COMPETITION AND THE PASS-THROUGH OF UNCONVENTIONAL MONETARY POLICY: EVIDENCE FROM TLTROS

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Abstract

We make use of an allocation rule by the ECB for Targeted Longer-Term Refinancing Operations (TLTROs) to provide causal evidence on the effect of unconventional monetary policy on the cost of loans to firms. Using transaction-level data from Italy's Central Credit Register and a difference-in-difference identification strategy, we show that treated banks decrease loan rates to the same firm by approximately 20 basis points compared with control banks. We then study how the effects of the liquidity injection vary according to the competition in the banking sector, exploiting the local nature of bank-firm lending relationships and exogenous variations in the number of pawnshops across Italian cities during the Renaissance. Our results suggest that banks' market power can significantly impair the effectiveness of unconventional monetary policy, especially for safer and smaller firms.

JEL Classification: E51, E52, L11.
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Contents

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1 Introduction[1]

Since the global financial crisis central banks around the world have implemented unprecedented measures to counteract the credit crunch and sustain economic activity, such as quantitative easing, liquidity injections and policy announcements. These new tools have spurred the academic and policy debate about the role of the banking sector for their transmission to the real economy (Gertler and Karadi, 2011; Chodorow-Reich, 2014; Acharya et al., 2015; Di Maggio et al., 2016; Rodnyansky and Darmouni, 2017; Agarwal et al., 2017; Krishnamurthy et al., 2017).

Empirical studies of the effects of both conventional and unconventional monetary policy on credit supply faces two well-known identification issues: simultaneous causality between credit demand and supply, and selection into treatment as banks choose to borrow from the central bank (Kashyap and Stein, 2000; Jiménez et al., 2012, 2014). Furthermore, disentangling the role of the banking sector in the transmission mechanism poses an additional identification challenge due to non-random assignment of banks' market power, which can be correlated in the cross-section with other confounding factors (Scharfstein and Sunderam, 2014; Drechsler et al., 2017; Agarwal et al., 2018).

In this paper we provide causal evidence on the effect of targeted unconventional monetary policy on banks' credit supply to firms and on the role of competition in the banking sector for the transmission mechanism. We study a series of Targeted Longer-Term Refinancing Operations (TLTROs) by the ECB announced on the 5th of June 2014 with the goal to enhance the functioning of the monetary policy transmission mechanism by supporting lending to the real economy. We exploit an allocation rule by the policy together with a rich dataset on transaction-level bank-firm lending relationships and with exogenous variation

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in banks' local market power to address three identification challenges and shed light on the functioning of the transmission of unconventional monetary policy through the banking sector.

First, the dynamics of credit in the lending market are driven by both demand and supply. In equilibrium, borrowers' willingness to take new loans and accept different conditions as well as lenders' incentives to supply and reprice loans jointly determine the amount of credit and its price. Less risky borrowers may have a higher demand for the liquidity coming through TLTROs so that a decrease in lending rates comes from selection on the demand side, rather than from treatment on the supply side. To control for demand factors, we leverage on a panel of firms borrowing from multiple banks and estimate an empirical model with a full set of firm-time interacted fixed effects, thus only exploiting the variation within a firm across banks, as pioneered in Khwaja and Mian (2008).

A second identification challenge arises from selection into treatment. Even after controlling for demand factors, the supply side variation across banks that we use for identification may be endogenous because banks' use of TLTROs is a choice. To control for time-invariant bank level unobservables, we include in our empirical model bank fixed effect. However, time-varying differences across banks that affect both TLTROs borrowing and lending strategies, can still bias our results. We construct an instrumental variable (IV) for banks' treatment using a rule in TLTROs guidelines, that set the maximum amount that banks can borrow in the first two operations to 7% of their outstanding amount of eligible loans on April 2014. The threshold is set by the ECB for the whole euro area and is based on a variable that is fixed before the announcement of the policy. The differences in potential treatment across banks are therefore predetermined and orthogonal to unobservables than may affect loan supply in the period after TLTROs. The relevance of our instrument is ensured by the fact that in the first two TLTROs more than 90% of the banks actively participating to the operations borrowed at least 95% of their borrowing limit.

Third, to study how the transmission mechanism is affected by the structure of the

banking sector we need exogenous variation in competition. We define local banking markets the Italian provinces, the equivalent of US counties, and we assume that each firm borrows in the same province where it has its headquarter.[2] We isolate the effect of competition on the pass-through of unconventional monetary policy by exploiting geographical variation in banks' market shares across provinces. As the latter may be correlated with other factors affecting the equilibrium in the local credit market, we design an IV strategy using variation in the presence of pawnshops across Italian cities during the Renaissance as an instrument for the level of local competition in the banking sector today.[3]

Our first set of results looks at the effect of unconventional monetary policy on credit supply for firms. We find that banks participating to TLTROs decrease their rates to the same firm by 20 basis points relative to banks that do not participate, when we instrument banks' borrowing choice using the exogenous allocation rule. This effect is significant and represents approximately 5 percent of the baseline cost of credit. We allow the pass-through to vary over time and find that treated banks start decreasing rates about two quarters after the first liquidity injection. Our IV estimates are significantly larger than the OLS estimates, where banks choosing to borrow from TLTROs decrease rate by about 5 basis points relative to banks choosing not to borrow.

Our second set of results examines the role of banks' market power for the transmission mechanism of unconventional monetary policy. We find that competition plays a significant role for the pass-through of unconventional monetary policy, limiting the sensitivity of the cost of corporate loans to the cost of bank funding. The magnitude of the result is significant: a one-standard-deviation increase in concentration reduces the impact of TLTROs on

[2]In our data we don't observe from which branch of the bank the firm borrows, but previous evidence for Italy (Bofondi and Gobbi, 2006; Felici and Pagnini, 2008; Crawford et al., 2018) and other countries (Petersen and Rajan, 1994, 1995; Mian, 2006) suggest that lending to firms has a local dimension. This choice is also motivated by the fact that provinces are the geographical units used by the regulator to approve branch openings. We use the structure of Italian provinces existing in 2005.

[3]Monte dei Paschi di Siena, the world's oldest surviving bank, was founded in Siena by the city magistrates as a pawnshop in 1472. Guiso et al. (2004) and Pascali (2016) show the importance of historical difference in access to credit for long-term financial development across region and provinces in Italy.

lending rates by approximately 14 basis points. This corresponds to a 32% decline in the transmission of unconventional monetary policy relative to the benchmark of perfect competition. Furthermore, we find that in provinces with low concentration lenders pass-on the lower rates to borrowers immediately, while in provinces with high concentration banks do not lower rates immediately after the policy change, but start after two quarters.

Finally, we explore heterogeneous effects in the transmission mechanism of TLTROs due to differences in firms' and banks' characteristics. Small firms and those with better credit rating borrowing from a bank using TLTROs experience a decrease in the cost of credit, while the reduction is not significant for the other firms of the same bank. Banks' local market power affects the pass-through for smaller and safer firms, but plays no role for larger and riskier firms. The differential effect on small firms is consistent with previous studies showing that small firms have less alternatives than large firms in raising funding and may be more affected by bank' competition (Berger and Udell, 1995; Beck et al., 2004). The differential effect on ex-ante safer firms is consistent with theories based on information asymmetries and hold-up problems (Sharpe, 1990; Rajan, 1992). Our heterogeneity analysis suggests a flight-to-quality within the corporate sector, with large banks competing to allocate the ECB liquidity toward smaller and ex-ante safer firms, especially in more competitive provinces.

Related literature Our paper is related to two main strands of literature. First, we contribute to the empirical macroeconomic literature about the transmission mechanism of monetary policy and how this is affected by financial imperfections, by studying how unconventional monetary policy affect the cost of credit for firms with an innovative research design.[4] The key empirical challenge is to identify how monetary policy affects supply side-factors, when there are confounding demand side effects (Kashyap and Stein, 2000). A stream of literature has used firm-time fixed effects to controls for unobservable demand factors, together with exogenous measures of exposure to a shock. This approach has been

[4]Theoretical works on the topic go back to the seminal contributions by Bernanke and Blinder (1992) and Bernanke et al. (1999). After the global financial crisis new models have included an active financial sector (Gertler and Kiyotaki, 2010; Brunnermeier and Sannikov, 2014) and studied its implications in a general equilibrium setting (Gerali et al., 2010; Gertler and Karadi, 2011).

adopted to study the effect of supply-side liquidity shocks (Khwaja and Mian, 2008; Schnabl, 2012; Gambacorta and Mistrulli, 2014), sovereign shocks (Bofondi et al., 2013; Albertazzi et al., 2014; De Marco, 2015), and the transmission mechanism of both conventional and unconventional monetary policy (Jiménez et al., 2012; Drechsler et al., 2016; Jiménez et al., 2014; Acharya et al., 2015; Carpinelli and Crosignani, 2017; Di Maggio et al., 2016).We are the first to study a new unconventional monetary policy which has been implemented with the explicit goal of increasing lending to the real economy, thus providing evidence on the value of setting a lending target for monetary policy effectiveness. Differently from most previous empirical studies that look at quantities our work focuses on the pass-through to interest rates, which have been less studied by the previous literature because of limited data availability on prices at the loan-level (Jiménez et al., 2014; Krishnamurthy et al., 2017). Most notably, in our setting we observe both actual and potential treatment based on an exogenous allocation rule, while previous studies generate cross-sectional variation in banks' exposure to a shock or a policy change using predetermined banks characteristics.

Second, our work contributes to the literature on the relation between competition and monetary policy. The industrial organization approach to banking literature has studied theoretically the link between competition and monetary policy (Freixas and Rochet, 2008; Rochet, 2009), but the empirical evidence about the relationship between market power and pass-through is ambiguous (Berger and Hannan, 1989; Neumark and Sharpe, 1992; De Graeve et al., 2007). On the one hand, in more competitive market the pass-through of borrowing rate to lending rates can be larger, as a results of higher elasticities of firms' loan demand and absence of smoothing coming from relationship lending (Cottarelli et al., 1995; Van Leuvensteijn et al., 2013). On the other hand, the response of lending rate can be higher in more concentrated market, if banks pass-through cost efficiency or exploit market power from holdup situations to adjust their markups (Petersen and Rajan, 1995). We develop a new identification strategy to study empirically the effect of competition on the transmission mechanism of unconventional monetary policy to corporate lending, complementing recent studies that look at the effect of competition for the transmission of monetary policy in the

US mortgage and deposit markets (Scharfstein and Sunderam, 2014; Drechsler et al., 2017). Our focus on targeted unconventional monetary policy has the unique advantage that the treatment is by design heterogeneous across lenders, which allows us to separate differences across banks from differences in market structure.

The rest of the paper is organized as follows. Section 2 describes the institutional background of TLTROs and the Italian banking system; Section 3 summarizes the data; Section 4 explains the identification strategy; Section 5 presents our results and Section 6 concludes.

2 Institutional Setting

2.1 Targeted Longer-Term Refinancing Operations

On the 5th of June 2014, the ECB decided to support bank lending to the euro area non-financial sector through a first series of Targeted Longer-Term Refinancing Operations (TLTROs). This policy measure is implemented through eight auctions, one each quarter from September 2014 to June 2016, and participation is open to institutions that are eligible for the Eurosystem open market operations. In July 2014 and February 2015 the ECB updated the rules on borrowing limits, maturities and early repayment options. A second series of four operations starting in June 2016 has been announced on the 10th of March 2016.

The ECB has been actively involved in supporting the financial system since the onset of the global financial crisis in September 2008. In October 2008, the ECB switched to a fixed-rate full-allotment mode for its refinancing operations, where the central bank sets an interest rate and banks can borrow an unlimited amount at that given rate. In this way the ECB provided a certain source of funding to banks, especially valuable in crisis time when other funding sources are impaired. The ECB also increased its support to the banking sector with Longer-Term Refinancing Operations (LTROs), complementing the weekly liquidity-providing transactions, that have usually a maturity of one to three months, with a one-year

operation in July 2009 and two three-years operations in December 2011 and February 2012. This longer-term liquidity allows banks to relax the roll-over risk coming from the mismatch between assets and liabilities, thus favoring longer-term investment. The popularity of the two three-years LTROs is evident from banks' participation and take-up: these operations provided more than 1 trillion euros liquidity to euro area banks, with Spanish and Italian institutions among the main beneficiaries (Carpinelli and Crosignani, 2017). Banks used the provided liquidity for rolling over previous debt, issuing new loans to firms and household and buying sovereign bonds.

The TLTROs come within the framework of increasing support by the ECB, but with some novelties about both goals and rules. While previous operations were designed to support the banking sector, TLTROs explicitly target lending to the real economy. For this reason, this policy represents an ideal experiment to understand the full transmission mechanism from the central bank to firms and households, via the financial sector. Both the goals and the rules are implicitly designed to reduce the incentives to banks to use the liquidity for buying sovereign debt, as happened in previous operations (e.g. LTROs), and to roll over existing debt.[5]

Figure 1 shows the time-line of the first series of TLTROs. Participation to the operations was possible both on an individual basis and as a "TLTRO group" of banks, not necessarily all part of the same banking group. The individual institution and the "lead institution" in the group should be an eligible Eurosystem counterpart. The eligibility criteria, valuation, haircuts and rules on the use of assets for collateral are the same of the other standard refinancing operations (ECB, 2014). The interest rate on the TLTROs will be fixed over the life of each operation at the rate on the Eurosystem Main Refinancing Operations prevailing at the time of take-up; an additional fixed spread of 10 basis points has been added for the first two TLTROs.

The main differences of TLTROs' rules relative to previous operations are on borrowing

[5]It is worth noting that the TLTROs overlap with the end dates of the previous LTROs, maturing on January 29, 2015 and February 26, 2015, and therefore part of the funds were anyway used to roll over the expiring debts of LTROs. For this reason in our estimation strategy we account for expiring debt.

limits. The borrowing limits rules are different for the first two operations at the end of September and December 2014 and the last six, from March 2015 to June 2016. Define q_k^b the quantity borrowed by bank b (single or "TLTRO group") in operation k. The initial borrowing limit for the first two operations is computed using the following formula:

$$q_b^1 + q_b^2 \leq 0.07 \times EL_b^{April2014} \equiv Rule_b. \tag{1}$$

Bank b borrowing in the first two TLTROs cannot exceeds 7% of its outstanding amount of eligible loans on 30 April 2014 ($EL_b^{April2014}$). The eligible loans include lending to domestic non-financial corporations and households in the euro area, and exclude loans securitised or otherwise transferred without derecognition from the balance sheet.[6] Moreover, they exclude loans to household for house purchases to emphasize even more the willingness of the ECB to channel new liquidity into productive investment. In Section 4 we describe how we use the rules regarding the borrowing limit for the first two TLTROs in our identification strategy, while in Appendix C we describe additional rules of the scheme for the last six operations and repayments.

2.2 The Italian Banking System

The supply of bank credit is particularly important in Italy as firms are heavily dependent on intermediated credit, relative for example to U.S. firms (Langfield and Pagano, 2016). Italian banks have traditional business models, based on loans to the real economy and close relationship with their customers, through a developed network of branches. Guiso et al. (2004) report that "The president of the Italian Association of Bankers (ABI) declared in a conference that the banker's rule-of-thumb is to never lend to a client located more than three miles from his office" and they show how distance continue to segment local markets. Between 2008 and 2013 the number of branches decreased by 7% from 34,100 to 31,700, mostly as a results of large groups reorganizations. Despite this reduction in the network, the

[6] The definitions are detailed in ECB (2014).

number of banks' employees working in local branches is stable at 65% and a survey of senior executives of the main Italian banks reveal that business originations through branches will continue to play a leading role together with online banking (PwC, 2010). In our analysis we consider a province as the relevant market for banks lending to firms. Provinces are geographical entities very similar to U.S. counties and they are used by the Italian antitrust authority as proxies for the local markets for deposits (Bofondi and Gobbi, 2006; Felici and Pagnini, 2008; Crawford et al., 2018). Figure 2 shows the geographical distribution of the quartiles of the Herfindahl index (HI) across provinces calculated on the outstanding amounts of the term loans in the first quarter of 2014. It shows that, even if competition is slightly stronger in the north-east, generally there is a lot of variability among geographically neighboring provinces.[7]

Italian banks' funding has experienced significant changes during the European sovereign crisis. With respect to short-term funding, retail deposits remained a stable source for Italian banks, while short-term wholesale funding was affected by a widespread flight-to-quality from peripheral to core countries. Long-term unsecured wholesale funding became increasingly harder to obtain for Italian banks, which restored to secured long-term funding via covered bonds. The rating of the debt issued have deteriorated, mostly as a results of the increase in non-performing loans, due to a fall by 9% of GDP and 25% of industrial production. These losses impacted negatively on Italian banks' capital and together with the deleveraging needed to improve capital ratio, severely reduce the capacity to provide loans to the real economy. In this context, central bank liquidity become increasingly more important as a source of funding for banks. The reliance of Italian banks on ECB funding, measures as a percentage of assets, grew from less than 1% at the end of 2010 to more than 6% at the end of 2012 (Van Rixtel and Gasperini, 2013). The new TLTROs by the ECB strengthen this trend, by providing additional long-term liquidity to banks in the euro area, with the explicit goal of promoting loan to firms. In the first two TLTROs, the banks of the euro area

[7]The main exception here is Sardinia, that being a relatively distant island from the mainland suffers from isolation.

borrowed collectively 212 billion euros, with Italian institutions in the first place borrowing 57 billion euros. The transmission of TLTROs could have therefore important implications for lending to the Italian economy. The local and bank-centered Italian loan market and the importance of the ECB TLTROs for the liquidity of Italian banks' make our environment particularly suitable to investigate the transmission mechanism of monetary policy to the real economy.

3 Data

In this work we construct a unique dataset at the bank-firm-time level, combining four different sources of data.[8] The main one is the Italian Credit register, which collects individual data on borrowers with exposure above 30 thousand euros from all the intermediaries operating in Italy. From this source we extract information at a monthly frequency about the interest rates of term loans charged on bank debt for each borrower. Each observation is a bank-firm pair and we observe a unique identifier for both the lending and the borrowing institution. We collapse the data at the level of firm-banking group relationship using the mapping from the Supervisory register of the Bank of Italy, where the legal structure of all the Italian banking groups is publicly available.

We complement this data with additional information from both the bank and the borrower side. On the one hand, we collect quarterly data on the geographical distribution of branches and the structure of its balance sheet for each bank from the confidential Supervisory reports and the Supervisory register of the Bank of Italy. On the other hand, we exploit the borrower identifier to add information on the geographical location, the credit quality and the size of the firm, matching our dataset with the Company Accounts Data Service (CADS) managed by Cerved, one of the most comprehensive sources of information about balance sheets of Italian firms, also used by banks for credit decision. A last piece

[8]We use the term bank to indicate both standalone banks and banking groups henceforth. For banks belonging to a banking group we aggregate the data at the banking group level, which is the relevant entity for borrowing from the ECB.

of information includes confidential data about participation and the amounts lent from the central bank to the Italian banks after each TLTRO bid.

The final dataset is a quarterly balanced panel, in a time span between the start of 2014 and the second quarter of 2015. Table 1 shows the summary statistics of the variables of the dataset. Panel A shows the main dependent variable of the analysis is the overall interest rate (r_{bft}), including the accessory expenses, on the stock of term loans, charged by bank b to firm f at time t, shown in panel A of the table. The first and the last percentile of the distribution of the interest rates have been winsorized, to minimize the impact of outliers in the sample. The charged interest rate has been equal on average to about 4% considering the whole time series and the whole distribution is included between about 0.5% and 12%. For this kind of loans the impact of the expenditures on the overall rate is not particularly strong. We also show the statistics on the interest rate on the flow of new term loans of each period, used in a robustness check, which are not substantially different from those on the stocks.

Panel B shows the Herfindahl Index of the local term loans markets. The first one is calculated using quantities of credit for each province in the first quarter of 2014.[9] The credit market in Italy is relatively concentrated, with an average value of the index of 0.17 and a range of values included between 0.09 and 0.36. In section 5.3 we assume in an extension of our empirical model that markets are segmented according to the credit quality of the borrower, summarized in nine ordinal categories by an index of credit riskiness taken from CADS and calculated from the available balance sheet data. We construct for this exercise separate HI assuming that the market of credit for firms of average and high credit quality (classes 1-6 of the rating index) is different from the one for firms of low quality (classes 7-9).[10] The statistics for the HI of the two segmented markets are very similar both among them and to those of the HI by province. We also show summary statistics for the total

[9]We used the structure of 103 Italian provinces existing until 2005 to get a homogeneous classification of the provinces from the different datasets.

[10]We also segmented the credit market in three categories instead of two, but the final results were the same as those presented here.

number of pawnshops that opened during the Italian Renaissance across Italian province that we compute aggregating the city level data from Pascali (2016). The average number of pawnshop by province is about one and it ranges from zero to eight.

Panel C shows the variables regarding the first two TLTROs; 78 banks in our sample participated at either the first or the second TLTRO and the average borrowed amount was about 670 million euros. Several of those banks used anyway either part or all the borrowed liquidity to rollover already existing debts with the Eurosystem; for this reason we calculated a corrected amount of the exposition to central bank coming from the first two TLTROs, netting out the debts towards the Eurosystem expiring in the same quarter. 43 banks had a positive net amount after this correction and the average net borrowed amount was of about 550 million euros; the distribution is skewed to the left and the range of values is included between 5 and about 5500 million euros. The borrowing limit for the first two TLTROs, calculated for the whole sample of 104 banks was on average of about 550 million euros too, but is more skewed to the left. From the comparison of the raw amount borrowed from the 78 banks participating to the TLTROs with their borrowing limit we find that more than 90% of those banks borrowed more than 95% of their limit.

In panel D we report the main structural characteristics of the banks in the first quarter of 2014: they had on average 30 billion euros of assets, almost half of which are loans and about 20% are government bonds. The riskiness of the credit portfolio of the banks and capital adequacy are respectively measured by the ratio between bad loans and overall loans, equal on average to about 9%, and by the capital ratio, based on the Basel rules, equal on average to about 15%.

Last, in panel E we report some statistics regarding firm characteristics, taken from the balance sheets in CADS for the year preceding the policy (2013) and used in the analysis of heterogeneous effects in Section 5.3. We show the distribution of firm assets, equal on average to 4 million euros, and the percentages of firms whose credit quality is either high/average (about three quarters of the sample) or low. We compare the statistics where the statistical unit is the firm with those where the statistical unit is the firm-bank relationship (which is

the relevant statistical unit in our final dataset); the statistics are substantially similar in both cases, taking into account that on average bigger firms have more credit relationships and therefore their weight is bigger when the statistical unit is the relationship.

In Table 2 we compare the characteristics of the banks borrowing a positive additional amount of resources from the TLTROs and of their customer firms (treated group) with the other banks and firms (control group). Panel A shows the existing differences in the endogenous variables in the first three quarters of 2014, between relationships of firms with a treated bank and the other relationships. We do not find appreciable differences in the statistics. In panels B and C we check the borrowing limit and the structural characteristics for treated and control banks. We find that on average the former are bigger than the latter and have therefore a bigger borrowing limit, but they are substantially similar when checking for the other characteristics. In panel D we contrast the statistics weighted by the number of firm-bank relationships of the firms borrowing respectively from a treated or a control bank; also in this case we do not find evidence of relevant differences in the two samples.

4 Identification Strategy

First, to study the effect of unconventional monetary policy on the cost of credit, ideally one would randomly assign liquidity to identical banks lending to the same firm. Any decrease in the lending rate from the bank receiving the liquidity will come from the treatment and not from other banks characteristics (the two banks are identical) or firms characteristics (they are lending to the same firm). Second, to study the effect of bank competition on the pass-through of unconventional monetary policy, ideally one would like that the bank receiving the random liquidity injection operates in two identical markets, which differ only on the level of bank competition. Any differential decrease in the lending rate from the bank receiving the liquidity in the market with high bank competition will come from the differences in bank competition and not from other banks characteristics (it is the same bank) or other markets characteristics. Our empirical strategy proceeds in three steps to address the

key identification challenges: simultaneous causality, selection into treatment and omitted variables.

Simultaneous causality. TLTROs were designed and implemented by the policymaker as a reaction to macroeconomic conditions to explicitly promote lending to the real economy. Therefore, macroeconomic shocks correlated to the policy may induce unobservable loan demand shifts that are contemporaneous to the ECB interventions, leading to simultaneity and omitted variables bias. An upward bias in the evaluation of the effects of the policy would result if safer firms demand from banks borrowing from TLTROs; while a downward bias would emerge if riskier firms increase their loan demand by more. To control for changes in lending opportunities we include in our specification interacted firm-time fixed effects. In this way, we capture firm-specific time-varying shocks to loan demand and we exploit only the variation within each firm-time pair across banks for identification.

We address possible concerns about differences at bank level controlling for time-invariant unobserved heterogeneity with bank fixed effects. In this way we capture, among other things, constant differences across banks in lending strategies and funding costs and we exploit only variation within bank over time. Moreover, we include time-varying bank controls (bank capital, non-performing loans, government bonds), that can have an effect on both banks' funding costs and borrowing decisions and are exogenous with respect to the rate decisions regarding a single transaction.

We estimate a difference-in-differences model on a balanced panel of firm-bank relationships.[11] We include in our equation time varying coefficients to capture the dynamics of the transmission mechanism and we cluster the standard errors both by firm and by bank-time. Hence, the resulting OLS empirical specification is:

$$Y_{bfmt} = \sum_{\tau} \alpha_{\tau} \mathbb{I}_{\tau=t} \times TLTRO_{b\tau} + \gamma_{ft} + \gamma_b + \theta X_{bt} + \varepsilon_{bfmt}, \tag{2}$$

[11] The use of the difference-in-differences methodology on a balanced panel implies that our conclusions only regards the credit relationships already existing before the start of the policy since the beginning of the pre-treatment period in the dataset (first quarter of 2014) and whose existence continued until the second quarter of 2015.

where Y_{bfmt} is the loan rate from bank b to firm f in market m and period t; $TLTRO_{bt}$ is the treatment variable; γ_{ft} are firm-time fixed effects; γ_b are bank fixed effects and X_{bt} are time varying banks controls.

Selection into treatment. Even controlling for endogenous timing of TLTROs, participation is on a voluntary basis, within the rules set by the ECB and described in Section 2. This may add additional selection bias, due to non-random treatment assignment: the evaluation of the policy may be biased upward if banks with higher return to lending or lower funding costs *choose* to borrow more, or biased downward if banks with unobservable funding problems or lower marginal propensity to lend exploit more the ECB facilities. We explicitly address this self-selection problem, exploiting the institutional setting of the policy: we instrument *actual* borrowing for the first two TLTROs with the *maximum* borrowing limit rule described in equation (1) in Section 2. Our first stage regression of *actual* participation ($TLTRO_{bt}$) on the exogenous regressors and the excluded instrument is:

$$TLTRO_{bt} = \phi Rule_b \times Post_t + \gamma_{ft} + \gamma_b + \theta X_{bt} + \epsilon_{bfmt}, \tag{3}$$

where $TLTRO_{bt}$ is the actual treatment variable; $Rule_b$ is the allocation rule for bank b from equation (1) and $Post_t$ is a dummy equal to one after the implementation of the TLTROs. The borrowing limit has been set by the ECB in its announcement in June 2014 and it is based on an exogenous parameter, which is common across banks, and pre-determined banks' balance sheet characteristics.[12] The identifying assumption is that the borrowing limit established by the ECB for the first two TLTROs is a valid instrument for bank access to central bank liquidity controlling for unobservable time-varying demand heterogeneity (firm-time fixed effects), unobserved bank heterogeneity (bank fixed effects) and time-varying

[12]We find a correlation of -0.007 between the loan-level interest rate in the pre-treatment period and the borrowing limit, suggesting that the borrowing limit is essentially uncorrelated with the dynamics of the cost of credit before the treatment.

bank characteristics. The resulting IV empirical specification is:

$$Y_{bfmt} = \sum_{\tau} \alpha_{\tau} \mathbb{I}_{\tau=t} \times \widehat{TLTRO}_{b\tau} + \gamma_{ft} + \gamma_b + \theta X_{bt} + \varepsilon_{bfmt}, \tag{4}$$

where $\widehat{TLTRO}_{bt}$ is the predicted participation and all other variables are as in equation (2).

Omitted variables. In the second part of the paper we study the role of the local banking system for the pass-through of TLTROs. To identify the effect of competition among lenders on the pass-through of unconventional monetary policy, we exploit variation in the competitive structure at the local geographical level. We measure competition with the HI for corporate loans in the province where a firm headquarter is located (HI_m), as Figure 2 shows. We augment equation (4) with time varying coefficients on the interaction between the treatment and the HI, to capture the dynamic effect of market power on the transmission mechanism:

$$Y_{bfmt} = \sum_{\tau} \alpha_{\tau} \mathbb{I}_{\tau=t} \times \widehat{TLTRO}_{b\tau} + \sum_{\tau} \beta_{\tau} \mathbb{I}_{\tau=t} \times \widehat{TLTRO}_{b\tau} \times HI_m + \gamma_{ft} + \gamma_b + \theta X_{bt} + \varepsilon_{bfmt}. \tag{5}$$

Variation in the HI can be correlated with other factors affecting the pass-through of unconventional monetary policy.[13] To account for endogeneity in market power we also instrument the HI using exogenous variation in the presence of pawnshops across Italian cities during the Renaissance. Pascali (2016) shows that variation in the presence of Jewish communities and pawnshops during the Italian Renaissance is correlated with the variation in financial development across Italian cities today. We exploit the same historical variation to instrument for the level of competition in the banking sector today. Figure 2 shows the distribution of HI today across Italian provinces, while Figure 3 shows the number of pawnshops during the Renaissance in the currently established provinces. From a graphical inspection of the two maps we see that provinces with a high number of pawnshops during

[13] For example Beraja et al. (2017) show how the time-varying regional distribution of housing equity influences the aggregate consequences of monetary policy through its effects on mortgage refinancing.

the Renaissance tend to have a less concentrated banking sector today. The correlation coefficient is -0.27 and we formally test the relevance of our instrument with the first stage regression:

$$TLTRO_{bt} \times HI_m = \phi Rule_b \times Post_t \times Pawnshop_m + \gamma_{ft} + \gamma_b + \theta X_{bt} + \epsilon_{bfmt}, \quad (6)$$

where $Pawnshop_m$ is the number of pawnshops across Italian provinces during the Renaissance. To capture jointly the causal effects of unconventional monetary policy and of competition on the transmission mechanism, we estimate the following IV empirical specification:

$$Y_{bfmt} = \sum_{\tau} \alpha_\tau \mathbb{I}_{\tau=t} \times \widehat{TLTRO}_{b\tau} + \sum_{\tau} \beta_\tau \mathbb{I}_{\tau=t} \times \widehat{TLTRO_{b\tau} \times HI_m} + \gamma_{ft} + \gamma_b + \theta X_{bt} + \varepsilon_{bfmt}, \quad (7)$$

where $\widehat{TLTRO_{b\tau} \times HI_m}$ is the predicted interaction between the policy and the HI from the first stage regression of the actual interaction on the exogenous variables and the excluded instruments (the allocation rule and the presence of pawnshops during the Renaissance). The interaction term $\widehat{TLTRO_{bt} \times HI_m}$ captures the causal effect of competition on the pass-through of unconventional monetary policy.

5 Results

In this section we describe our results. In Section 5.1 we show our first set of results on the effect of targeted monetary policy on the cost of credit. In Section 5.2 we discuss our second set of results on the role of bank competition for the transmission of targeted monetary policy. In Section 5.3 we study how the transmission mechanism varies with firms' and banks' characteristics, namely credit-risk and size.

5.1 The Effect of Targeted Monetary Policy

The first empirical result of interest is the identification of the causal effect of targeted monetary policy on the dynamics of the overall cost of credit. We estimate both one specification where the TLTRO variable is a dummy equal to one after the start of the policy if the institution participates in one of the first two operations and another specification where we use the log of the actual additional borrowed amount measuring the intensity of treatment.

Table 3 presents our results for the OLS model. Column (1) shows the results for the full sample in which we control for bank, firm and time fixed effects separately. Treated banks decrease interest rates relative to control banks, but the effects are not significant. In column (2) we estimate the OLS model on the sample of firms with multiple banking relationships and control for demand with interacted firm-time fixed effects. The effects are stronger and marginally significant. Banks borrowing from the ECB through TLTROs decrease lending rate relative to banks not borrowing by approximately 3 basis points on average. Finally in column (3) we add time-varying banks' control. The results are stronger and marginally more significant. In the last three columns of Table 3 we estimate the same model with the actual amount borrowers from the ECB, rather than the binary participation dummy. The results are similar to the ones with the binary treatment.

Table 4 presents our results for the IV model.[14] Column (1) shows the results for the full sample in which we control for bank, firm and time fixed effects separately, and we instrument the binary TLTROs participation with the ECB allocation rule. When we instrument the actual amount borrowed in the first two TLTROs in column (1) of Table 4, we find that treated banks decrease interest rates relative to control banks. Most notably, we find a statistically significant negative coefficients in the first and second quarter of 2015, therefore just after the implementation of the second round of the policy.

[14] In Appendix B we show the first stage regression for the benchmark case with interacted firm-time fixed effects. *Predicted* TLTROs participation has a significant positive effect on *actual* TLTROs participation. The overall Kleibergen-Paap F-statistics for the first stages, approximately 42 and 56 for dummy and continuous treatments respectively, are well above the 10% Stock and Yogo (2002) weak identification test critical values of about 16.

In column (2) of Table 4 we estimate the benchmark case with interacted firm-time fixed effects, to capture differences in firms credit demand. Treated banks decrease rate to the same firm on average by about 23 basis point relative to control banks in the first and second quarter of 2015. Finally, in column (3) we control for time varying bank factors that can affect differentially the pricing within firm-time across banks. The results are still significant and the magnitude is reduced to about 20 basis points. A comparison of columns (3) from Tables 3 and 4 shows that our IV estimates are stronger than the OLS estimates, suggesting that unobservable heterogeneity is likely to bias our estimates downward. For example banks choosing to borrow from the ECB may have been the ones planning to lower corporate rates for other reasons (e.g. business strategy), that can be correlated with the choice to borrow from the ECB in the first place.

Overall, our results on price suggest an outward shift after the second TLTRO in the supply of loan by banks exploiting the liquidity injection by the ECB. In the next section we further corroborate this hypothesis and explore if the competitive environment has an effect on the pass-through of unconventional monetary policy.

5.2 The Effect of Competition on the Transmission Mechanism

Our second set of results shows how bank competition affects the transmission mechanism of TLTROs to the cost of credit. Table 5 presents the results. Also in this section, we focus on firms with multiple lending relationship, to isolate a credit supply shock, and control for differences across banks with both banks' fixed effects and time-varying controls. The effect of the instrumented TLTROs treatment broadly confirm the results from Table 4: banks exploiting the ECB liquidity injections decrease loan rates for firms more than banks not participating to TLTROs.

The coefficients of interest capture the interaction between TLTROs treatment and bank competition, measured by the local HI. Our estimates in column (1) of Table 5 imply that high concentration reduce the pass-through of unconventional monetary policy to firms through the cost of credit. In markets with an average level of concentration treated banks

pass on the lower rates to borrowers immediately after the treatment. In markets with higher level of concentration treated banks do not lower rates immediately after the policy change, but start after two quarters. This effect may be due to second round effects following the reactions of other competitors in the market.

We find that competition plays a significant role for the pass-through of ECB liquidity on the cost of credit. The magnitude of the result is also significant: a firm in a province with a standard deviation higher level of concentration experiences a 14 basis points lower decline in the cost of credit. Higher concentration reduces the transmission mechanism of unconventional monetary policy to firms by approximately 32% relative to the theoretical case of perfect competition.[15] Our estimates of the effect of competition on lending rates are slightly larger than the ones from recent works on the pass-through of monetary policy to mortgage and deposits rates (Scharfstein and Sunderam, 2014; Drechsler et al., 2017). There are many possible reasons for this difference. First, relationship lending, information frictions and market power may play a more important role for corporate lending than for mortgage lending and bank deposits, in which products are more standardized. Second, the type of policy we are looking at. Both Scharfstein and Sunderam (2014) and Drechsler et al. (2017) focus on the transmission of conventional monetary policy, while we look at targeted monetary policy operations. Third, our identification strategy differs in how we control for banks' lending opportunities.

In column (2) of Table 5 we show the estimates of equation (7), thus instrumenting for both participation to TLTROs and local competition with the number of pawnshop in the same province during the Italian Renaissance.[16] Column (2) of Table 5 shows that our results on the competition channel are robust to confounding factors at the market level. Higher concentration in the local banking market, coming from exogenous historical

[15] We compute the effect using the estimates from column (1) of Table 5 and taking the average of the effect of a standard deviation increase in concentration in each period.

[16] In Appendix B we show the first stage estimate for our IV strategy, when we instrument both the TLTROs treatment and the interaction term TLTROs × HI. Our instruments are significant and have the expected sign. The overall Kleibergen-Paap F-statistics for the first stages for both dummy and continuous treatments and both endogenous variables are well above the 10% Stock and Yogo (2002) weak identification test critical values of about 7.

variation, significantly reduces the pass-through of central bank liquidity to lending rates to firms, confirming our baseline result. Finally in columns (3) and (4) of Table 5 we report the estimates using a continuous treatment variable and the results are robust.

In Appendix B we show several robustness checks. First, we replicate the analysis using the raw amounts borrowed by banks in the TLTROs instead of the additional amount net of the rolled over already existing debts towards the Eurosystem. The results are qualitatively similar to the previous ones. Second, we reply the analysis for rates constructed with interest expenditures only, excluding accessory expenses from the calculation. As expected, the results are unaffected. Third, we show the results considering the interest rate on the flows of new loans of the period instead of the one on the overall stock. On one hand flows allow to better capture the dynamics of the new credit loans period by period, on the other hand they are less suitable than stocks to construct a representative balanced panel because the firm would need to borrow a new amount of credit in each period to be included in the sample. When considering the direct effect only, the results are stronger than for stocks and it is already statistically significant at the end of 2014, even if weaker than in the following quarters. The larger magnitude and significance can be explained by the fact that we are now only focusing on the new credit contracts agreed in each period and not on the overall stock of loans already agreed. When including the interaction with competition, the results are qualitatively similar to those for stocks, even if not strongly significant as the results of Table 5 because of the loss of precision in the estimates due to the smaller number of observations.

5.3 Heterogeneous Effects Across Firms and Banks

In this section we study whether there are heterogeneous effects in the pass-through of unconventional monetary policy and the impact of the competitive environment due to differences in some relevant banks' and firms' characteristics. In particular, we focus on riskiness and size, which the previous literature identified as important determinants of access to credit (Jiménez et al., 2014; Agarwal et al., 2018). In both cases we take ex-ante

measures of credit risk and size, to deal with possible endogeneity concerns.

Table 6 shows the estimates of model (4) in the different subgroups.[17] Columns (1) and (2) focus on firms' credit risk. We assume that credit markets are segmented by credit rating of the firm and calculated a different HI separately for each group of firms. We split the full sample into two subgroups: firms with good or average credit rating (classes 1-6) and those with a bad one (7-9).[18] We find that the reduction in the cost of credit is driven by loans to safer firms, while we do not find significant reduction in the cost of credit for riskier firms. Moreover, competition affects the pass-through of unconventional monetary policy to safer firms, but plays no role for riskier firms. This result corroborates the hypothesis that banks using the ECB facility to compete for the safest borrowers, as proxied by their ex-ante riskiness, while there is less space for competition in riskier lending.

Columns (3) and (4) of Table 6 look at differences in the pass-through between large and small firms. Here we split the sample taking firms above and below the median of the distribution of assets in the pre-treatment year (2013). We find that both groups benefit from the reduction in the cost of credit following the first two TLTROs, but the effect is stronger and only significant for smaller firms. Banks taking the ECB facility lowered the cost of credit to small firms by about 60 basis point, while the decrease is about 30 basis points smaller and not significant for large firms. Competition affects the pass-through of policy to the cost of credit for small firms, while it plays no significant role for large firms. This result is consistent with the idea that small firms benefit more from competition between lenders, because they have less alternatives than large firms in raising funding (Berger and Udell, 1995; Beck et al., 2004).

Finally, in columns (5) and (6) of Table 6 we study heterogeneity on the supply side and compare the largest five banks in Italy with other medium and co-operative banks. Treated large banks decrease their lending rate relative to control banks, while we do not

[17] In Appendix B we report the estimates for the same specification using the continuous TLTROs measure as treatment variable. Results are confirmed.

[18] We also considered a sample split in three categories (1-3) (4-6) (7-9) and the results were very similar to the split in two groups presented here.

find significant differences when the treated bank is of smaller size. Competition affects how large is the banks' pass-through to lending rates of the ECB liquidity. We find a positive significant interaction between the policy and the HI. Large banks decrease lending rate as a response to the lower funding cost in markets where they face competition from other banks, while they increase profit margins in markets where they have market power.

6 Conclusions

In this paper we empirically study the transmission mechanism of unconventional monetary policy to lending to firms and how it is affected by banks' market power. We exploit a rule set by the ECB on banks' borrowing limit as an instrument to identify an exogenous expansion in banks' funding availability, together with rich transaction-level dataset on term loans bank-firm lending relationship and exogenous historical variation in competitiveness of local lending market.

We show three main new findings. First, banks participating to the first two TLTROs decrease on average loan rates to the same firm by approximately 20 basis points relative to banks not participating to the ECB liquidity injection. Second, competition in the banking sector plays a significant role for the pass-through of TLTROs on the cost of credit: a one standard deviation increase in concentration reduces the decline in the cost by about 14 basis points, thus lowering the effect of unconventional monetary policy by approximately 32% relative to a perfect competition benchmark. Third, our effects are driven by large banks passing-through the ECB liquidity injection via lower loan rates to smaller and ex-ante safer firms, especially in more competitive markets.

Our results have important implications for both the implementation of monetary policy and the design of regulation to promote competitiveness in lending markets. Our analysis suggests that targeted monetary policy could be an effective tool for channeling banks funding into productive investment such as corporate lending, potentially avoiding unintended consequences (Acharya and Steffen, 2015; Crosignani et al., 2017). However, variation in banking

competition changes the effects of monetary policy, potentially amplifying pre-existing differences in local credit access and economic conditions. We leave a more thorough analysis of the effects for the real economy to future work, but our results suggest that it is important for policy makers to consider the interactions between monetary and competition policies, especially following the recent changes in the competitive landscape due to consolidations, branch closures and the rise of shadow banks (Buchak et al., 2017; Stackhouse, 2018).

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A Main Figures and Tables

Figure 1: TLTRO timeline

The figure shows a timeline of the ECB TLTROs. On the 5th of June 2014, the ECB decided the first series of Targeted Longer-Term Refinancing Operations (TLTROs). The policy measure is implemented through eight auctions, one at the end of each quarter from the end of September 2014 to the end of June 2016. Banks borrowing in the first two TLTROs cannot exceeds 7% of the outstanding amount of eligible loans on 30 April 2014. All TLTROs will mature in September 2018, but banks have the option to repay any part of the amounts they were allotted in a TLTRO after 24 months at a biannual frequency. The ECB imposes a mandatory early repayment in September 2016, if some lending requirements are not satisfied. A second series of four operations starting in June 2016 has been announced on the 10th of March 2016.

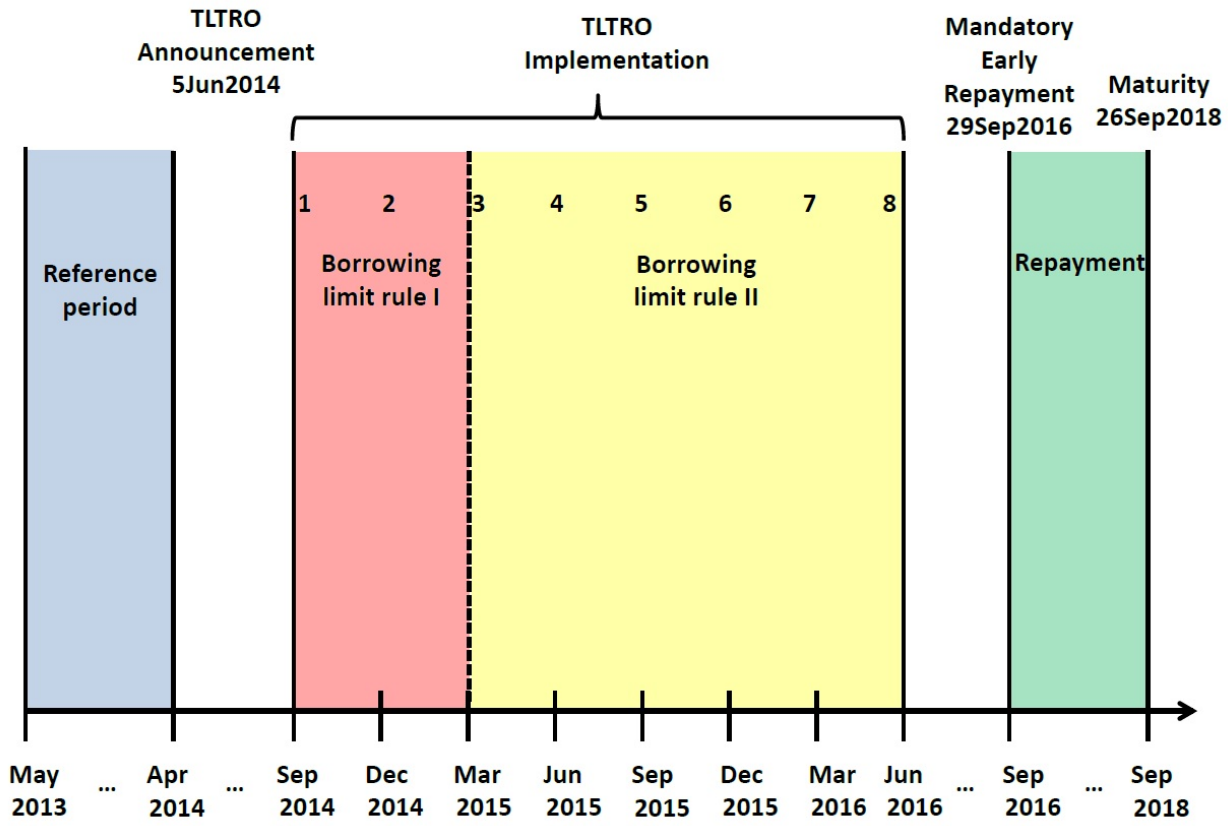

Figure 2: Geographical distribution of Herfindahl Index

The figure shows the geographical distribution of the quartiles of the Herfindahl index in the term loan sector. The index is calculated using quantities of credit for each province in the first quarter of 2014. We used the structure of 103 Italian provinces existing until 2005 to get a homogeneous classification of the provinces from the different datasets. The credit market in Italy is relatively concentrated, with an average value of the index of 0.17 and a range of values included between 0.09 and 0.36 (see Table 1).

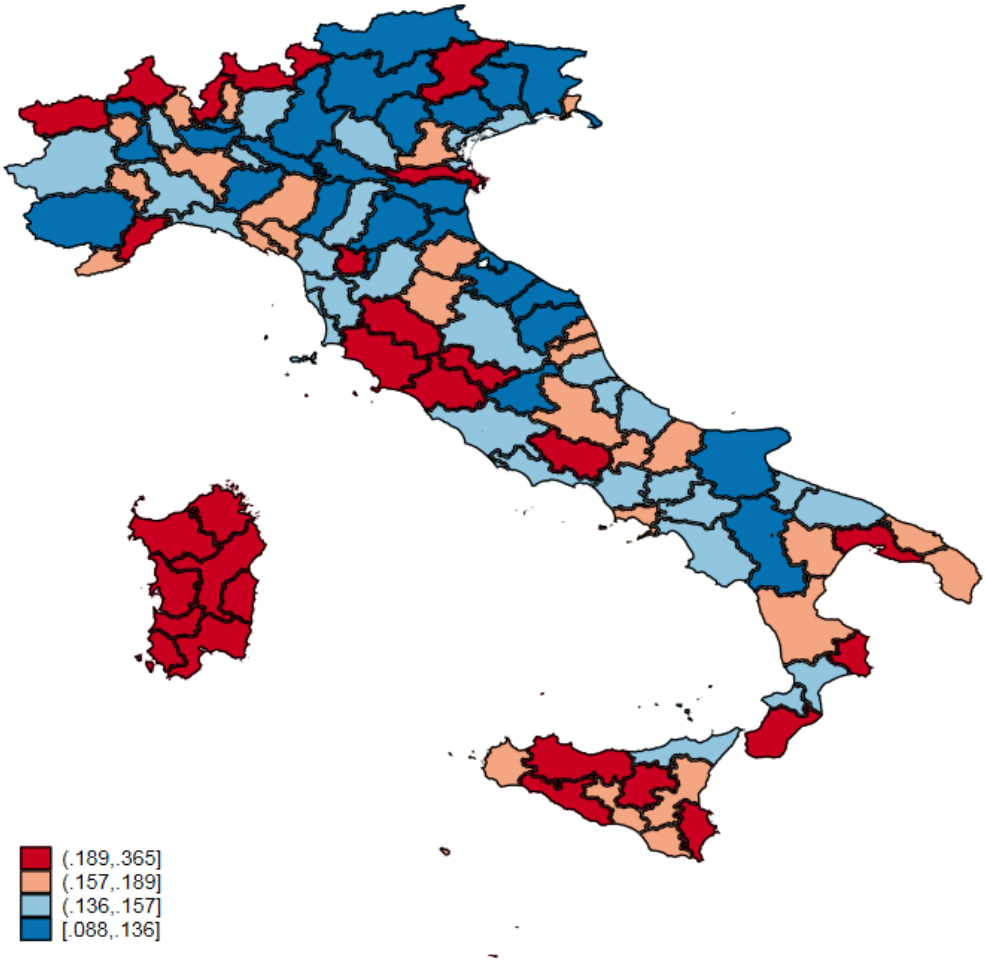

Figure 3: Geographical distribution of pawnshops

The figure shows the geographical distribution of the number of pawnshop during the Renaissance. The index is calculated aggregating the number of pawnshops by cities using the structure of 103 Italian provinces existing until 2005. The number of pawnshops comes from Pascali (2016).

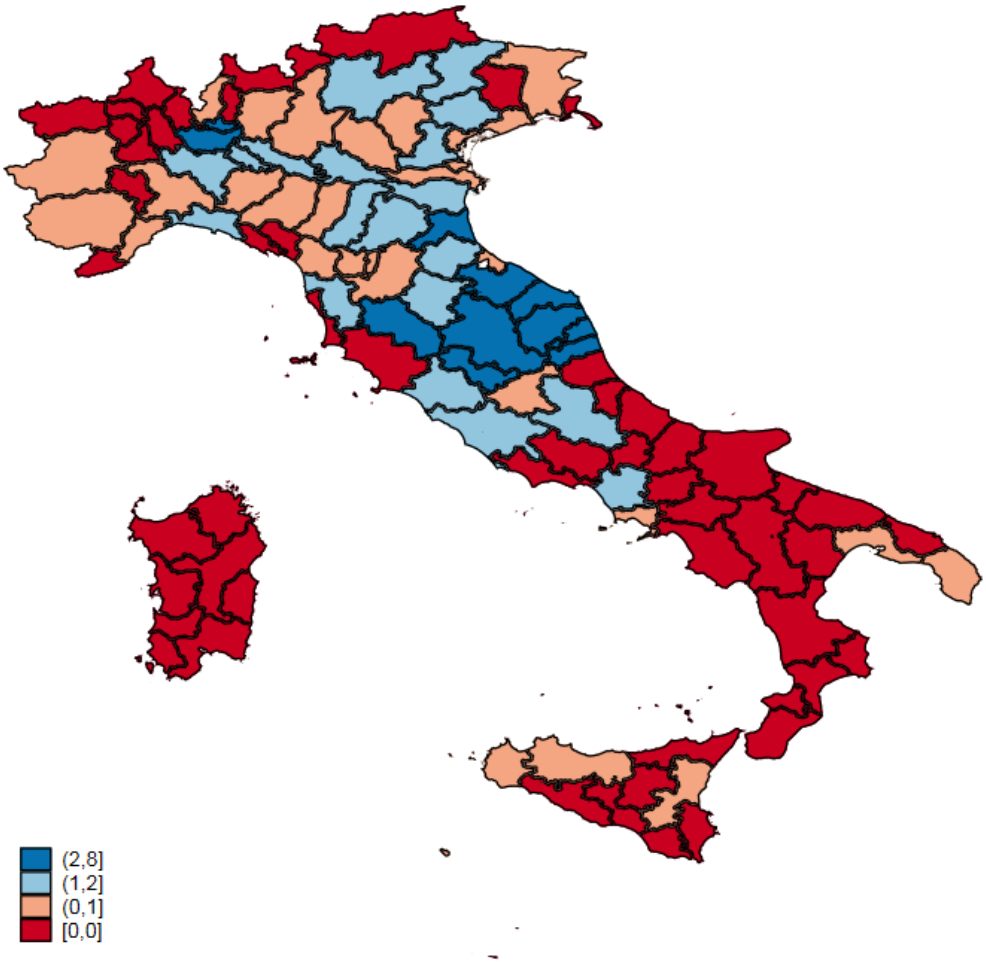

Table 1: Descriptive statistics

The table shows the summary statistics for the main variables in our analysis. Panel A shows the overall interest rate, with and without accessory expenses, on the stock of term loans and including expenditure for the flows of new loans. In Panel B, Herfindahl index at province level is calculated using quantities of credit for each province; the one at province and rating level is constructed segmenting markets by province, separately for firms of average and high credit quality (classes 1-6 of the rating index) and firms of low quality (classes 7-9). Pawnshops is the total number of pawnshops in each province using data from Pascali (2016). In Panel C amount borrowed is the total amount borrowed in the first two TLTROs; additional amount borrowed is the corrected amount of the exposition to central bank coming from the first two TLTROs, netting out the debts towards the Eurosystem expiring in the same quarter; maximum allowance is the borrowing limit computed from expression (1). In panel D we report the main structural characteristics of the banks in the first quarter of 2014: total assets and ratio of government bonds, total loans, bad loans and capital. In Panel E we report the distribution of firm assets and compare the statistics where the statistical unit is the firm with those where the statistical unit is the firm-bank relationship (which is the one we use in our final dataset); the statistics are substantially similar in both cases, taking into account that on average bigger firms have more credit relationships and therefore their weight is bigger when the statistical unit is the relationship.

	Obs	Mean	Std. Dev.	Min	Median	Max
Panel A: Transaction level variables (1st quarter 2014-2nd quarter 2015)						
Interest rate incl. expenditures (%)	671951	4.06	1.96	0.49	3.85	12.10
Interest rate w/out expenditures (%)	671951	4.05	1.95	0.49	3.85	11.83
Interest rate incl. expenditures (flows; %)	58098	4.85	2.30	0.50	4.56	14.31
Panel B: Province level variables (1st quarter 2014 for HI)						
Province level HI on credit amount	103	0.17	0.06	0.09	0.16	0.36
Province - Rating 1-6 HI	103	0.17	0.06	0.08	0.16	0.36
Province - Rating 7-9 HI	103	0.18	0.08	0.09	0.16	0.48
Pawnshops (number)	103	1.02	0.50	0.00	0.0	8.00
Panel C: I-II TLTRO variables (bank level)						
Amount borrowed (million euros)	78	670.0	1843	5	85.72	12500
Additional amount borrowed (million euros)	43	542.7	1167	5	123	5495
Maximum allowance (million euros)	104	560.3	1635	16.11	83.49	12500
Panel D: Other bank level variables (1st quarter 2014)						
Assets (billion euros)	104	30.19	101.27	0.46	2.97	777.91
Loans over assets ratio (%)	104	54.07	11.64	8.21	55.75	74.86
Bad loans over loans ratio (%)	104	9.33	5.44	0.09	8.75	27.57
Government bonds over assets ratio (%)	104	18.26	8.86	1.09	18.25	43.30
Capital ratio (%)	104	15.48	9.24	0.25	13.86	94.89
Panel E: Firm level variables (2013)						
Assets (million euros; by firm)	73174	3.95	30.08	1	0.59	2548.20
Assets (million euros; by relationship)	113246	7.24	40.66	1	0.95	2548.20
		Percentage distribution				
Classes:		1-6			7-9	
Credit rating (by firm)		73%			27%	
Credit rating (by relationship)		74%			26%	

Table 2: Descriptive statistics for treated and controls

The table shows the summary statistics for the main variables in our analysis in the group of treated and control banks. Panel A shows the main the overall interest rate, with and without accessory expenses, on the stock of term loans and including expenditure for the flows of new loans. In Panel B maximum allowance is the borrowing limit computed from expression (1). In panel C we report the main structural characteristics of the banks in the first quarter of 2014: total assets and ratio of government bonds, total loans, bad loans and capital. In Panel D we report the distribution of firm assets and the percentages of firms whose credit quality is either high/average (about three quarters of the sample) or low, using as statistical unit the firm-bank relationship (which is the relevant statistical unit in our final dataset).

	Treated			Controls		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Panel A: Transaction level variables (1st-3rd quarter 2014)						
Interest rate incl. expenditures (%)	220776	4.23	2.04	115046	4.14	1.84
Interest rate w/out expenditures (%)	220776	4.22	2.03	115046	4.12	1.82
Interest rate incl. expenditures (flows; %)	21243	5.21	2.27	7806	4.74	2.16
Panel B: I-II TLTRO variables (bank level)						
Max allowance (million euros)	43	841.7	2238	61	359	979.1
Panel C: Other bank level variables (1st quarter 2014)						
Assets (billion euros)	43	47.87	145.61	61	17.72	48.81
Loans over assets ratio (%)	43	53.20	10.25	61	54.68	12.58
Bad loans over loans ratio (%)	43	7.85	2.65	61	10.38	6.57
Government bonds over assets ratio (%)	43	17.93	7.79	61	18.50	9.60
Capital ratio (%)	43	16.75	12.68	61	14.58	5.64
Panel D: Firm level variables (2013)						
Assets (million euros)	74372	6.75	38.14	38874	8.17	45.04

	Percentage distribution			
	Treated		Controls	
Classes:	1-6	7-9	1-6	7-9
Credit rating	75%	25%	72%	28%

Table 3: Targeted monetary policy - OLS estimates

The table reports the estimated parameters and their standard errors from the OLS estimation of equation (2). Column (1) reports the estimates with the full balanced dataset. Columns (2) and (3) report estimates with the balanced panel of relationships for firms with more than one lender. The dependent variable is the interest rate including expenditure on the stock of loan from bank b to firm f in quarter t. Binary treatment is a dummy equal to one if the bank borrows from the TLTROs. Continuous treatment is a continuous variable equal to the logarithm of the actual additional amount the bank borrows from the TLTROs. Bank-time controls include bank capital, non-performing loans, government bonds. All standard errors are double clustered by firm and bank-quarter. *,**, *** indicates significance at the 0.10, 0.05 and 0.01 levels, respectively.

	Binary treatment			Continuous treatment		
	All	Within		All	Within	
	(1)	(2)	(3)	(4)	(5)	(6)
TLTROs ×						
2014 - Q3	-0.034	-0.025	-0.032	-0.0019	-0.0014	-0.0017
	(0.041)	(0.028)	(0.028)	(0.002)	(0.0015)	(0.0014)
2014 - Q4	0.025	0.011	-0.013	0.001	0.00047	-0.00061
	(0.035)	(0.022)	(0.023)	(0.0017)	(0.0011)	(0.0011)
2015 - Q1	-0.011	-0.024	-0.047*	-0.0011	-0.0015	-0.0026**
	(0.039)	(0.024)	(0.025)	(0.0018)	(0.0012)	(0.0012)
2015 - Q2	-0.019	-0.051**	-0.065**	-0.0014	-0.0027**	-0.0033***
	(0.047)	(0.024)	(0.025)	(0.0023)	(0.0012)	(0.0013)
Firm f.e.	Yes	No	No	Yes	No	No
Time f.e.	Yes	No	No	Yes	No	No
Bank f.e.	Yes	Yes	Yes	Yes	Yes	Yes
Firm-time f.e.	No	Yes	Yes	No	Yes	Yes
Bank-time controls	No	No	Yes	No	No	Yes
Observations	654,948	354,600	354,060	654,948	354,600	354,060
Adjusted R^2	0.71	0.36	0.36	0.71	0.36	0.36

Table 4: Targeted monetary policy - IV estimates

The table reports the estimated parameters and their standard errors from the IV estimation of equation (4). Column (1) reports the estimates with the full balanced dataset. Columns (2) and (3) report estimates with the balanced panel of relationships for firms with more than one lender. The dependent variable is the interest rate including expenditure on the stock of loan from bank b to firm f in quarter t. Binary treatment is a dummy equal to one if the bank borrows from the TLTROs. Continuous treatment is a continuous variable equal to the logarithm of the actual additional amount the bank borrows from the TLTROs. Both the binary and the continuous treatment are instrumented. Bank-time controls include bank capital, non-performing loans, government bonds. All standard errors are double clustered by firm and bank-quarter. *,**, *** indicates significance at the 0.10, 0.05 and 0.01 levels, respectively.

	Binary treatment			Continuous treatment		
	All	Within		All	Within	
	(1)	(2)	(3)	(4)	(5)	(6)
TLTROs ×						
2014 - Q3	-0.18	-0.12	-0.12	-0.0067	-0.0043	-0.0044
	(0.14)	(0.097)	(0.082)	(0.005)	(0.0035)	(0.003)
2014 - Q4	-0.049	0.039	0.076	-0.0018	0.0014	0.0026
	(0.12)	(0.083)	(0.069)	(0.004)	(0.0028)	(0.0023)
2015 - Q1	-0.39**	-0.23**	-0.20***	-0.014**	-0.0085**	-0.0073***
	(0.18)	(0.098)	(0.076)	(0.0057)	(0.0033)	(0.0026)
2015 - Q2	-0.36*	-0.24*	-0.19*	-0.013*	-0.0087**	-0.0071*
	(0.21)	(0.13)	(0.11)	(0.0071)	(0.0044)	(0.0041)
Firm f.e.	Yes	No	No	Yes	No	No
Time f.e.	Yes	No	No	Yes	No	No
Bank f.e.	Yes	Yes	Yes	Yes	Yes	Yes
Firm-time f.e.	No	Yes	Yes	No	Yes	Yes
Bank-time controls	No	No	Yes	No	No	Yes
Observations	654,948	354,600	354,060	654,948	354,600	354,060
Adjusted R^2	0.71	0.36	0.36	0.71	0.36	0.36

Table 5: Targeted monetary policy and competition

The table reports the estimated parameters and their standard errors from the IV estimation of equations (5) and (7). All columns report estimates with the balanced panel of relationships for firms with more than one lender. The dependent variable is the interest rate including expenditure on the stock of loan from bank b to firm f in quarter t. Binary treatment is a dummy equal to one if the bank borrows from the TLTROs. Continuous treatment is a continuous variable equal to the logarithm of the actual additional amount the bank borrows from the TLTROs. Bank-time controls include bank capital, non-performing loans, government bonds. All standard errors are double clustered by firm and bank-quarter. *,**, *** indicates significance at the 0.10, 0.05 and 0.01 levels, respectively.

	Binary treatment		Continuous treatment	
	(IV-OLS)	(IV-IV)	(IV-OLS)	(IV-IV)
	(1)	(2)	(3)	(4)
TLTROs ×				
2014 - Q3	-0.48**	-1.60**	-0.018**	-0.061**
	(0.23)	(0.69)	(0.0088)	(0.025)
2014 - Q4	-0.44*	-1.38**	-0.016*	-0.054**
	(0.25)	(0.69)	(0.009)	(0.025)
2015 - Q1	-0.38*	-2.08***	-0.014*	-0.077***
	(0.24)	(0.8)	(0.0086)	(0.028)
2015 - Q2	-0.42*	-1.71**	-0.016*	-0.063**
	(0.24)	(0.76)	(0.0086)	(0.027)
TLTROs × HI ×				
2014 - Q3	2.61*	10.8**	0.097*	0.41**
	(1.56)	(4.87)	(0.058)	(0.18)
2014 - Q4	3.72*	10.4**	0.13**	0.40**
	(1.91)	(4.97)	(0.065)	(0.18)
2015 - Q1	1.29	13.6**	0.052	0.50**
	(1.81)	(5.68)	(0.064)	(0.20)
2015 - Q2	1.66	10.9**	0.065	0.40**
	(2.02)	(5.46)	(0.071)	(0.19)
Firm-time f.e.	Yes	Yes	Yes	Yes
Bank f.e.	Yes	Yes	Yes	Yes
Bank-time controls	Yes	Yes	Yes	Yes
Observations	354,060	354,060	354,060	354,060
Adjusted R^2	0.36	0.35	0.36	0.35

Table 6: Targeted monetary policy and competition - Heterogeneity

The table reports the estimated parameters and their standard errors from the IV estimation of equation (5) in different subsets of the data. All columns report estimates with the balanced panel of relationships for firms with more than one lender. The dependent variable is the interest rate including expenditure on the stock of loan from bank b to firm f in quarter t. TLTROs is a dummy equal to one if the bank borrows from the TLTROs. High risk firms are firms with a bad credit score (7-9), while low risk are firms with a good or average credit rating (classes 1-6). Small firms are firms below the median of the distribution of assets in the pre-treatment year (2013). Large banks are the top 5 banks in Italy. Bank-time controls include bank capital, non-performing loans, government bonds. All standard errors are double clustered by firm and bank-quarter. *,**, *** indicates significance at the 0.10, 0.05 and 0.01 levels, respectively.

	Firm risk		Firm size		Bank size	
	High	Low	Small	Large	Large	Small
	(1)	(2)	(3)	(4)	(5)	(6)
TLTROs ×						
2014 - Q3	-0.59	-0.34**	-0.65**	-0.37	-0.43**	0.46
	(0.48)	(0.19)	(0.33)	(0.27)	(0.21)	(0.80)
2014 - Q4	-0.25	-0.28	-0.58	-0.32	-0.55***	1.30
	(0.54)	(0.19)	(0.39)	(0.27)	(0.19)	(1.02)
2015 - Q1	-0.58	-0.20	-0.53	-0.30	-0.55***	1.18
	(0.50)	(0.18)	(0.37)	(0.26)	(0.17)	(1.34)
2015 - Q2	-0.18	-0.43**	-0.78**	-0.22	-0.36	0.05
	(0.47)	(0.18)	(0.36)	(0.28)	(0.23)	(1.40)
TLTROs × HI ×						
2014 - Q3	4.35	1.36	3.29	2.18	1.90	-3.56
	(3.77)	(1.22)	(2.37)	(1.87)	(1.22)	(6.85)
2014 - Q4	2.84	2.36**	4.95*	2.76	3.71***	-9.61
	(3.89)	(1.35)	(2.90)	(2.00)	(1.26)	(9.85)
2015 - Q1	3.04	-0.03	1.72	1.11	3.20***	9.81
	(3.47)	(1.27)	(2.62)	(2.07)	(1.12)	(12.30)
2015 - Q2	0.65	1.43	3.61	0.60	2.64*	1.14
	(3.16)	(1.32)	(2.60)	(2.43)	(1.33)	(11.90)
Firm-time f.e.	Yes	Yes	Yes	Yes	Yes	Yes
Bank f.e.	Yes	Yes	Yes	Yes	Yes	Yes
Bank-time controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	81,930	272,130	154,458	199,602	135,936	106,680
Adjusted R^2	0.30	0.36	0.31	0.34	0.41	0.34

B Additional Figures and Tables

Table 7: Targeted monetary policy - First stage

The table reports the estimated parameters and their standard errors for the first stage of the IV model of equation (4). All columns report estimates with the balanced panel of relationships for firms with more than one lender. The dependent variables are the TLTROs binary and continuous treatments. Rule is the allocation rule for bank b from equation (1), Post is a dummy equal to one after the implementation of the TLTROs. Bank-quarter control includes bank capital, non-performing loans, government bonds. The Kleibergen-Paap F-statistic test for weak instruments with cluster-robust standard errors. The Kleibergen-Paap LM-statistic test for underidentification with cluster-robust standard errors. All standard errors are double clustered by firm and bank-quarter. *,**, *** indicates significance at the 0.10, 0.05 and 0.01 levels, respectively.

	Binary treatment	Continuous treatment
	(1)	(2)
Rule × Post	2.15***	0.080***
	(0.287)	(0.012)
Firm-time f.e.	Yes	Yes
Bank f.e.	Yes	Yes
Bank-time controls	Yes	Yes
Kleibergen-Paap F-statistic	41.81	56.36
Kleibergen-Paap LM-statistic	17.44	20.52
Observations	354,060	354,060
Adjusted R^2	0.82	0.82

Table 8: Targeted monetary policy and competition - First stage

The table reports the estimated parameters and their standard errors for the first stage of the IV model of equation (7). All columns report estimates with the balanced panel of relationships for firms with more than one lender. The dependent variables in columns (1) and (3) are the TLTROs binary and continuous treatments, while in columns (2) and (4) the dependent variables are the interactions with the HI. Rule is the allocation rule for bank b from equation (1). Post is a dummy equal to one after the implementation of the TLTROs. Pawnshop is the number of pawnshops across Italian provinces during the Renaissance. Bank-time controls include bank capital, non-performing loans, government bonds. The Kleibergen-Paap F-statistic test for weak instruments with cluster-robust standard errors. The Kleibergen-Paap LM-statistic test for underidentification with cluster-robust standard errors. All standard errors are double clustered by firm and bank-quarter. *,**, *** indicates significance at the 0.10, 0.05 and 0.01 levels, respectively.

	Binary treatment		Continuous treatment	
	(1)	(2)	(3)	(4)
Rule × Post	1.825***	-0.548	0.073***	-0.001
	(0.278)	(0.058)	(0.011)	(0.003)
Rule × Post × Pawnshop	2.428*	2.645***	0.051	0.091***
	(1.313)	(0.461)	(0.054)	(0.021)
Firm-time f.e.	Yes	Yes	Yes	Yes
Bank f.e.	Yes	Yes	Yes	Yes
Bank-time controls	Yes	Yes	Yes	Yes
Kleibergen-Paap F-statistic	10.49	10.02	15.57	13.86
Kleibergen-Paap LM-statistic	9.81	10.46	12.46	12.87
Observations	354,060	354,060	354,060	354,060
Adjusted R^2	0.82	0.81	0.82	0.81

Table 9: Targeted monetary policy and competition - Main - Robustness

The table reports the estimated parameters and their standard errors from the IV estimation of equation (5) for different robustness exercises. All columns report estimates with the balanced panel of firms with more than one lender. The dependent variable is the interest rate on the loan from bank b to firm f in quarter t. Binary treatment is a dummy equal to one if the bank borrows from the TLTROs. Continuous treatment is a continuous variable equal to the logarithm of the actual additional amount the bank borrows from the TLTROs. Bank-time controls include bank capital, non-performing loans, government bonds. All standard errors are double clustered by firm and bank-quarter. *,**, *** indicates significance at the 0.10, 0.05 and 0.01 levels, respectively.

	No correction		No expenditure	
	Binary	Continuous	Binary	Continuous
	(1)	(2)	(3)	(4)
TLTROs ×				
2014 - Q3	-0.92	-0.024*	-0.53**	-0.020**
	(0.56)	(0.014)	(0.23)	(0.0086)
2014 - Q4	-0.78	-0.021	-0.52**	-0.019**
	(0.54)	(0.014)	(0.25)	(0.0087)
2015 - Q1	-0.85*	-0.021*	-0.46**	-0.017**
	(0.51)	(0.013)	(0.23)	(0.0082)
2015 - Q2	-0.96*	-0.024*	-0.51**	-0.019**
	(0.54)	(0.013)	(0.23)	(0.0083)
TLTROs × HI ×				
2014 - Q3	4.91	0.13	3.01**	0.11**
	(3.57)	(0.091)	(1.53)	(0.056)
2014 - Q4	6.37	0.17*	4.22**	0.15**
	(3.95)	(0.099)	(1.91)	(0.063)
2015 - Q1	3.17	0.081	1.78	0.07
	(3.54)	(0.09)	(1.71)	(0.061)
2015 - Q2	3.84	0.099	2.26	0.087
	(3.92)	(0.099)	(1.88)	(0.067)
Firm-time f.e.	Yes	Yes	Yes	Yes
Bank f.e.	Yes	Yes	Yes	Yes
Bank-time controls	Yes	Yes	Yes	Yes
Observations	354,060	354,060	354,060	354,060
Adjusted R^2	0.36	0.36	0.36	0.36

Table 10: Targeted monetary policy and competition - New loans - Robustness

The table reports the estimated parameters and their standard errors from the IV estimation of equations (4) and (5) for the flows of new loans. All columns report estimates with the balanced panel of firms with more than one lender. The dependent variable is the interest rate on the loan from bank b to firm f in quarter t. Binary treatment is a dummy equal to one if the bank borrows from the TLTROs. Continuous treatment is a continuous variable equal to the logarithm of the actual additional amount the bank borrows from the TLTROs. Bank-time controls include bank capital, non-performing loans, government bonds. All standard errors are double clustered by firm and bank-quarter. *,**, *** indicates significance at the 0.10, 0.05 and 0.01 levels, respectively.

	Direct effect only		Including interaction with competition	
	Binary (1)	Continuous (2)	Binary (3)	Continuous (4)
TLTROs ×				
2014 - Q3	-0.12	-0.004	-1.92	-0.054
	(0.15)	(0.004)	(1.78)	(0.034)
2014 - Q4	-0.34**	-0.014***	-1.77	-0.055*
	(0.15)	(0.003)	(1.38)	(0.028)
2015 - Q1	-0.73***	-0.025***	-2.42	-0.073*
	(0.15)	(0.004)	(1.64)	(0.032)
2015 - Q2	-0.91***	-0.031***	-2.31*	-0.071*
	(0.23)	(0.005)	(1.33)	(0.025)
TLTROs × HI ×				
2014 - Q3			8.17	-0.23
			(8.32)	(0.16)
2014 - Q4			6.51	-0.18
			(6.22)	(0.12)
2015 - Q1			7.71	0.22
			(7.15)	(0.14)
2015 - Q2			6.4	0.18*
			(5.56)	(0.11)
Firm-time f.e.	Yes	Yes	Yes	Yes
Bank f.e.	Yes	Yes	Yes	Yes
Bank-time controls	Yes	Yes	Yes	Yes
Observations	33,528	33,528	33,528	33,528
Adjusted R^2	0.68	0.69	0.68	0.69

Table 11: Targeted monetary policy and competition - Heterogeneity - Robustness

The table reports the estimated parameters and their standard errors from the IV estimation of equation (5) in different subsets of the data. All columns report estimates with the balanced panel of relationship for firms with more than one lender. The dependent variable is the interest rate including expenditure on the stock of loan from bank b to firm f in quarter t. TLTROs is the logarithm of the actual additional amount the bank borrows from the TLTROs. High risk firms are firms with a bad credit score (7-9), while low risk are firms with a good or average credit rating (classes 1-6). Small firms are firms below the median of the distribution of assets in the pre-treatment year (2013). Large banks are the top 5 banks in Italy. Bank-quarter controls include bank capital, non-performing loans, government bonds. All standard errors are double clustered by firm and bank-quarter. *,**, *** indicates significance at the 0.10, 0.05 and 0.01 levels, respectively.

	Firm risk		Firm size		Bank size	
	High	Low	Small	Large	Large	Small
	(1)	(2)	(3)	(4)	(5)	(6)
TLTROs ×						
2014 - Q3	-0.018	-0.013*	-0.024**	-0.014	-0.018*	0.034
	(0.013)	(0.007)	(0.012)	(0.01)	(0.008)	(0.071)
2014 - Q4	-0.006	-0.011	-0.02	-0.012	-0.023***	0.094
	(0.015)	(0.007)	(0.013)	(0.01)	(0.008)	(0.12)
2015 - Q1	-0.02	-0.008	-0.02	-0.012	-0.023***	-0.09
	(0.014)	(0.006)	(0.013)	(0.009)	(0.007)	(0.16)
2015 - Q2	-0.006	-0.017**	-0.029**	-0.009	-0.014	-0.011
	(0.015)	(0.006)	(0.013)	(0.01)	(0.009)	(0.12)
TLTROs × HI ×						
2014 - Q3	0.13	0.054	0.12	0.082	0.08	-0.28
	(0.099)	(0.047)	(0.083)	(0.07)	(0.05)	(0.62)
2014 - Q4	0.078	0.088*	0.17*	0.098	0.16***	-0.73
	(0.10)	(0.049)	(0.094)	(0.074)	(0.054)	(1.08)
2015 - Q1	0.097	0.001	0.067	0.045	0.14***	0.75
	(0.10)	(0.048)	(0.091)	(0.075)	(0.048)	(1.42)
2015 - Q2	0.024	0.058	0.13	0.026	0.11*	0.15
	(0.094)	(0.05)	(0.091)	(0.087)	(0.058)	(1.03)
Firm-time f.e.	Yes	Yes	Yes	Yes	Yes	Yes
Bank f.e.	Yes	Yes	Yes	Yes	Yes	Yes
Bank-time controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	81,930	272,130	154,458	199,602	135,936	106,680
Adjusted R^2	0.30	0.36	0.31	0.34	0.41	0.33

C Additional Features of TLTROs

In this appendix we briefly describe some additional features of the TLTROs.The borrowing limit on the third to eight TLTROs is differently computed from the first two operations. The ECB defines a benchmark BE_b^k for each bank b in each TLTRO k given by the formula:

$$\begin{aligned} BE_b^k &= 0 \qquad for\ k = 3, ..., 8 \quad if\ \overline{NL} \geq 0 \\ BE_b^k &= \overline{NL} \times n_k \quad for\ k = 3, ..., 8 \quad if\ \overline{NL} < 0 \end{aligned} \tag{8}$$

where $\overline{NL} = \frac{(NL_b^{May2013} + ... + NL_b^{Apr2014})}{12}$ is the average eligible net lending of institution b from May 2013 to April 2014 and $n_k = 9$ for $k = 3$ and $n_k = 12$ for $k = 4, ..., 8$.[19] The additional borrowing limit is then computed as:

$$q_b^k \leq\ 3(CNL_b^k - BE_b^k) - \sum_{j=3}^{k-1} q_b^j\ for\ k = 3, ..., 8 \tag{9}$$

where $CNL_b^k = NL_b^{May2014} + ... + NL_b^{Month(k)-2}$ is the cumulative net lending in operations from May 2014 until two months before operations k takes place.

Finally, the ECB set also some special rules for the TLTROs on repayment. Even if all TLTROs will mature in September 2018, there are prepayment options and a mandatory repayment rule. On the one hand, intermediaries have the option to repay any part of the amounts they were allotted in a TLTRO after 24 months at a biannual frequency. On the other hand, the ECB imposes a mandatory early repayment (MR_b) in September 2016, if some lending requirements are not satisfied. The early repayment rule is applied according to the following formula:

$$\begin{aligned} MR_b &= \textstyle\sum_{j=1}^{8} q_b^j \qquad\qquad\qquad if\ BE_b^8 > CNL_b^8 \\ MR_b &= \textstyle\sum_{j=3}^{8} q_b^j - 3(CNL_b^8 - BE_b^8) \quad if\ BE_b^8 \leq CNL_b^8. \end{aligned} \tag{10}$$

[19] "Eligible net lending" means gross lending in the form of eligible loans net of repayments of outstanding amounts of eligible loans during a specific period. For details see again ECB (2014).

Thus the bank has to repay the whole borrowed amount through the TLTROs if the total eligible net lending in the period May 2014-April 2016 (CNL_b^8) is less than the benchmark for the last operation. Otherwise, the bank has to pay back in September 2016 the amount borrowed in the last six TLTROs in excess of the amount used for the calculation of the additional allowance for the last operations, that is thrice the cumulative net lending exceeding the benchmark.