentive to demand loans. We address this first issue by implementing the *multibank firm* estimation approach of Khwaja and Mian

(2008). This amounts to consider the sample of firms that borrow from several banks and to include firm-specific fixed effects in the previous regression, namely:

$$\Delta L_{ij} = \beta_j + \beta_1 LTRO_i + v_{ij}. \quad (1)$$

Such firm fixed effects β_j ensure that all relevant firm characteristics, like their investment opportunities, their credit risk, their financial soundness, etc., that may impinge on their demand for bank credit are controlled for. A note of caution is worth on such "within-firm" approach which is now a standard strategy for identifying credit supply in the empirical banking literature. As emphasized recently in Paravisini et al. (2014), one should bear in mind that this approach may fail to control effectively for all demand effects if for some reason borrowing firms are not randomly "assigned" to banks.[11] We deem this very relevant point should be of little consequence in our case. Indeed, large French banking groups, which make up the bulk of the observations in our dataset, are so-called "universal" banks. These banking groups have on their books very large and diversified portfolios of retail corporate loans, in terms of loan type as well as in terms of the sector and geographical location of their customer firms.[12]

The second identification challenge we face is related to the fact that banks' LTRO uptakes are endogenous and depends on a set of banks' characteristics that also affect banks' loan supply. Formally, $LTRO_i = f(\widetilde{Z}_i, \varepsilon_i)$ with $\widetilde{Z}_i$ the variables that also influence banks' loan supply (hence correlated with v_{ij} in equation (1)) and ε_i factors that are not related to banks loan supply (hence are orthogonal to v_{ij}). Addressing this second issue could be done by either *(i)* instrumenting $LTRO_i$ with ε_i in equation (1) or *(ii)* controlling for banks determinants $\widetilde{Z}_i$ in (1). It is hard to think of a natural candidate for instrumenting LTROs in our loan supply equation. Indeed LTRO uptakes should primarily be function of banks' characteristics that would prevent them to access wholesale funding. Facing such liquidity risk, banks may want to reduce their assets hence lower their supply of credit. We thus implement the second strategy and control for a set of observed bank characteristics Z_i estimating the following

[11] This can for instance happen when simultaneously *(i)* the liquidity shock that affects lenders is for some reason correlated either with changes in the demand for a specific type of loan or changes in the demand emanating from a particular sector of the economy and *(ii)* "treated" banks specialize in issuing this type of loan or supplying credit to this sector.

[12] Note however that in the robustness check section, we provide an analysis at the loan type level that partially answers this concern disentangling the effects of the LTRO on short term and long term credit.

regression:

$$\Delta L_{ij} = \beta_j + \beta_1 LTRO_i + Z_i'\gamma + \eta_{ij}. \quad (2)$$

In the baseline specification of this regression, Z_i includes a large set of bank level balance sheet and credit register data which pertain to differences in banks' stress in the access to wholesale liquidity, their insolvency risk, the liquidity of their assets, the average risk of their loan portfolio (data are detailed in Section 4.1 below), the selection being based on economic reasoning.

Although such baseline specification factors in a relatively large set of controls Z_i, the issue that it differs from $\widetilde{Z}_i$ and that a potential omitted variable bias remains still applies. Nonetheless, we go further to address this concern by checking whether the baseline results are robust when the control variables are derived from a data-driven procedure and that we detail in the appendix. Under this approach the set of controls Z_i is made of the union of variables that are statistically significant and have the strongest explanatory power on loan growth on a pre-LTRO sample, together with the variables that are statistically significant and have the strongest explanatory power on banks' LTRO take-up. We now describe the data we use to measure ΔL_{ij}, $LTRO_i$ and Z_i before turning to the results.

4. Data

In this section, we describe the various sources of data we merged and how we measure the variables involved in the empirical analysis. We then detail how we select the firm-bank pairs that we use to identify the impact of the LTROs. Finally, we report some salient descriptive statistics for the selected sample.

4.1. Data sources and definition of variables

We merge several datasets to conduct our empirical exercise.

First, we exploit the French national credit register available at the Banque de France (called "Centrale des risques"). This register collects quasi-exhaustively the bilateral credit exposures of resident financial institutions, or "banks", to individual firms on a monthly basis.[13] A bank has to report its credit exposure to a given firm as soon as its total exposure on this firm is larger than EUR 25,000. This total exposure includes not only funds effectively granted to the firm (or drawn credit), but also the bank's commitments on credit lines (or undrawn credits) and guarantees, as well as specific operations

[13]Financial institutions include all resident credit institutions, investment firms, and other public institutions.

(medium and long-term lease with purchase option, factoring, securitized loans, etc...). Firms are defined here as legal units (they are not consolidated under their holding company when they are affiliated with a corporate group) and referenced by a national identification number (called a "SIREN" number). They include single businesses, corporations, and sole proprietors engaged in professional activities.[14]

As Ivashina and Scharfstein (2010) show in their analysis of the dynamics of credit lines drawdowns during the US subprime crisis, firms' drawing on their pre-committed credit lines with banks can result in an apparent increase in the availability of bank credit even though the economic outlook deteriorates. However, this increase may be only apparent as banks simultaneously try to contract their off-balance sheet exposure to firms and to cut the provision of new, not-precommitted, loans. To avoid this measurement problem, we focus in the remainder of the paper on the evolution of total credit, which we define as the sum of effectively drawn credit and of still undrawn, but available, credit lines. For convenience, we will refer below to total credit indifferently as loans or credit, unless otherwise specified. We assess in our exercise the intensive margin of the growth of bank credit to firm between September 2011 and September 2012 (i.e., roughly two months before the announcement of the 3-year LTROs and about seven months after the implementation of the second round). For each loan exposure of a bank i to a firm j that appears in the dataset both in September 2011 and in September 2012, we can calculate a loan growth rate ΔL_{ij} (in logs).

To conclude with this first data source, note that the credit register also provides information on the credit risk of borrowing firms. Indeed, the Banque de France estimates internally its own credit ratings for a large population of resident firms. These ratings are used by banks to evaluate whether loans to firms are eligible as collateral to the refinancing operations with the Eurosystem. We use this information to calculate for each bank the share of its portfolio of loans to firms that is eligible (i.e., highly rated). This provides us with a measure of the risk of each bank's loan portfolio.

Second, we use an exhaustive record of the access of French banks to the Eurosystem's refinancing operations.[15] The dataset covers all the operations of individual credit institutions located in France (both domestic and foreign-owned) with the Eurosystem at weekly frequency. We first use this information to reconstruct for each individual institution the total end-of-month outstanding amount of liquidity

[14]Note that individual entrepreneurs are dropped from the dataset, as their reporting also underwent a methodological break in April 2012. We also exclude observations relating to firms that are incorporated abroad.

[15]These include the main refinancing operations, 3-month to 3-year longer-term operations, fine-tuning operations, etc.).

borrowed from all types of operations, net of repayments. We also measure the LTRO uptakes of resident institutions (at the first and the second round of the program). However, because of internal capital markets within large banking groups, the right level of analysis of net borrowing with the Eurosystem is not the individual credit institution, but the banking group.

Indeed, we observe that in most major French banking groups, only a few subsidiaries bid in the Eurosystem's operations. We infer that they borrow for the benefit of their whole group and that the liquidity is dispatched within the group structure. We deal with this issue by aggregating the data at the banking group level.[16] We then use this group level information to compute changes in total borrowed liquidity from all Eurosytem facilities over the period of implementation of the LTROs.[17] Note that, for consistency, we also sum in the credit register database the bilateral exposures of all individual institutions belonging to a given banking group in order to measure linkages at the banking group-firm level.[18] We thus calculate a change in credit exposure of bank group i to firm j, ΔL_{ij}. We can then merge these two datasets for a given banking group i. For simplicity, we nevertheless use the term "bank" for banking group in the remainder of the paper.

Third, we take bank-level balance-sheet information from the regulatory reporting of banks to the French Supervisory Authority. All balance sheet variables of French groups are measured as of June 2011 and refer to consolidated group statements.[19] We use this information, as well as the data from the refinancing operations, to compute our main variable of interest, which is, for each bank i, the ratio of its LTRO uptake to its total assets, $LTRO_i$.[20] We also compute standard ratios, such as a capital ratio (Tier 1 capital to unweighted total assets), a liquidity ratio (cash and interbank loans to total assets), and an interbank liability ratio (total interbank liabilities, net of Eurosystem's ones, to total assets) as indicators of the financial soundness of each banking group. All these variables are included in our set of banking group controls Z_i in our baseline regression.

[16] We identify the boundaries of groups using the Supervisor's mapping of individual credit institutions into so-called *Groupes économiques d'appartenance*, or "GEA".

[17] Namely September 2011 to December 2012 as regards the first LTRO round, December 2011 to March 2012 as regards the second, and the six months from September 2011 to March 2012 when considering both rounds.

[18] Note that in the case of foreign banking groups, of which we can just observe the local subsidiaries registered in France, the GEA is the sum of these local subsidiaries and not the whole group.

[19] Regarding the subsidiaries of foreign groups, individual balance sheet items are aggregated within each group across all the subsidiaries chartered in France.

[20] Note that for each bank we compute ratios relating to both the total uptake and the uptake at each round of the LTROs.

Fourth, we merge the previous datasets with firm-level accounting information available from the Banque de France's "FIchier Bancaire des ENtreprises" (FIBEN) database. Firm balance sheets and income statements are available only for a subsample of the whole population of firms which are present in the national credit register, but this sample is nevertheless sizeable.[21] A firm's financial statements are collected as soon as its turnover exceeds EUR 0.75 million. As this information is annual, we compute the relevant firm accounting ratios by using the average of accounting variables observed in the end-of-year 2010 and 2011 reports. As we detail below, this information can be used to investigate whether the response of bank loan supply to the LTROs differed depending on the characteristics of customer firms.

4.2. Sample selection

We describe here the selection filters we apply to the original dataset in order to get rid of outliers. We proceed in four steps.

First, we discard banks that do almost not lend to firms. Some 200 banking groups or stand-alone banks were registered as active lenders in the complete credit register dataset as of September 2011. We calculate the share of each group in total bank lending to domestic non-financial firms. The distribution of these groups' market share of corporate credits is very skewed to the left, with 170 banks holding less than 0.1 percent of total credit to firms. This reflects the strong concentration of the French banking industry. We discard these "small" lenders, which collectively account for only 2.4 percent of total credit to firms.

Second, among the remaining 30 banking groups, we also eliminate 5 banking groups whose total assets jump by more than 50% in absolute value terms over the 12-month period from September 2011 to September 2012. These are likely to have merged with other institutions or to have been restructured over this time period. Keeping them would blur our measure of changes in their credit supply. These 5 banks make up less than 2 percent of total drawn credit offered to domestic firms. We also drop the Belgian-French banking group Dexia. Indeed, it nearly went bankrupt in early October 2011, was bailed out by the French and Belgian Governments and then had to undergo a long process of restructuring.[22] This

[21] For instance, the database includes the balance sheets of more than 160,000 firms in their legal unit form (i.e., unconsolidated balance sheets) as of the end of 2011.

[22] In September 2011 Dexia accounted for a significant 6.5 percent of drawn bank credit to firms in France. We checked that our main results are robust to the inclusion of this bank in the sample.

leaves us with a sample of 24 banks.[23] It includes all major French private banking groups, a handful of public credit institutions which are active lenders to firms (notably to SMEs, like OSEO/Bpifrance), as well as 13 French subsidiaries of foreign banking groups. Discarding credit links which do not involve any of these 24 selected banks leaves us with a set of bilateral credit exposures which accounts for more than 89 percent of all reported loans to firms in the Fall of 2011.The selected banking groups also account for 91% of the total 3-year LTROs amounts allotted in France over the two rounds.

Third, we drop very small credit exposures, which tend to be very volatile and are often associated with very small borrowers. Namely we delete bilateral observations for firms borrowing less than a total (over the 24 selected banks) of EUR 25,000 in September 2011.[24] Applying this filter amounts to dropping 48 061 firms which account for 0.15 percent of total banks credit. We end up with a large selection of 1,360,000 firms borrowing from 24 banking groups.

Finally, we also drop bilateral credit exposures with extreme growth rates over the period of study. Namely, we excluded every firm-bank pair with a September 2011-September 2012 loan growth rate that is below the 2nd percentile or above the 98th percentile in the whole distribution of loan growth rates. The observations deleted account for a bit less than 9 percent of total bank credit to domestic firms.

Overall, we end up with a sample of 1,390,270 bank-firm credit links (involving some 1,172,000 firms), which account for 79 percent of the total amount of bank credit to firms located in France. The sub-sample of multi-bank firms, which we use for our baseline regressions, is of course smaller. Nevertheless, it still includes 211,209 firms with 428,594 bank-firm relationships and accounts for 57 percent of total bank credit to French firms.

4.3. Descriptive statistics

Our final sample of 24 banks is quite representative of credit provision to non-financial firms in France. Table 1 presents some descriptive statistics. The average bank is relatively large, with total assets at EUR 494 billion, but the sample ranges from quite small institutions (mostly foreign subsidiaries) to the big players of the French banking sector (groups with total assets of the order of magnitude of France's nominal GDP). Although the total assets of these banks increases over the 12-month period of

[23]The complete list of selected banks is reported to the online appendix.

[24]Note that this threshold is slightly more restrictive than the official reporting threshold, as we define it in terms of loans and undrawn credit lines, which does not include guarantees and other exposures.

study, their total supply of credit to firms decreases by 1.43 percent on average. The average bank is well capitalized, with a (Tier 1) capital to total assets leverage ratio of roughly 8 percent.

Table 2 compares the profiles of banks according to whether they bid or not in the 3-year LTRO facility, and whether they bid in the first or the second round. All banks did not participate: among the 24 French banking groups and foreign subsidiaries in our sample, only 10 borrowed from the LTROs; 6 participated in the first round; 8 in the second and 4 in both. For the banks which bid in the operations, the average uptake was significant as it amounted to some 2.8% of total assets. Interestingly, participants in the first round differ from participants in the second round. On average, bidders in the first round were larger and more complex (as reflected by the number of observed subsidiaries) than bidders in the second one, they de-leveraged more over 2011-2012, they were less capitalized, and they relied slightly less on interbank market funding. This in turn suggests that they were, at this stage of the crisis, on average more dependent than other banks from Eurosystem financing.

Table 3 presents descriptive statistics for the selected firms in September 2011, that is before the ECB announced the LTROs. The upper panel presents statistics for all firms, while the next two panels contrast single-bank firms with multi-bank firms. The last panel relates to the subsample of firms for which we have access to balance sheet information from the FIBEN database. As intuition would suggest, multi-bank firms are larger borrowers than mono-bank ones. However, they are also very heterogeneous as the difference between the average and the median of total credit borrowed by these firms (EUR 4.6 million and EUR 0.4 million respectively) indicates. While, on average, mono-bank firms experienced a contraction of credit between September 2011 and September 2012, multi-bank firms did not. Multi-bank firms are relatively well rated: 14 percent have a Banque de France rating that makes their bank debt eligible as collateral to the Eurosystem's operations (high quality firms). They also have relatively long-lasting relationships with their lenders: 76 percent of their credit relationships have an average duration of more than three years. Firms for which we have complete balance sheet information in the FIBEN database account for some 17 percent of the selected multi-bank firms. These multi-bank FIBEN firms are even larger, better rated and have an even higher probability of maintaining a long-term relationship with their lenders. The average size of their assets is EUR 43 millions and they employ an average of 85 staff. Their low average profitability reflects the weak macroeconomic situation that was prevalent in September 2011.

Table 4 illustrates further the heterogeneity of borrowers. It provides descriptive statistics for four categories of firms sorted according to their borrowing size.[25] Not surprisingly, this distribution is very skewed to the left. The first grouping, that we call "very small borrowers", is made of firms with total bank credit below the median of the total borrowing distribution (EUR 136,000). Their average borrowing[26] is indeed quite small and stands at around EUR 70,000. Consequently, these more than 682,000 firms account for only 3.4 percent of total bank credit to firms. The second grouping, which we call "small borrowers", includes the 542,000 firms between the sixth and the ninth deciles of the borrowing distribution. They make up about 11 percent of banks' credit to firms and their average amount of credit is about four times larger than the amount granted to a very small borrower, with about EUR 295,000. The third grouping of "intermediate borrowers" includes the 122,000 firms in the last decile of the distribution, with the exception of the last percentile. They account for about 15 percent of total bank credit to firms and their average amount of credit is six times larger than for "small borrowers", at about EUR 1.83 million. Lastly, "large borrowers" are the 13,600 selected firms that belong to the last percentile of the total firm distribution. They account for 58 percent of the total quantity of bank credit received by domestic firms, and each of them receives on average EUR 69 million of bank credit.

The LTROs were in part motivated by the dire situation of smaller firms during the sovereign debt crisis, because small firms tend to rely more on banks to fund their activity and are less able than large firms to tap wholesale financial markets instead. Table 4 reveals that indeed, smaller firms are more exposed to a credit crunch. They are connected to a smaller number of banks on average, which implies that they have less opportunities to substitute between lenders. They also face a sharper contraction of credit over the period of study. Looking at the sub-sample of firms for which we have access to balance sheet information reveals that smaller borrowers are also on average smaller firms. For this subsample of firms, we find that total borrowing size has a strong positive correlation (of about 0.74) with total asset size. Borrowing size is also positively correlated with the number of employees although the correlation is lower (about 0.20).[27]

[25] As observed in September 2011. Note that quantiles of the firm size distribution are computed from the credit register over the whole population of borrowing firms in France (i.e., before selection for the purpose of our study).

[26] This measure includes loans granted by banks that we do not keep in the sample.

[27] This lower correlation may be due to the fact that our firm data are not consolidated. Holding companies may for instance be large in terms of their bank debt, as they may borrow on behalf of their whole network of affiliates, but they may be small

5. Did the 3-year LTROs increase loan supply to firms?

This section reports our estimates of various versions of equation (2) and counterfactual estimates of what credit supply would have been had the policy not been implemented. We first look at the program as a whole. We then distinguish between the effects of the first round (implemented in December 2011) and of the second round (implemented in February 2012). We also disentangle the *quantitative easing* impact of these massive long-term liquidity injections from the *maturity swap* impact associated with the longer maturity of the facility. Finally we provide a set of robustness checks of our baseline results.

5.1. Overall impact

The first nine columns in Table 5 provide estimates of the combined impact of the two rounds of LTROs on bank credit supply to firms.[28] Columns (1) and (2) show the results for the whole population of selected firms, including firms that are connected to only one lender when firm characteristics, the firm-fixed effects β_j, are not controlled for. Both show a non-significant impact of the 3-year LTROs on loans distributed to firms, but the sign of the coefficient becomes positive once the regression includes usual credit-supply relevant bank covariates as controls. Columns (3) and (4) focus on multi-bank firms, with and without relevant bank-level controls, but still without controls for firm-specific demand. Over this sub-sample of firms, which is central for our analysis, the LTRO coefficient also increases and as a matter of fact more than doubles when bank characteristics are controlled for. It also becomes significant, which confirms that LTRO bidders are indeed special: omitting to control for their overall weakness and business profile as captured by usual balance sheet ratios would lead to largely underestimate the impact of the LTRO measure.

Last, firm fixed effects, which control for firm-specific demand and risk, are then included in the regressions shown in all subsequent columns.

Column (5) shows the results when we do not control for the bank-specific risk factors. The impact of the LTROs becomes positive and significant. Column (6) provides our baseline estimate of the impact of the LTROs when we now control for both firm demand and for the key balance sheet

in terms of staff employed. Conversely, subsidiaries employing a relatively large number of staff may be small in terms of relative debt as they draw part of their funding from the holding company they belong to.

[28] In all regressions, standard errors are clustered at the level of the bank-(1 digit) firm industry sector, except in columns (7) and (8) where other corrections of standard deviations obtained in the baseline regression are shown for robustness.

characteristics of banks, hence their degree of financial stress before the measure. We find that the 3-year LTROs had an overall positive and significant impact on loans distributed to firms. Controlling for banks' characteristics reveals a positive impact that is almost four times as large as in column (5). This confirms the intuition that the banks that were more financially constrained bid more in the LTROs while they also deleveraged more than the average bank. As a consequence, not controlling for bank characteristics would lead us to severely underestimate the impact of the policy measure on loan growth over 2012. The amount of credit supplied to firms by stressed banks would have been lower in 2012 in France, had this unconventional policy measure not been implemented.

Column (6) also shows the impact of the characteristics of banks on their loan supply. Larger banks, less leveraged banks, and banks having an easier access to funds on the interbank market offered more loans than others. Banks with more liquid assets and larger portfolios of securities supplied marginally less loans to firms than the average, probably reflecting different business models. Banks with more loans on their books increased their lending marginally less, suggesting some mean-reverting behavior. Last, the quality of banks' loan portfolios, as measured by the share of loans which are eligible to the Eurosystem's refinancing operations, does not seem to impinge much on lending over the period.

We can easily get a sense of the economic significance of our baseline result. Remember that we measure the LTRO uptake of a given bank as a fraction of its total assets and look at its impact on the growth rate of loans (expressed in log difference) distributed to firms by this bank between September 2011 and September 2012. Let δ_i denote the growth rate of loans supplied by bank i to all its customer firms. An estimate of this growth rate can be derived from the LTRO uptake of bank i and our estimate of the LTRO semi-elasticity of credit supply: $\widehat{\delta}_i = 1.17 \times LTRO_i$. The change in loans supplied by bank i, knowing its pre-LTRO stock of loans L_i, is then: $\Delta\widehat{L}_i = \widehat{\delta}_i \times L_i$. Summing over all banks, one gets an increase of EUR 28.4 billion in credit supply. This is to be compared with the total LTRO take-up by the banks in our sample, which amounts to EUR 153 billion. Put differently, everything else being constant, we find that EUR 1 billion injected by the Eurosystem led the average bank to supply EUR 186 million in supplementary loans and credit lines to firms.

5.2. First vs second LTRO rounds

So far, we have analyzed the total impact of the two 3-year LTROs as a whole. However, it is worth investigating whether the first and the second rounds had different effects on the supply of bank

credit to firms. Indeed a striking feature of the operations is the surge in the number of participating banks as well as in the quantities borrowed between the two rounds.

Banks had incentives to use the facility because of the low cost involved, even for banks that were able to obtain longer-term funds in the bond market. Why did less banks participate in the first round although both rounds were announced at the same time in early December 2011? One explanation is the fear of stigma: healthier banks may have refrained from tapping the facility during the first round as they did not urgently need this liquidity and might not have wished to send out bad signals about their financial situation.[29] By contrast, banks who participated in the first round may have been under relatively higher pressure to find liquidity in order to re-finance their existing assets. The surge in the number of participating banks as well as in the quantities borrowed between the two rounds may result from official ECB statements, made between the two rounds, which aimed at encouraging all banks to bid in the operations and try to dismiss stigma.[30] Under this assumption and according to the bank lending channel view of credit supply, the effect of LTRO on credit supply should be stronger for the first than for the second round, as the program should have a larger impact on banks that are the most constrained in their access to funding.

We do find evidence supporting this interpretation. First, the assumption that banks which bid at the first facility were more under funding pressure gains some empirical support if one looks at the descriptive statistics shown in Table 2. Notably, bidders in the first LTRO have a capital ratio that is twice as small as the capital ratio of bidders in the second round. Table 6 provides further evidence. Columns (1) and (2) report the probit regression results of the bank's decision to bid in the first and the second round respectively, as a function of its capital ratio. The coefficient on capital is significantly negative for the first round but not significant for the second round. Columns (3) and (4) report similar evidence from Tobit regressions of banks' LTRO uptake on bank capital in the first and the second round respectively.[31]

[29] Armantier et al. (2015) provide evidence of such stigma for the US. They show that during the 2007-08 crisis, US banks were ready to pay a premium of about 44 bps to avoid borrowing at the Fed's Discount Window.

[30] In a press conference following the Governing Council of 9 February 2012, ECB's President Mario Draghi stressed very explicitly that there was and should be "no stigma whatsoever attached to these facilities."

[31] Comparable results can be found in Drechsler et al. (2016). They find that less capitalized banks bid more than the average in the euro-system liquidity facilities that were put in place before the 3-year LTROs.

Second, the first round of LTRO had a stronger positive impact on credit than the second one. This is illustrated in Columns (10) and (11) of Table 5 which report the estimation results of regression (2), respectively for the first and the second round of LTROs. It turns out that the impact of the first LTRO round is larger by some 10% than estimates obtained for the two rounds as a whole. By contrast, the impact of the second round is much smaller.

5.3. Quantity and maturity effects

The 3-year LTROs were not the first unlimited liquidity operations conducted in the euro area. They came after similar refinancing operations with maturities of 3 months, 6 months or even 1 year, which the Eurosystem had conducted since October 2008. As regards the 3-year LTROs, the total amount of liquidity borrowed from the central bank by euro area banks was quite substantial (above one trillion euros) and larger than what banks had borrowed at past or still existing liquidity facilities since 2008. So, like other operations that led to an increase of the central bank's balance sheet, a first direct consequence of the 3-year LTRO was to increase the amount of liquidity in the financial system. In addition to such quantitative easing feature of the operation, the 3-year LTROs also provided an extension of the maturity at which the liquidity could be secured. Indeed some banks substituted short-term central bank liquidity for the longer term one offered with this new facility.

We investigate whether the maturity swap the 3-year LTRO allowed had a specific impact on bank loan supply. More precisely, we first calculate the increase in each bank's total borrowing from the central bank over the period of implementation of the 3-year LTRO, including shorter-term central bank borrowing. We then define the *quantitative easing* associated with the 3-year LTROs, that we denote ΔQ_i for bank i, as the *increase* in total borrowed liquidity at the time of the LTROs. We also construct a *maturity swap* variable for each bank, MS_i, which measures the amount of shorter-term central bank liquidity that has been swapped by bank i for 3-year borrowing from the central bank and that we define as $MS_i = 0$ if $LTRO_i = 0$ and $MS_i = \max(LTRO_i - \Delta Q_i, 0)$ if $LTRO_i > 0$. Figure 3 schematically illustrates the difference between these two variables and their link with the total LTRO uptakes for an hypothetical bank.

We then estimate the following regression on our sample:

$$\Delta L_{ij} = \beta_j + \beta_{qe}\Delta Q_i + \beta_{ms} MS_i + Z_i'\gamma + \eta_{ij}. \tag{3}$$

Table 5 shows the results. Looking at the estimates for the two rounds of the operation as a whole (Column 9) shows that both the effect of quantitative easing and of maturity swap are significantly positive. So, the fact that the 3-year LTRO allowed banks to extend the maturity of their central bank borrowing also had a positive impact on credit supply in addition to the usual quantitative easing channel of these liquidity operations. In other words, the 3-year LTRO would have had a positive impact on credit supply, even if banks did not increase the net amount of central bank liquidity. This evidence also shows up in the results we obtain for the first round (Column 12) where the effect of the quantitative easing part drops to almost zero while the maturity swap remains large and significantly positive.

We can use these estimates to compute the counterfactual impact LTROs would have had on credit supply had they been a pure swap of short-term central bank funding facilities into long ones, controlling for the quantity of liquidity. Under such a scenario, the counterfactual maturity swap is $MS_i = LTRO_i$ for each bank i. We thus get an estimated counterfactual change in loans supplied by bank i, knowing its pre-LTRO stock of loans L_i, of: $\widehat{\beta}_{ms} \times MS_i \times L_i$ hence an estimated increase of EUR 60.9 billion in credit supply associated with a total liquidity uptake of EUR 153 billion. Put differently, everything else being constant, we find that EUR 1 billion of pure maturity swap injected by the Eurosystem would have led the average bank to supply EUR 398 million in supplementary credit to firms.

We can similarly compute the counterfactual impact LTROs would have had on credit supply had they been a pure short-term liquidity injection of central bank funding, keeping the maturity of the central bank liquidity at its the same level than before the 3-year LTRO operations for each bank, namely $\widehat{\beta}_{qe} \times LTRO_i \times L_i$. Summing up across banks we get an estimated increase in credit supplied by EUR 21.5 billion, against the same total liquidity uptake of EUR 153 billion. Put differently, everything else being constant, we find that EUR 1 billion of pure liquidity injected by the Eurosystem would have led the average bank to supply EUR 140 million in supplementary credit to firms.

These results are in line with recent extensions of Gertler and Karadi (2011)'s model showing that central bank liquidity provision is more effective when the maturity of such liquidity increases. In particular, Cahn et al. (2017) emphasize that long-term central bank liquidity provisions relieve financially constrained intermediaries for several periods which magnifies their impact on current credit supply. According to their model, an injection 1 billion long-term central bank liquidity (with no reimbursement option) is comparable to a pre-announced injection of 1 billion short-term liquidity that

would be rolled-over the whole LTRO horizon.[32] Another potential reason why increasing the maturity of central bank liquidity provision can have a positive impact on current loan supply is that it helps to alleviate the risk that banks that are not constrained today become constrained in the future. As Bocola (2012) shows, an increasing probability of hitting the constraint in the future reduces current credit supply.

5.4. Robustness

We provide evidence that our main results are robust to a variety of tests related to the type of the bank or several potential omitted controls.

5.4.1. Robustness to the type of bank

A first potential concern with our baseline results is that the set of bank level variables we consider may imperfectly capture individual bank factors that are correlated with both a bank's credit growth and its LTRO uptake. Column (2) of table 8 reports the estimation results of regression (2) when we include three additional banks' controls in Z_i (column (1) repeats the baseline results for comparison purpose). First, we add a dummy variable, denoted "MRO user", which singles out groups that were used to bid in regular operations before 2011, and thus had the technology to also easily bid in the 3-year LTROs in the winter of 2011–2012.[33] Second, we add two dummies accounting for foreign-owned and state-owned (or public) banks, respectively. Including the latter controls increases marginally the LTRO coefficient, which suggests that our baseline is conservative.

Another concern stems from the fact that foreign subsidiaries of European groups in our sample may have benefited from the LTRO uptakes of their parent company located in other euro area countries. Ignoring this potential liquidity spill-over within foreign banking groups can potentially bias our estimate of the policy's impact on credit supply. This bias can a priori go in either directions. On the one hand, most foreign subsidiaries did not borrow at the LTRO in France, so they are considered as non-participating banks in our sample. However, they might have benefited from the (unobserved) LTRO uptake of other affiliates of the same banking group or of their parent company headquartered in another euro area country and hence may supply more credit to firms than the banks which did really not to

[32] Note that, in the case of the 3-year LTRO, banks had the option of reimbursing the liquidity only after 1 year.

[33] This variable equals one for banking groups which took part in at least one of the ordinary weekly refinancing operations over the years 2006–2011.

participate. This would bias our estimate downward. On the other hand, one large foreign bank in our sample is not headquartered in the euro area but tapped the LTROs in France so that it is considered as participating in the program. However, in addition to its LTRO uptakes in France, this bank may also have benefited from some other uptakes of parent institutions located elsewhere in the euro area and may therefore have supplied more credit than banks benefiting only from the LTRO uptake that we observe. This can potentially bias our estimate upward, which is more worrisome. To assess the extent of this potential upward bias, we therefore run the same regressions as before on a sample excluding this foreign LTRO bidder. The results are presented in column (4) of Table 8. They show that our baseline results remain qualitatively unaffected, although the coefficient of interest is slightly below the baseline (1.11 instead of 1.17).

More generally, our results might also be driven by some specific bank business models. We therefore checked that our results are robust if we exclude some banks with specific business models. More precisely, we rely on the Single Supervisory Mechanism classification of European banks' business models. According to this classification, we have 5 types of banks in our sample: "Diversified lender", "Retail Lender", "Sectoral Lender", "Universal" and "Global Systemically Important Banks" (G-SIB). In Table C.1 of the Appendix we report the results we get when excluding each of these groups of banks from our sample with the exception of G-SIB (since they account for 8 banks and 76% of the bilateral credit exposures in our sample). The results illustrate that our baseline results still holds to these change in the sample of banks so they are not driven by a specific type of banks.

Finally, as emphasized recently in Paravisini et al. (2014), firms' fixed effects may fail to control effectively for all demand effects if firms are not randomly "assigned" to banks. This can happen for instance when banks are specialized and offer specific type of loans for a given firm on for some reason borrowing. To address this concern, we run our baseline regressions on different categories of loans namely short term credit (below one year maturity), long term credit (above one year of maturity) and drawn credits. We find an impact of LTROs that is still positive and significant. Interestingly, the results also underline that the supply of short term loans reacts more than long term ones.

5.4.2. Robustness to omitted controls

In addition to structural differences across banks we also implemented a number of exercises to verify that our baseline specification is not subject to a major omitted variable bias.

To start with, we check that the previous results do not stem from pre-existing different loan dynamics between the group of banks which bid a lot in the LTROs and the others. To do so, we run a so-called *placebo* regression version of equation (2) where *(i)* the dependent variable ΔL_{ij} is the growth rate of total credit of bank i to firms j over the year before the announcement of the 3-year LTRO, i.e. from September 2010 to September 2011, *(ii)* bank balance sheet ratios, Z_i, are measured as of June 2010 instead of June 2011, while *(iii)* the variable of interest $LTRO_i$ is kept the same. For the purpose of comparison, the sample of multi-bank firms and of banks is kept the same as before.[34] Table 7 shows that neither the LTRO uptakes of the winter of 2011-2012, nor the associated maturity swaps of central bank borrowing, had any significant impact on bank lending to firms over the year *before* the announcement of the LTROs. Our main findings therefore do not not reflect a correlation of banks' LTRO uptakes with pre-existing credit growth trends.

We also analyze the impact of the forced recapitalization of major European banking groups engineered by the European Banking Authority (EBA) as part of its 2011 Capital Exercise on our baseline results. The EBA announcements about the capital shortfall of individual banking groups were released just before the first round of LTROs. One may therefore worry that this information may have also influenced banks' bid in the LTROs and that not accounting for it could induce some omitted variable bias. Banks identified by the EBA as facing a capital shortfall were compelled to make it up before June 2012. As Mésonnier and Monks (2015) show, this exercise impinged negatively on credit supplied by shortfall banks in the euro area in 2012. Moreover, banks reported as facing a shortfall presumably faced a higher level of funding stress. So they were likely to bid more in the LTROs while at the same time deleveraging more. In sum, not accounting for this EBA Capital Exercise could lead us to underestimate the impact of LTRO on credit supply. We therefore check what happens when we also include the level of the EBA capital shortfall among the variables measuring the financial strength of a bank.[35] Column

[34] Some bank-firm links drop out from the sample as they are not observed over this different period. In addition, one balance sheet ratio is not available for one small foreign bank subsidiary in June 2010, which limits the sample of banks to 23 when bank controls are included as regressors.

[35] We use the detailed bank capital information released by the EBA. The EBA calculation is based on balance sheet information and sovereign bond market prices as of September 2011. The shortfall variable is truncated at zero: banking groups with a capital surplus according to the EBA, as well as banks which are not monitored by the EBA, are considered unconstrained by the Capital Exercise. Note also that foreign subsidiaries belonging to European groups monitored by the EBA are assumed here to face the same constraint as their parent company. As non-EU banks are not supervised by the EBA, their EBA shortfall is by definition zero.

(3) of table 8 reports the results. The coefficient associated with the EBA capital shortfall is negative as expected but close to zero and not significant when all the other controls are included, and the main coefficient of interest remains unchanged.

Finally, we conduct an automatic LASSO-type model selection procedure on a wider set of banks explanatory variables than in our baseline regression. This set includes other observable banks characteristics that might measure their vulnerability to funding shocks such as the deposit-to-assets ratio or their off-balance sheet exposure measured as the fraction of undrawn credit lines to assets. The procedure selects banks' controls from this set as the variables that maximize information content for regressions explaining (i) credit supply on a pre-LTRO sample and (ii) banks LTRO take-ups. For the sake of parsimony, we keep the variables that are statistically significant in the models with the best information criteria. We then estimate our baseline regression controlling for all the variables selected by the procedure. More practical details as the results of this procedure are given in Appendix B. Note that, in the spirit of a propensity score method, Step (ii) in this procedure is an attempt to control for observable banks characteristics that are the most informative so that the residual variation in their LTRO demand is as close as possible to a random assignment. We end up with three main determinants of LTRO take-up: capital-to-assets ratio, interbank liabilities and the share of securities held in total assets which account for a large share (about 64%) of their variation. Overall, the results show that our parameter of interest barely changes when introducing bank controls selected with this statistical procedure in our baseline regression.

6. Additional results

In this section, we investigate whether the impact of the LTROs on loan supply differs across borrowing firms. This is interesting for several reasons. Firstly, LTROs were in part motivated by concerns that smaller firms, which are supposed to rely more on bank credit, could face a credit crunch.[36] Secondly, LTRO-uptakes may have been associated with risk-shifting strategies if banks chose to lend

[36]Chodorow-Reich (2014b) for the US and Iyer et al. (2014) for one euro-area country (Portugal) show that the 2007-09 banking crisis hit small and young firms more severely than large ones.

to riskier firms.[37] Thirdly, the LTROs may have encouraged some form of "zombie lending" or "evergreening". This happens when banks roll-over credit to impaired relationship customers in order notably to avoid writing down their loans and posting provisions that would dent their capital basis.[38] We address these issues by looking at the differentiated effect of the LTROs on firms of different sizes (in terms of their total bank borrowing), but also different levels of credit risk, bargaining power (proxied by the number of banks serving a given firm), and length of the average relationship with its banks. Moreover, for a subset of firms for which we have balance-sheet information, we also look at differences in terms of firms' size (i.e., total assets) as well as firms' profitability and financial soundness.

6.1. Differentiated effects of the LTROs according to firms' size

Table 9 presents results on the differentiated impact of the LTROs when firms are sorted according to their borrowing size.[39] For comparison, the results obtained in the baseline for the whole population of multi-bank firms are repeated in column (1) of the Table. Columns (2) to (5) then present the results obtained for the four sub-samples of firms ranked by increasing borrowing size as detailed in the data section above.

The results underline that the LTROs had a strong positive impact on banks' credit supply to intermediate and large borrowers (i.e., firms which are in the top decile of the borrowing size distribution). The measured effect is much weaker as far as very small firms are concerned. The operations benefited the largest borrowers (i.e., the top 1 percent of firms in terms of total borrowing size), about 50% more than firms in the rest of the top decile from this increased supply of bank credit, and 63% more than the average firm in the sample.

A legitimate concern could be that our methodology which only looks at a sample of multibank firms undermines the impact of LTROs on credit supply to very small firms as most of them should only borrow from one bank. Indeed, as is visible in column (2) of Table 9, our sample includes relatively few

[37] Drechsler et al. (2016) find evidence of such risk-shifting strategies for European banks bidding in Eurosystem's liquidity facilities. They focus on changes in sovereign bond portfolios. Meanwhile, Chodorow-Reich (2014a) find no evidence of an aggregate risk shifting impact of the Fed's unconventional monetary policies implemented after the Great Recession.

[38] For instance, Caballero et al. (2008) provide evidence in support of such "zombie lending" during the Japanese "lost decade".

[39] More precisely, we rank firms according to their total amount of outstanding credit with all their banks. As noted in Section 3, firms' borrowing size is a good proxy of firms' total balance sheet size. Note however that, since our firm dataset is not consolidated, we cannot distinguish between firms that are independent SMEs and firms that belong to large corporations.

links between banks and "very small" firms. Moreover, the impact on very small firms could also show up on new firm-bank loan relationship (the extensive margin) rather than on the intensity of existing relationships (the intensive margin).

The data we have does not allow us to fully address this concern and to assess the impact of the program in the extensive margin. However, we can run additional linear probability regressions, where we test whether the LTROs contributed to *maintaining* existing credit relationships for a given firm (that is, controlling for firm's demand). The sample now includes all multi-bank firms with active credit relationships as of September 2011. Our dependent variable at the bank-firm level is then a dummy variable which equals one if a pre-existing credit link is still active in September 2012, i.e., after the LTROs, and zero otherwise. Table 10 shows that the LTROs significantly contributed to maintaining firm-bank credit links active over this 12-months period, and this benefited all borrowers, including the smaller ones.

All in all, the results reported in this section suggest that the LTROs were more effective in sustaining credit supply to large firms rather than to small ones. As larger firms might be on average less risky than smaller ones, these results suggest that banks were relatively cautious when they increase their supply of credit in response to LTROs. The next subsection gives more direct evidence that indeed the policy did not lead to risk-shifting.

6.2. Did the LTROs benefit riskier and less profitable firms?

Table 11 provides further evidence on how firms' characteristics, and in particular risk, may affect banks' loan supply. Specifically we estimate the following, augmented, version of equation (2) where the LTRO uptake of bank i is interacted with characteristics of its customer firm j, denoted here X_j:

$$\Delta L_{ij} = \beta_j + \beta_1 LTRO_i + \beta_2 (X_j \times LTRO_i) + Z_i' \gamma + \varepsilon_{ij}, \tag{4}$$

We first investigate whether riskier firms received less funds than others from their lenders' LTRO uptake. Indeed, as discussed above in the data section, the credit register includes credit-risk ratings, which are computed by the Banque de France for a large number of firms in the sample. Loans to the firms which get a rating above a certain threshold are eligible as collateral for the refinancing operations of banks with the Eurosystem. Low rated firms, or firms without any rating, are gauged as much riskier and are not eligible. We use this information to distinguish between low risk (eligible) and

high risk (non-eligible) firms as of September 2011. The estimates presented in column (1) of Table 11 show that low rated, namely riskier, firms did not benefit more from their lenders' uptake in the LTROs.

An interesting special case in terms of firms' credit risk is the bucket of firms which were not eligible prior to the LTROs, but became eligible in February 2012. At this date, the Eurosystem implemented an extension of the pool of eligible collateral and included loans to firms with a rating just a notch below the previous threshold. These firms are denoted "ACC" firms (which stands for *Additional Credit Claims*) in what follows. As shown in column (2) of Table 11, firms belonging to the newly eligible credit category indeed benefited from a stronger transmission of the LTRO liquidity borrowed by their lenders.[40] We read this as suggesting that (i) some of the bidding banks were constrained in terms of available collateral and (ii) ACC firms faced some credit rationing on the part of these banks. As the extension of collateral eligibility to this firm bucket lowered the opportunity cost of funding them, banks were more willing to funnel some of the liquidity borrowed into these firms of intermediate credit quality.

We then ask whether the strength of the borrower-lender relationship helps to explain the transmission of the LTROs to firms. We show in column (3) of Table 11 that firms with more bank relationships fared better overall: the higher the number of banks lending *ex-ante* to a given firm, the more this firm benefited from an increase in credit supply associated with the LTROs. However, this effect disappears when the regression is run separately for each size bucket.[41] Indeed, as the number of lenders for a given firm is strongly correlated with its borrowing size, the effect of multiple banking may be difficult to disentangle from the effect of firm size. In contrast, firms with an older (longer than 3-year) relationship with their bank received fewer loans from the LTROs than the average.[42] We interpret this result as suggesting that little, if any, ever-greening of existing bad loans took place over this period. Indeed, incentives to roll-over credit to "zombie" firms are likely to be stronger in the presence of a long relationship.

Finally columns (5) and (6) of Table 11 provide additional results for the sub-sample of firms for which complete balance sheet information is available. For this sub-sample of some 37,000 multi-bank firms, we find that the financial soundness of the firm – measured as the ratio of earnings before tax to

[40] We also ran additional regressions on sub-sample of firms sorted by borrowing size as previously and find that this result holds for all categories of firms' size.

[41] Detailed results are not shown here for brevity, but available upon request.

[42] Unreported results show that this finding holds for the whole sample of firms as well as within each size bucket.

earnings before net interest payments and tax – does not matter in the allocation of credit supply induced by the LTROs. In contrast, the past profitability of a firm – measured as the ratio of net operating profits to net turnover – has a positive impact. This last finding is consistent with our diagnosis that the LTROs did not encourage "zombie lending".

7. Conclusion

In this paper, we use the Eurosystem's 3-year LTROs of 2011–2012 to test whether central bank liquidity injections can stimulate the provision of bank credit to the economy during a financial crisis. We base our investigation on a very rich dataset of bank-firm credit exposures in France, which allows us to control effectively for credit demand by individual firms as well as for characteristics of banks. We find robust evidence that a quantitative monetary policy can work via the bank lending channel when banks are financially constrained and the policy measure relieves this constraint. Banks did on average use their LTROs uptake to increase their lending to firms on the intensive margin. Importantly, we show that the possibility offered to banks to swap their existing short-term borrowing at the central bank for long-term borrowing enhanced such positive effect of liquidity operations. Furthermore, the increased supply of credit benefited more to larger corporate borrowers, to more profitable firms and did not encourage ever-greening of existing bad loans on banks' books.

Overall, our results illustrate that these policies were more effective than just "pushing on a rope". However, they also suggest that the LTROs were not very effective in shielding small firms, which are deemed to be more dependent on banks than large firms, from the heightened risk of a credit crunch. This finding can be interpreted as an argument for more targeted forms of quantitative policies, such as the "funding-for-lending" scheme implemented by the Bank of England over 2012-2014 or the "Targeted-LTROs" announced by the Eurosystem in June 2014. To date, the success of these recent experiments is largely perceived as mixed. The relevance of more sophisticated forms of large injections of central bank liquidity that aim to stimulate the provision of credit to some groups of borrowers thus remains a largely unsettled issue, which we leave for further research.

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TABLE 1. Descriptive statistics for the selected banking groups

	mean	p50	sd	p10	p90
All banks					
Total Assets (bns)	494·44	27·01	1,059·08	1·62	1,918·24
Total Assets Growth	2·31	3·01	15·59	−13·89	20·18
Loans	37·47	16·18	37·97	5·12	96·93
Total Credit Growth	−1·43	1·75	14·11	−22·24	12·68
Drawn Credit Growth	−3·90	0·19	17·48	−26·22	14·86
Liquid Assets	18·90	13·58	20·38	1·82	51·46
Securities Portfolio	16·05	4·58	19·88	0·00	44·30
Capital	8·01	6·40	5·99	2·33	16·68
EBA Capital Shortfall	0·33	0·00	0·72	0·00	1·90
Interbank Liabilities	31·58	17·50	30·58	1·73	83·14
Bank Eligib. Loans	29·07	20·38	22·48	5·60	66·10
LTRO	1·15	0·00	2·27	0·00	2·31
LTRO Maturity Swap	0·29	0·00	0·59	0·00	1·07
LTRO Quant. Easing	1·09	0·00	2·32	0·00	3·40
# of indiv. banks included	13·04	2·50	22·36	1·00	34·00

Note. This table presents descriptive statistics for the 24 selected banking groups in our sample (thereafter banks). Bank total assets are expressed in billions of euros. Total assets and credit growth are given as a percentage and are defined in terms of logarithm difference of the corresponding variable. Unless otherwise stated, the other rows refer to ratios of the mentioned balance sheet item to the banks total assets (as a percentage). All balance sheet variables are measured as of June 2011 in terms of a ratio to their total assets and refer to consolidated banking group statements in the case of French groups. Balance sheet items of French subsidiaries of foreign groups are aggregated at the group-country level. *Bank loans* is the ratio of drawn credit to firms to the bank's total assets. *Bank Capital* is the unweighted Tier 1 capital-to-assets ratio. *EBA Capital Shortfall* is the core equity tier one shortfall (as a percentage of RWA) of the banking group as disclosed by the EBA in December 2011 (as part of the Agnecy's 2011 Capital Exercise). *Bank Liquid Assets* and *Bank Interbank Liabilities* are, respectively, the ratios of cash and interbank loans, and of total interbank liabilities (excluding liabilities vis-à-vis the Eurosystem) to total assets. *Bank Eligib. Loans* is the ratio of loans eligible as collateral for refinancing operations with the Eurosystem to total loans. *LTRO* is the ratio of the bank's LTRO uptake to total assets. *LTRO Maturity Swap* measures the substitution of 3-year LTRO funding for ECB funding of shorter maturity (as a proportion of total assets), while *Quant. Easing* measures the overall increase of ECB borrowing by the banking group (as a proportion of total assets). *Nb of banks* refers to the number of subsidiaries of each banking group for which we observe bank-firm credit linkages in September 2011.

TABLE 2. Characteristics of banking groups in the sample by LTRO bidding behaviour

	No LTRO $N = 14$	LTROs $N = 10$	LTRO 1 $N = 6$	LTRO 2 $N = 8$
Total Assets (bns)	11.72	1,170.24	1,908.57	1,105.63
Total Assets Growth	2.30	2.31	-0.77	1.84
Loans	51.52	17.79	8.04	19.87
Total Credit Growth	-3.36	1.27	-3.77	2.08
Drawn Credit Growth	-7.14	0.63	-3.92	1.12
Liquid Assets	25.05	10.29	14.24	8.30
Securities Portfolio	6.18	29.88	31.61	28.13
Capital	7.94	8.11	4.83	9.20
EBA Capital Shortfall	0.45	0.17	0.29	0.10
Interbank Liabilities	43.70	14.62	13.58	14.86
Bank Eligib. Loans	30.09	27.64	20.19	29.27
LTRO	0.00	2.76	1.47	2.97
LTRO Maturity Swap	0.00	0.69	1.16	0.49
LTRO Quant. Easing	0.24	2.28	0.68	2.47
# of indiv. banks included	2.57	27.70	43.00	22.38

Note. This table presents the mean of selected characteristics of the 24 selected banking groups (thereafter banks), sorted by their LTRO bidding behavior. Column (1) refers to banks that did not bid in the LTROs, column (2) to LTRO bidders, columns (3-4) to banks that bid in the first LTRO round, or in the second round respectively (note that some groups bid in both). Bank total assets, total credit to firms (incl. credit lines) and drawn credit to firms (the latter two aggregated from credit register information) are expressed in billions of euros. Total credit growth is given as a percentage. Unless otherwise stated, the other rows refer to ratios of the mentioned balance sheet item to total assets of the bank (as a percentage). All balance sheet variables are measured as of June 2011 and refer to consolidated banking group statements in the case of French groups. Balance sheet items of French subsidiaries of foreign groups are aggregated at the group-country level. See the note of Table 1 for more details on the definition of the variables.

TABLE 3. Descriptive statistics for firms in the sample

	N	mean	p50	sd	p10	p90
All firms						
Total Credit Growth	1.17e+06	−5.71	−8.00	30.21	−31.30	21.55
Total Credit	1.17e+06	1,093.05	153.00	41,997.11	46.00	780.00
ECB Eligibility Status	1.17e+06	0.05	0.00	0.21	0.00	0.00
Relationship Age	1.17e+06	0.67	1.00	0.47	0.00	1.00
Nb of Banks	1.17e+06	1.25	1.00	0.64	1.00	2.00
with BS info	1.17e+06	0.06	0.00	0.23	0.00	0.00
Monobank firms						
Total Credit Growth	960,494	−7.58	−8.34	26.62	−31.51	13.63
Total Credit	960,494	330.36	128.00	7,733.52	43.00	493.00
ECB Eligibility Status	960,494	0.03	0.00	0.17	0.00	0.00
Relationship Age	960,494	0.64	1.00	0.48	0.00	1.00
Nb of Banks	960,494	1.00	1.00	0.00	1.00	1.00
with BS info	960,494	0.03	0.00	0.17	0.00	0.00
Multi-bank firms						
Total Credit Growth	211,209	2.82	−5.94	41.85	−30.54	44.63
Total Credit	211,209	4,561.44	417.00	97,457.69	116.00	3,242.00
ECB Eligibility Status	211,209	0.14	0.00	0.34	0.00	1.00
Relationship Age	211,209	0.76	1.00	0.43	0.00	1.00
Nb of Banks	211,209	2.41	2.00	0.82	2.00	3.00
with BS info	211,209	0.17	0.00	0.38	0.00	1.00
Subsample of multi-bank firms with balance sheet information						
Total Credit Growth	36,750	10.07	−0.98	51.59	−35.03	66.01
Total Credit	36,750	7,434.00	664.00	111428.99	145.00	5,330.50
ECB Eligibility Status	36,750	0.40	0.00	0.49	0.00	1.00
Relationship Age	36,750	0.82	1.00	0.38	0.00	1.00
Nb of Banks	36,750	2.80	2.00	1.10	2.00	4.00
Nb Employees	36,750	85.24	20.00	1,362.68	4.50	115.50
Size	36,750	42,986.64	2,872.29	1.15e+06	770.64	23,291.50
Profitability	36,750	−0.14	0.04	20.31	−0.01	0.15
Financial Soundness	36,750	0.59	0.77	15.22	0.11	1.03

Note. This table presents descriptive statistics for firms in our sample. Multi-bank firms refer to firms that received credit from at least two different banks in September 2011. In contrast, monobank firms are defined as firms that have a credit relationship with only one banking group at this date. *Total credit* includes undrawn credit lines and is expressed in thousands of euros. Growth rates are given as a percentage. *ECB Eligibility Status* is a dummy variable that takes the value of one if the firm's rating makes loans to this firm eligible as collateral for refinancing operations with the Eurosystem. *Relationship Age* is a dummy that takes the value of one if the average length of a firm's credit relationship with its lenders is above three years. *Nb of Banks* stands for the number of lenders to which a given firm is connected. *Firm with BS info* denotes firms for which detailed balance sheet information is available (from the FIBEN database). All firms'balance sheet and structural variables are averages over the 2010 and 2011 year-end values. *Size* is the firm's total asset size in thousands of euro. *Profitability* is the ratio of net operating profits to net turnover (as a percentage). *Financial Soundness* is the ratio of earnings before tax to earnings before net interest payments and tax (as a percentage).

TABLE 4. Descriptive statistics for multi-bank firms in the sample, sorted by borrower size

	Very Small	Small	Interm.	Large
All multi-bank firms				
Nb of firms	29,325	110,374	61,307	10,203
Total Credit	100	311	1,451	16,844
Total Credit Growth	−6.56	−6.73	−5.34	−0.98
Nb of Banks (incl. non-selected)	2.00	2.00	3.00	4.00
multi-bank firms with balance sheet information				
Nb of firms	3,366	15,861	14,988	2,641
Total Credit	97.00	347.00	1,605.00	15,885.00
Size	954.25	1,519.99	5,724.39	58,221.50
Nb Employees	12.00	15.50	33.50	102.00

Note. This table reports the median of listed variables across multi-bank firms in our sample (unless otherwise stated), sorted by the size of their total bank borrowings in September 2011. Multi-bank firms refer to firms that received credit from at least two different banking groups in September 2011. *Total credit* includes undrawn credit lines and is expressed in thousands of euro, as is *firm size* (which is measured with total assets). Growth rates are given as a percentage. *Nb of Banks* stands for the number of lenders to which a given firm is connected. Firm with balance sheet information are firms for which detailed balance sheet information is available from the FIBEN database. *Nb Employees* refers to the size of staff in units.

TABLE 5. Impact of the 3-year LTROs on bank lending to firms: baseline results

	Total LTROs									Round 1	Round 2	Round 1
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Bank LTRO	−0·16	0·28	0·34	0·89**	0·28**	1·17***	1·17***	1·17***		1·39***	0·40*	
	(0·46)	(0·41)	(0·25)	(0·35)	(0·14)	(0·31)	(0·08)	(0·27)		(0·36)	(0·23)	
LTRO Maturity Swap									2·51***			3·37***
									(0·60)			(0·88)
LTRO Quant. Easing									0·89***			0·18
									(0·22)			(0·41)
Bank Size		0·64*		0·79***		0·58**	0·58***	0·58*	0·92***	0·71***	0·55**	1·02***
		(0·35)		(0·30)		(0·23)	(0·08)	(0·34)	(0·23)	(0·25)	(0·25)	(0·28)
Bank Liquid Assets		0·03		−0·03		−0·08**	−0·08***	−0·08	−0·09***	−0·09**	−0·09**	−0·11***
		(0·07)		(0·06)		(0·04)	(0·01)	(0·06)	(0·03)	(0·04)	(0·04)	(0·04)
Bank Capital		0·31***		0·20**		0·14*	0·14***	0·14*	0·36***	0·42***	0·24**	0·53***
		(0·10)		(0·09)		(0·08)	(0·03)	(0·08)	(0·09)	(0·09)	(0·09)	(0·09)
Bank Interbank Liabilities		0·08**		0·09**		0·13***	0·13***	0·13***	0·19***	0·13***	0·08***	0·17***
		(0·04)		(0·04)		(0·03)	(0·01)	(0·02)	(0·04)	(0·03)	(0·03)	(0·04)
Bank Loans		−0·04***		−0·03**		−0·05***	−0·05***	−0·05*	−0·03*	−0·06***	−0·05**	−0·03
		(0·01)		(0·01)		(0·02)	(0·01)	(0·03)	(0·02)	(0·02)	(0·02)	(0·02)
Bank Eligib. Loans		0·05		0·04		−0·03	−0·03*	−0·03	−0·04*	0·02	−0·03	−0·02
		(0·05)		(0·03)		(0·03)	(0·01)	(0·03)	(0·02)	(0·03)	(0·02)	(0·03)
Bank Securities Portfolio		−0·06*		−0·11***		−0·10***	−0·10***	−0·10***	−0·12***	−0·06**	−0·05*	−0·08***
		(0·03)		(0·04)		(0·03)	(0·01)	(0·03)	(0·03)	(0·02)	(0·03)	(0·02)
Multi-bank firms	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank*Industry SD cluster	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
N	1,390,270	1,390,270	428,594	428,594	380,509	380,509	380,509	380,509	380,509	380,509	380,509	380,509
R^2	0·00	0·00	0·00	0·00	0·46	0·46	0·46	0·46	0·46	0·46	0·46	0·46

Note. This table presents the results of OLS regressions, where the dependent variable is the change in the (log) level of credit volume for each selected firm-bank pair over the period from September 2011 to September 2012 (as a percentage). Credit is defined as total commited credit (drawn and undrawn) in all columns. The sample is restricted in all regressions to firms that have at least two banking relationships in September 2011, except in columns (1) and (2) which provide with results on all firms. Some of these firms do not maintain all their credit relationships over the period of interest. When they become mono-bank firms in September 2012, they are dropped from the regressions that include firm fixed effects (hence the smaller number of observations used). *Bank LTRO* measures the ratio of the total amounts borrowed in the two 3-year LTROs by the lending bank, to this bank's total assets (as a percentage). In columns (10) and (11), this refers to the uptake in the first and second rounds of the LTROs respectively. *LTRO Maturity Swap* measures the substitution of 3-year LTRO funding for ECB funding of shorter maturity (as a proportion to total assets), while *Quant. Easing* measures the overall increase of ECB borrowing by the banking group (as a proportion to total assets). In column (12), this refers to the same measures as derived from the first round of LTROs. Bank controls are consolidated balance sheet variables and ratios (as of June 2011). See the note in Table 1 for more details. A constant is included but not shown. Standard errors are reported in parentheses. In column (7) we apply the White-robust correction. In column (8) they are clustered at the bank-level. Standard errors are clustered at the bank*firm sector (NAF 1 digit) level (210 clusters) otherwise. The symbols *, ** and *** denote significant coefficients at the 10, 5 and 1 percent levels respectively.

TABLE 6. Determinants of LTRO bids by selected banks, first vs second round.

	Prob. of bid		LTRO/A.	
	LTRO1	LTRO2	LTRO1	LTRO2
	(1)	(2)	(3)	(4)
Bank Capital	-0.17*	0.03	-0.28*	0.30*
	(0.09)	(0.04)	(0.14)	(0.16)
N	24	24	24	24
Pseudo R^2	0.15	0.02	0.12	0.05

Note. Columns (1-2) of this table present the results of a Probit regression, where the dependent variable is a dummy variable indicating whether a bank bid or not in the specified LTRO round, while columns (3-4) present the results of Tobit regressions, where the dependent variable is a bank's uptake of the specified LTRO round to this bank's total assets (as a percentage). Bank-specific regressors are defined in Table 1 above. A constant is included but not shown. Robust standard errors are shown in parentheses. The symbols *, ** and *** denote significant coefficients at the 10, 5 and 1 percent levels respectively.

TABLE 7. Placebo regressions: "impact" of the 3-year LTROs on bank lending to firms one year before (over Sept. 2010-Sept. 2011)

	Total LTROs									Round 1	Round 2	Round 1
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Bank LTRO	−0·43	−0·59	−0·31	−0·33	−0·52	0·18	0·18	0·18		0·74	−0·40	
	(0·55)	(0·68)	(0·40)	(0·83)	(0·37)	(0·73)	(0·14)	(0·28)		(1·35)	(0·31)	
LTRO Maturity Swap									1·71			0·62
									(2·40)			(1·35)
LTRO Quant. Easing									−0·06			0·59
									(0·34)			(1·65)
Bank controls	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Multi-bank firms	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank*Industry SD cluster	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
N	1,150,864	1,147,032	360,836	357,311	290,944	285,202	285,202	285,202	285,202	285,202	285,202	285,202
R^2	0·00	0·00	0·00	0·00	0·46	0·46	0·46	0·46	0·46	0·46	0·46	0·46

Note. This table presents the results of OLS regressions, where the dependent variable is the change in the (log) level of credit volume for each selected firm-bank pair over the period from September 2010 to September 2011 (as a percentage). Credit is defined as total commited credit (drawn and undrawn) in all columns. The sample is restricted in all regressions to firms that have at least two banking relationships, except in columns (1) and (2) which provide with results on all firms. Some of these firms do not maintain all their credit relationships over the period of interest. When they become mono-bank firms, they are dropped from the regressions that include firm fixed effects (hence the smaller number of observations used). *Bank LTRO* measures the ratio of total amounts borrowed in the two 3-year LTROs by the lending bank to this bank's total assets (as a percentage). In columns (10) and (11), this refers to the uptake in the first and second rounds of LTROs, respectively. *LTRO Maturity Swap* measures the substitution of 3-year LTRO funding for ECB funding of shorter maturity (as a proportion of total assets), while *Quant. Easing* measures the overall increase of ECB borrowing by the banking group (as a proportion of total assets). In column (12), this refers to the same measures as derived from the first round of LTROs. Bank controls are consolidated balance sheet variables and ratios (as of June 2010) as in Table 5. See the note in Table 1 for more details. A constant is included but not shown. A constant is included but not shown. Standard errors are reported in parentheses. In column (7) we apply the White-robust correction. In column (8) they are clustered at the bank-level. Standard errors are clustered at the bank*firm sector (NAF 1 digit) level (210 clusters) otherwise. The symbols *, ** and *** denote significant coefficients at the 10, 5 and 1 percent levels respectively.

TABLE 8. Impact of the 3-year LTROs on bank lending to firms. Robustness: controlling for ownership status, nationality, the EBA Capital exercise of 2011 and excluding foreign LTRO-bidders.

	All banks			No Foreign bidder
Bank LTRO	1.17***	1.24***	1.25***	1.11***
	(0.31)	(0.36)	(0.40)	(0.27)
Bank Size	0.58**	0.99*	0.99*	1.02***
	(0.23)	(0.52)	(0.53)	(0.28)
Bank Liquid Assets	-0.08**	-0.17***	-0.17***	-0.15***
	(0.04)	(0.06)	(0.06)	(0.04)
Bank Capital	0.14*	0.17	0.17	0.20***
	(0.08)	(0.12)	(0.12)	(0.08)
Bank Interbank Liabilities	0.13***	0.20***	0.20***	0.15***
	(0.03)	(0.06)	(0.07)	(0.03)
Bank Loans	-0.05***	-0.05***	-0.05**	-0.04**
	(0.02)	(0.02)	(0.02)	(0.02)
Bank Eligib. Loans	-0.03	0.00	0.00	-0.03
	(0.03)	(0.03)	(0.04)	(0.02)
Bank Securities Portfolio	-0.10***	-0.10**	-0.10**	-0.12***
	(0.03)	(0.05)	(0.05)	(0.03)
ECB MRO User		1.57	1.56	
		(1.89)	(1.88)	
Foreign Bank		3.03*	3.02*	
		(1.75)	(1.81)	
Public Bank		-1.73	-1.80	
		(2.87)	(3.52)	
EBA Capital Shortfall			-0.02	
			(0.62)	
N	380,509	380,509	380,509	364,550
R^2	0.46	0.46	0.46	0.47

Note. This table presents the results of OLS regressions, where the dependent variable is the change in the (log) level of credit volume for each selected firm-bank pair over the period from September 2011 to September 2012 (as a percentage). Credit is defined as total commited credit (drawn and undrawn) in all columns. The sample is restricted in all regressions to firms that have at least two banking relationships. Columns (1-2) refer to all selected banks, while columns (3-6) refer to French banking groups only. *Bank LTRO* measures the ratio of amounts borrowed in the 3-year LTROs by the lending bank to this bank's total assets (as a percentage). *LTRO Maturity Swap* measures the substitution of 3-year LTRO funding for ECB funding of shorter maturity (as a proportion of total assets), while *Quant. Easing* measures the overall increase of ECB borrowing by the banking group (as a proportion of total assets). *EBA Capital Shortfall* is the capital shortfall of a banking group in terms of its ratio of Core equity Tier 1 to RWA, as measured by the EBA in October 2011 as part of their 2011 Capital Exercise (ratio measured as of September 2011). Negative shortfalls (i.e., capital surplus positions) are set to zero. *ECB MRO user*, *Public bank* and *Foreign bank* are dummy variables for participation in standard refinancing operations, state-owned institutions and foreign subsidiaries respectively. Other bank variables are as defined in the note of Table 1 above. A constant is included but not shown. Standard errors reported in parentheses are clustered at the bank*firm sector (NAF 1 digit) level. The symbols *, ** and *** denote significant coefficients at the 10, 5 and 1 percent levels respectively.

TABLE 9. Impact of the 3-year LTROs on bank lending to firms, by size of borrowers

	(1) All	(2) Very Small	(3) Small	(4) Interm.	(5) Large
Bank LTRO	1.17***	0.92*	0.80***	1.29***	1.91***
	(0.31)	(0.49)	(0.30)	(0.39)	(0.55)
Bank controls	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
N	380,509	29,468	183,906	136,089	31,046
R^2	0.46	0.52	0.49	0.43	0.38

Note. This table presents the results of OLS regressions, where the dependent variable is the change in the (log) level of committed credit volume for each selected firm-bank pair over the period from September 2011 to September 2012 (as a percentage). The sample is restricted in all regressions to firms that have at least two banking relationships. Firms are sorted into size buckets according to the distribution of total bank credit across firms in September 2011. Column (1) repeats the results for all multi-bank firms, while columns (2-5) present the results of separate regressions run on sub-samples of firms sorted by borrowing size. *Very Small* firms are below the median, *Small* in the 6th to 9th deciles, *Intermediate* in the 90th to 99th percentiles, *Large* in the top percentile of the (total) credit size distribution (as measured over all firms present in the French credit register). *Bank LTRO* measures the ratio of total amounts borrowed in the 3-year LTROs by the lending bank, to this bank's total assets (as a percentage). Bank controls are consolidated balance sheet variables and ratios (as of June 2011). See the note in Table 1 for more details. A constant is included but not shown. Standard errors reported in parentheses are clustered at the bank*firm sector (NAF 1 digit) level. The symbols *, ** and *** denote significant coefficients at the 10, 5 and 1 percent levels respectively.

TABLE 10. Impact of the 3-year LTROs on the probability of maintaining an existing bank-firm credit exposure, by size of borrower

	(1) All	(2) Very Small	(3) Small	(4) Interm.	(5) Large
Bank LTRO	0.02***	0.02***	0.02***	0.02***	0.01**
	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)
Bank controls	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
N	521,318	65,284	250,883	167,932	37,082
R^2	0.51	0.53	0.49	0.45	0.43

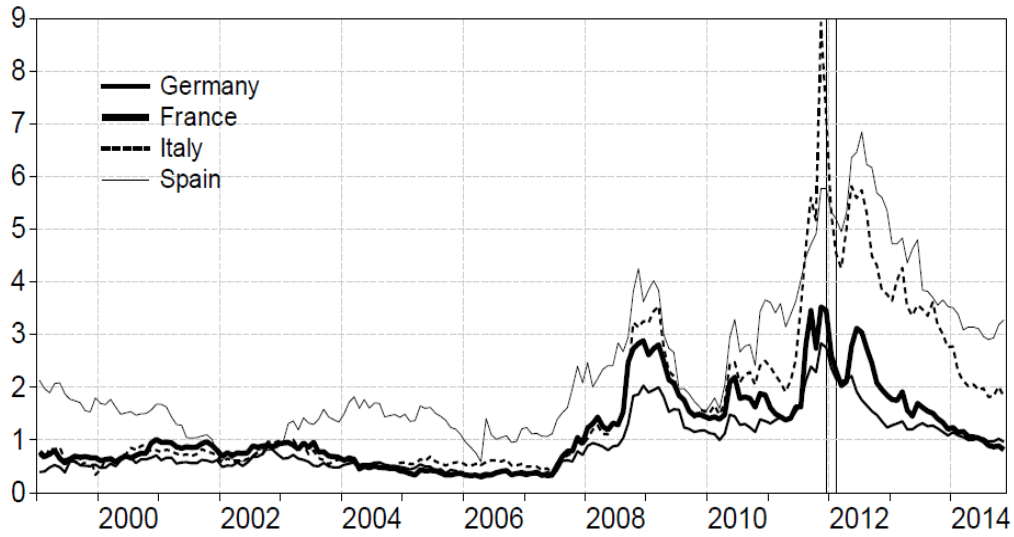
Note. This table presents the results of linear probability regressions, where the dependent variable is a dummy variable taking the value of one if the level of committed credit volume for a selected firm-bank pair was strictly positive in September 2011 and remained active in September 2012 (surviving link). The sample is restricted in all regressions to firms that have at least two active banking relationships in September 2011. Firms are sorted into size buckets according to the distribution of total bank credit across firms in September 2011. Column (1) shows the results for all multi-bank firms, while columns (2-5) present the results of separate regressions run on sub-samples of firms sorted by borrowing size. *Very Small* firms are below the median, *Small* in the 6th to 9th deciles, *Intermediate* in the 90th to 99th percentiles, and *Large* in the top percentile of the (total) credit size distribution (as measured over all firms present in the French credit register). *Bank LTRO* measures the ratio of total amounts borrowed in the 3-year LTROs by the lending bank to this bank's total assets (as a percentage). Bank controls are consolidated balance sheet variables and ratios (as of June 2011) as in Table 5. See the note in Table 1 for more details. A constant is included but not shown. Standard errors reported in parentheses are clustered at the bank*firm sector (NAF 1 digit) level. The symbols *, ** and *** denote significant coefficients at the 10, 5 and 1 percent levels respectively.

TABLE 11. LTROs and credit supply to firms: non-linear firm effects

Interaction term (X)	(1) Eligible	(2) ACC	(3) Nb Bk	(4) Relation.	(5) X=Size	(6) Profitab.	Fin. Sound.
		All firms			*Firms with BS info*		
Bank LTRO	1·15***	1·10***	0·31	2·47***	1·01	2·21***	2·19***
	(0·32)	(0·30)	(0·32)	(0·44)	(1·45)	(0·40)	(0·40)
X*LTRO	0·27	0·90***	0·28***	−1·86***	0·13	0·01***	−0·00
	(0·32)	(0·32)	(0·07)	(0·31)	(0·15)	(0·00)	(0·01)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	
N	380,509	380,509	380,509	380,509	72,400	72,288	72,400
R^2	0·46	0·46	0·46	0·46	0·44	0·44	0·44

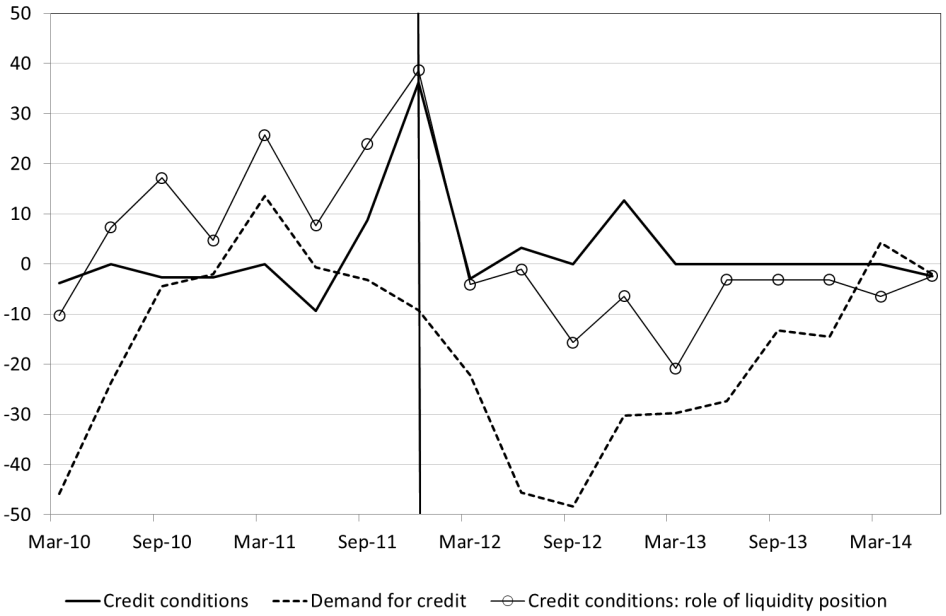
Note. This table presents the results of OLS regressions, where the dependent variable is the change in the (log) level of committed credit volume (drawn and undrawn) for each selected firm-bank pair over the period from September 2011 to September 2012 (as a percentage). The sample is restricted in all regressions to firms that have at least two banking relationships. *ECB Eligibility Status* is a dummy variable that takes the value of one if the firm's rating makes loans to this firm eligible as collateral for refinancing operations with the Eurosystem. Firm *ACC Status* is a dummy variable that takes the value of one if the firm's rating makes loans to this firm eligible as collateral as part of the Additional Credit Claim category. *Firm Relationship Age* is a dummy that takes the value of one if the average length of a firm's credit relationship with its lenders is above three years. *Profitability* is the ratio of net operating profits to net turnover (as a percentage). *Financial Soundness* is the ratio of earnings before tax to earnings before net interest payments and tax (as a percentage). *Bank LTRO* measures the ratio of total amounts borrowed in the 3-year LTROs by the lending bank to this bank's total assets (as a percentage). Bank controls are consolidated balance sheet variables and ratios (as of June 2011) as in Table 5. See the note in Table 1 for more details. A constant is included but not shown. Standard errors reported in parentheses are clustered at the bank*firm sector (NAF 1 digit) level. The symbols *, ** and *** denote significant coefficients at the 10, 5 and 1 percent levels respectively.

FIGURE 1. Bond spreads for euro area banks



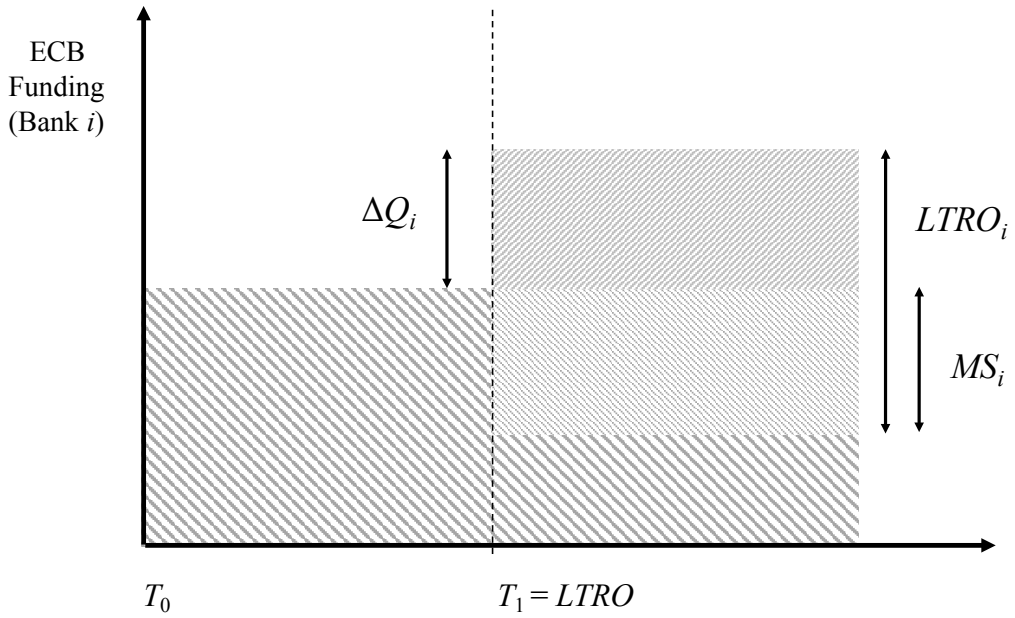
Note. This figure shows for each country the average spread of bank bonds with the German Bund. Aggregate spreads are computed from individual bond data following the methodology in Gilchrist and Mojon (2017). Vertical lines stand for the two rounds of LTROs.

FIGURE 2. Tightness of credit conditions (credit supply) to, and demand for credit from non-financial corporations in France



Note. This figure shows the index of credit conditions for bank lending to non-financial firms (solid line) and the index for credit demand from non-financial firms (dashed line), as taken from the Eurosystem's Bank Lending Survey for France. A third line (circles) shows reporting banks' assessment of the contribution of their funding liquidity stress to their credit supply tightening. Positive numbers denote tighter supply and stronger demand respectively. End-of-quarter figures refer to perceived changes over the previous three months.

FIGURE 3. LTRO Breakdown into Maturity Swap and Quantitative Easing



Note. This figure illustrates how the LTRO take-up can be broken down into a *maturity swap* and a *quantitative easing* compontent. The *quantitative easing* part, ΔQ_i is defined as the increase in total borrowed liquidity between before (T_0) and after (T_1) the time of the LTROs. The *maturity swap* component, MS_i is then defined as the amount of shorter-term central bank liquidity that has been swapped by the bank for 3-year borrowing. More formally, we have $MS_i = 0$ if $LTRO_i = 0$ and $MS_i = \max(LTRO_i - \Delta Q_i, 0)$ if $LTRO_i > 0$.

Can the Provision of Long-Term Liquidity Help to Avoid a Credit Crunch? Evidence from the Eurosystem's LTRO

Philippe Andrade, Christophe Cahn, Henri Fraisse, Jean-Stéphane Mésonnier

Online appendix, not intended for publication

A. List of banking groups

TABLE A.1. List of banking groups in sample

Code	Name of BHC	Nb. of banks	Public	Foreign
1163	BPCE	91	0	0
27	CREDIT AGRICOLE	59	0	0
29	CREDIT MUTUEL	34	0	0
768	BNP-PARIBAS	34	0	0
30	SOCIETE GENERALE	33	0	0
1133	CREDIT IMMOBILIER DE FRANCE	13	0	0
263	GENERAL ELECTRIC	11	0	1
160	HSBC HOLDINGS	7	0	1
129	ING	4	0	1
223	RABOBANK	4	0	1
52	RENAULT	3	0	0
291	COMMERZBANK	3	0	1
63	PSA PEUGEOT CITROEN	2	0	0
159	BARCLAYS	2	0	1
248	AGENCE FRANCAISE DE DEVELOPPEMENT	2	1	0
1024	OSEO	2	1	0
1186	ABN AMRO BANK	2	0	1
158	ESPIRITO SANTO	1	0	1
349	BBVA	1	0	1
839	MIZUHO FINANCIAL GROUP	1	0	1
923	JP MORGAN CHASE	1	0	1
970	HYPO REAL ESTATE	1	0	1
1033	MITSUBISHI UFJ FINANCIAL	1	0	1
40031	CDC	1	1	0

Note. Column (2) displays the number of individual banks considered in our sample for each selected banking group. This number may differ from the total number of affiliates of each group. French subsidiaries of foreign banks are treated as independent groups and are not consolidated with their holding companies overseas.

B. Automatic Selection of Banks' Controls

Our procedure goes as follows:

- start with a large set of banks' variable X_i;
- use information criteria to select the set of variables X_{1i} that is the most efficient to explains ΔL_{ij} (i.e. the most parsimonious set giving the best regression fit) prior to the LTRO policy;
- do the same to identify the most efficient set of variables X_{2i} to explains $LTRO_i$;
- estimate equation (2) with $Z_i = (X_{1i} \cup X_{2i})$;

We implement this procedure on a set of banks explanatory variables X_i that includes our baseline regression explanatory variables and other observable banks characteristics that might measure their vulnerability to funding shocks such as the fraction of undrawn credit lines to assets and the deposit-to-assets ratio. We ran the `gsreg` routine in Stata, comparing more than 500 different model specifications on the basis of 3 information criteria: R^2–*adj*, AIC, and BIC.

Tables B.1 and B.2 below display the best model specifications we obtain for respectively credit growth before the 3-year LTROs were implemented and banks' LTRO uptakes. Note that for this second regression, the best models account for a large share (64%) of the cross-section variance of banks' LTROs uptake.

Finally Table B.3 compares our baseline estimates with the ones obtained when choosing banks' controls as the union of the regressors that are significant in these best model specifications.[43]

Note that regressions selecting bank level covariates X_{1i} and X_{2i} are both run on the same sample of bank-firm data. Yet, regressions used to select X_{2i} only involve bank level observations. However, we can still run this regression for a sample of bank-firm data, where each bank observation is repeated for every connection of the same bank to different firms. This is equivalent to run weighted least squares estimates, with more weight for banks having more connections to firms. That approach has the advantage of implementing a consistent statistical procedure in which banks' covariates X_{1i} and X_{2i} are both selected on the same sample of observations.[44]

[43] Including also the variables that are not significant amounts to control for all the variables in our set of observable banks' characteristics, so that the procedure does not select particular controls. Estimating such model does not change our results either.

[44] Selecting X_{2i} from regressions with non-repeated banks' level observations changes the set of covariates. However, our main results still hold under this alternative specification.

TABLE B.1. Automatic Model Selection of Credit Supply Drivers

	R^2–*adj.*	AIC	BIC
	(1)	(2)	(3)
Bank Size	0.86*	0.86*	0.77*
	(0.43)	(0.43)	(0.45)
Bank Liquid Assets	-0.21***	-0.21***	-0.21***
	(0.05)	(0.05)	(0.05)
Bank Capital	-0.52	-0.52	-0.45
	(0.45)	(0.45)	(0.31)
Bank Interbank Liabilities	0.06	0.06	0.08***
	(0.03)	(0.03)	(0.02)
Bank Loans			
Eligib. Loans	0.03	0.03	
	(0.05)	(0.05)	
Bank Securities Portfolio	-0.11**	-0.11**	-0.08***
	(0.04)	(0.04)	(0.03)
Bank Undrawn Commit.	0.12	0.12	0.13*
	(0.08)	(0.08)	(0.07)
Bank Deposits	-0.04	-0.04	
	(0.03)	(0.03)	
Multi-bank firms	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Bank*Industry SD cluster	Yes	Yes	Yes
R^2	0.46	0.46	0.46
R^2–*adj.*	0.05	0.05	0.05
AIC	2,833,058	2,833,058	2,833,062
Observations	285,202	285,202	285,202

Note. This table displays the results from an automatic model, lasso-type selection of the main drivers of the bank credit supply in our sample. To do so, we make use of the Stata command `gsreg`. The dependent variable is the change in the (log) level of credit volume for each selected firm-bank pair over the period from September 2010 to September 2011 (our *Placebo* sample). The selection set consists of our baseline set of controls plus *Bank Undrawn Commitment*, the ratio of undrawn credit to firms to the bank's total assets, and *Bank Deposits*, the ratio of bank's deposits to bank's total assets. Among all the possible combinations of independent variables (i.e., $2^9 - 1 = 511$), the routine select the one that maximizes the adjusted R^2 (column (1)), that minimizes the Akaike Information Criterion (column (2)), and the Bayesian Information Criterion (column (3)). Standard errors reported in parentheses are clustered at bank*NACE 1 industry level The symbols *, ** and *** denote significant coefficients at the 10, 5 and 1 percent levels respectively.

TABLE B.2. Automatic Model Selection of LTRO Uptakes Drivers

	R^2–*adj.*	AIC	BIC
	(1)	(2)	(3)
Bank Size	0.08	0.08	0.08
	(0.14)	(0.14)	(0.14)
Bank Liquid Assets	-0.01	-0.01	-0.01
	(0.03)	(0.03)	(0.03)
Bank Capital	0.17**	0.17**	0.17**
	(0.06)	(0.06)	(0.06)
Bank Interbank Liabilities	-0.06*	-0.06*	-0.06*
	(0.03)	(0.03)	(0.03)
Bank Loans	0.01	0.01	0.01
	(0.02)	(0.02)	(0.02)
Eligib. Loans	0.00	0.00	0.00
	(0.03)	(0.03)	(0.03)
Bank Securities Portfolio	0.04**	0.04**	0.04**
	(0.02)	(0.02)	(0.02)
Bank Undrawn Commit.	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)
Bank Deposits	-0.03	-0.03	-0.03
	(0.03)	(0.03)	(0.03)
Multi-bank firms	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Bank*Industry SD cluster	Yes	Yes	Yes
R^2	0.80	0.80	0.80
R^2–*adj.*	0.64	0.64	0.64
AIC	586,320	586,320	586,320
Observations	380,509	380,509	380,509

Note. This table displays the results from an automatic model, lasso-type selection of the main drivers of the *LTRO* uptakes in our sample. To do so, we make use of the Stata command `gsreg`. The dependent variable is the ratio of the bank's LTRO uptake (rounds 1 and 2) to toal assets over the period from September 2011 to September 2012 (our *Baseline* sample). The selection set consists of our baseline set of controls plus *Bank Undrawn Commitment*, the ratio of undrawn credit to firms to the bank's total assets, and *Bank Deposits*, the ratio of bank's deposits to bank's total assets. Among all the possible combinations of independent variables (i.e., $2^9 - 1 = 511$), the routine select the one that maximizes the adjusted R^2 (column (1)), that minimizes the Akaike Information Criterion (column (2)), and the Bayesian Information Criterion (column (3)). Standard errors reported in parentheses are clustered at bank level The symbols *, ** and *** denote significant coefficients at the 10, 5 and 1 percent levels respectively.

TABLE B.3. Automatic Model Selection – Model Comparison

	Baseline	Selection
	(1)	(2)
Bank LTRO	1.17***	1.18***
	(0.31)	(0.29)
Bank Size	0.58**	1.07***
	(0.23)	(0.26)
Bank Liquid Assets	-0.08**	-0.10**
	(0.04)	(0.04)
Bank Capital	0.14*	0.04
	(0.08)	(0.07)
Bank Interbank Liabilities	0.13***	0.15***
	(0.03)	(0.04)
Bank Loans	-0.05***	
	(0.02)	
Eligib. Loans	-0.03	
	(0.03)	
Bank Securities Portfolio	-0.10***	-0.11***
	(0.03)	(0.03)
Bank Undrawn Commit.		
Bank Deposits		
Multi-bank firms	Yes	Yes
Firm fixed effects	Yes	Yes
Bank*Industry SD cluster	Yes	Yes
R^2	0.46	0.46
Observations	380,509	380,509

Note. This table compares our baseline model regression (column (1)) with a model in which the bank controls have been selected by an automatic model, lasso-type selection of both the main bank supply determinants and the main drivers of the *LTRO* uptakes in our sample. Standard errors reported in parentheses are clustered at bank*NACE 1 industry level The symbols *, ** and *** denote significant coefficients at the 10, 5 and 1 percent levels respectively.

C. Additional Tables

TABLE C.1. Robustness Check – Bank Business Model

		Excluding			
	All	Diversified	Retail	Sectoral	Universal
	(1)	(2)	(3)	(4)	(5)
Bank LTRO	1.17***	1.25***	1.49***	1.13***	1.00***
	(0.31)	(0.32)	(0.35)	(0.30)	(0.27)
Bank Size	0.58**	0.68**	0.09	0.53**	0.87***
	(0.23)	(0.26)	(0.25)	(0.23)	(0.29)
Bank Liquid Assets	-0.08**	-0.09**	-0.06	-0.08**	-0.10**
	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)
Bank Capital	0.14*	0.12	0.24**	0.14*	0.18**
	(0.08)	(0.08)	(0.10)	(0.08)	(0.07)
Bank Interbank Liabilities	0.13***	0.13***	0.08**	0.13***	0.15***
	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)
Bank Loans	-0.05***	-0.05***	-0.07***	-0.07***	-0.03**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Eligib. Loans	-0.03	-0.02	-0.11***	0.03	-0.04*
	(0.03)	(0.03)	(0.03)	(0.05)	(0.02)
Bank Securities Portfolio	-0.10***	-0.11***	-0.12***	-0.11***	-0.08**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
Multi-bank firms	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Bank*Industry SD cluster	Yes	Yes	Yes	Yes	Yes
R^2	0.46	0.46	0.47	0.47	0.48
Observations	380,509	379,209	372,861	374,067	248,619

Note. This table compares our baseline model regression (column (1)) with the results of OLS regressions in which observations related to banks with specific business models have been removed from the sample. *Diversified* (column (2)) refers to banks that can perform both *Retail* (column (3)) and sectoral activities. *Sectoral* (column (4)) refers to specific banks business models and covers automotive banks. *Universal* refers to banks that perform other activites on top of credit lending. The dependent variable is the change in the (log) level of credit volume for each selected firm-bank pair over the period from September 2011 to September 2012 (our *baseline* sample). Standard errors reported in parentheses are clustered at bank*NACE 1 industry level The symbols *, ** and *** denote significant coefficients at the 10, 5 and 1 percent levels respectively.

TABLE C.2. Robustness Check – Credit Category

	Baseline	Short Term	MLT	Drawn	MLT Share
	(1)	(2)	(3)	(4)	(5)
Bank LTRO	1.17***	16.15***	0.76*	1.53***	-4.18***
	(0.31)	(2.40)	(0.44)	(0.46)	(0.58)
Bank Size	0.58**	0.48	0.72**	0.62**	-0.47
	(0.23)	(1.15)	(0.32)	(0.28)	(0.45)
Bank Liquid Assets	-0.08**	0.85***	-0.08	-0.10**	-0.25**
	(0.04)	(0.26)	(0.05)	(0.05)	(0.11)
Bank Capital	0.14*	0.86	0.22	-0.00	-2.34***
	(0.08)	(0.78)	(0.16)	(0.09)	(0.59)
Bank Interbank Liabilities	0.13***	0.51***	0.19***	0.11***	0.16**
	(0.03)	(0.18)	(0.05)	(0.04)	(0.06)
Bank Loans	-0.05***	0.02	-0.11***	-0.05**	-0.21***
	(0.02)	(0.21)	(0.02)	(0.02)	(0.04)
Eligib. Loans	-0.03	-0.36	0.06	-0.05	-0.08
	(0.03)	(0.22)	(0.06)	(0.04)	(0.06)
Bank Securities Portfolio	-0.10***	-0.79***	-0.10**	-0.12***	-0.02
	(0.03)	(0.11)	(0.04)	(0.04)	(0.05)
Bank controls					
Multi-bank firms	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Bank*Industry SD cluster	Yes	Yes	Yes	Yes	Yes
R^2	0.46	0.49	0.50	0.48	0.67
Observations	380,509	68,280	242,101	364,776	42,986

Note. This table presents the results of OLS regression, where the dependent variable is, for each selected firm-bank pair over the period from September 2011 to September 2012, the change in the (log) level of total credit (drawn plus undrawn) volume (column (1)), the change in the (log) level of short term credit (column (2)), the change in the (log) level of medium-long term credit (column (3)), the change in the (log) level of drawn credit (column (4)), and the ratio of medium/long-term credit over total drawn credit (column (5)). Standard errors reported in parentheses are clustered at bank*NACE 1 industry level The symbols *, ** and *** denote significant coefficients at the 10, 5 and 1 percent levels respectively.