Bank Competition and Targeted Monetary Policy*

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Abstract

We exploit an allocation rule by the ECB for Targeted Longer-Term Refinancing Operations (TLTRO-I) to provide causal evidence on the effect of targeted monetary policy on the cost of credit for firms. Using transaction-level data from the Italian credit register and an instrumental variable identification strategy, we find that banks increasing their long-term exposure towards the Eurosystem decrease loan rates to the same firm by approximately 20 basis points relative to other banks. We then study how the effects of policy vary with competition in the banking sector, exploiting the local and sticky nature of bank-firm lending relationships and historical variation in local access to credit. Our results suggest that banks' market power can impair the effectiveness of targeted monetary policy, especially for safer and smaller firms.

JEL classification: E51, E52, L11.

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1 Introduction

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 their effectiveness and 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; Agarwal et al., 2017; Krishnamurthy et al., 2017).

In this paper we provide causal evidence on the effect of targeted unconventional monetary policy on banks' loan rates to firms and on the role of competition in the banking sector for the transmission mechanism. We study the impact of the first two auctions of the first series of Targeted Longer-Term Refinancing Operations (TLTRO-I) by the ECB that provided long-term cheap funding to banks with the explicit goal to "enhance the functioning of the monetary policy transmission mechanism by supporting lending to the real economy".[1]

We exploit an allocation rule by the policy together with a rich dataset on transaction-level bank-firm lending relationships and with exogenous variation in banks' local market power to study the transmission of targeted monetary policy through the banking sector to the cost of credit for firms. Our identification strategy addresses two well-known identification issues usually faced by empirical studies on the effects of both conventional and unconventional monetary policy on credit supply: 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; Nakamura and Steinsson, 2018). Furthermore, we address a third identification challenge in disentangling the role of

[1]The ECB press release with the announcement of TLTRO-I on the 5th of June 2014 is available here: https://www.ecb.europa.eu/press/pr/date/2014/html/pr140605_2.en.html. Central banks around the world are increasingly adopting new tools to foster lending, which share some features of the program we focus on. See for example the Funding for Lending Scheme (FLS) in the UK announced by the Bank of England in July 2012. The ECB announced two further series of quarterly Targeted Longer-Term Refinancing Operations, the last one starting in September 2019 and ending in March 2021.

the banking sector in the transmission mechanism 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). We discuss all of them in turn.

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 TLTRO-I 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).[2]

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 TLTRO-I is a choice. To control for time-invariant bank level unobservables, we include in our empirical model bank fixed effect; moreover, we include time-varying bank controls, 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. However, our results can still bias, as participation to TLTRO-I is voluntary and therefore can be correlated with the dynamics of other unobservable borrowing and lending strategies of the bank. We construct therefore an instrumental variable (IV) for banks' treatment using a rule in TLTRO-I guidelines, that set the maximum amount that banks can borrow in the first two auctions to 7% of their outstanding amount of loans to firms and households excluding mortgages on April 2014. The threshold is set by the ECB

[2]When focusing on firms that borrow from more than one lenders we lose some representativeness of the sample, as multi-lender firms are 30% of the firms and cover about 70% of the overall amount of term loans credit stock. Our results are shown to be qualitatively confirmed with a less accurate, but more inclusive, identification strategy using separate firm and time fixed effects.

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 that may affect loan supply in the period after the start of TLTRO-I. The relevance of our instrument is ensured by the fact that in the first two TLTRO-I auctions more than 90% of the banks actively participating to the operations borrowed at least 95% of their borrowing limit. To address additional concerns about selection into treatment and time-varying omitted variables, we perform several additional checks: 1) we show that treated and control lenders do not different significantly before the treatment along many observable characteristics; 2) we repeat our analysis for the group of borrowing banks, exploiting non-linear effects within the group of treated banks depending on the intensity of treatment. and 3) we run a bank-level placebo test using additional information on mortgage rates, exploiting the fact that TLTRO-I regulation explicitly excludes loans to households for house purchase.

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.[3] We isolate the effect of competition on the pass-through of the unconventional monetary policy measure 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 test the robustness of our results using historical events that affected the location of banks' branches across Italy as instruments for the level of local competition in the banking sector today.[4]

[3]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.

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

Our first set of results looks at the effect of the unconventional monetary policy measure here analysed on loan rates for firms. We find that, when we instrument banks' borrowing choice using the exogenous allocation rule, banks borrowing additional positive liquidity from the Eurosystem in the first two TLTRO-I auctions decrease their rates to the same firm by 20 basis points relative to other banks. This effect is statistically 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, which shows that banks *choosing* to borrow additional liquidity from the first two TLTRO-I decrease rate by about 5 basis points relative to banks *choosing* not to do it. Failing to account for banks' endogenous selection into TLTRO-I could severely underestimate the effects of the policy on the cost of credit for firms.

Our second set of results examines the role of banks' market power for the transmission mechanism of the policy measure. We find that absence of competition plays a significant role for the pass-through, limiting the sensitivity of the cost of corporate loans to the cost of bank funding. The magnitude of the result is also significant: a one-standard-deviation increase in concentration reduces the impact of the first two TLTRO-I on lending rates by approximately 14 basis points. This corresponds to a 32% decline in the transmission of the unconventional monetary policy measure relative to the benchmark of perfect competition. We also 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. Therefore, pre-existing differences in competition can increase loan rates dispersion across markets after an expansionary policy intervention, amplifying the premium in the cost of credit that similar firms pay in concentrated markets relative to more competitive ones.

Finally, we explore heterogeneous effects in the transmission mechanism of the first two TLTRO-I due to differences in firms' and banks' characteristics. Small firms and those with better credit rating borrowing from a treated bank experience a decrease in the cost of credit

relative to credit lines from other banks, while the reduction is not significant for the other firms. Banks' local market power affects the pass-through for small and safer firms, but plays no role for large and riskier firms. The differential effect on small firms is consistent with previous studies showing that they have less alternatives than large firms in raising funding and may be more affected by banks health and competition among banks (Berger and Udell, 1995; Beck et al., 2004; Chodorow-Reich, 2014). The differential effect on ex-ante safer firms is consistent with theories based on information asymmetries and hold-up problems (Sharpe, 1990; Rajan, 1992; Bolton et al., 2016). These findings of differential effects by both firm size and ex-ante risk can also serve as a specification check for the validity of the research design. 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.[5] 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 control for unobservable demand factors, together with exogenous measures of exposure to a shock. This approach has been adopted to study the effect of supply-side liquidity shocks (Khwaja and Mian, 2008; Schnabl, 2012), sovereign shocks (Bofondi et al., 2013; De Marco, 2015), and the transmission mechanism of both conventional and unconventional monetary policy (Jiménez et al., 2012, 2014; Acharya et al., 2015; Di Maggio et al., 2016; Drechsler et al., 2016; Carpinelli and Crosignani, 2017; Rodnyansky and Darmouni, 2017). We contribute by studying a new form of unconventional

[5]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).

monetary policy which has been implemented with the explicit goal of increasing lending to the real economy. Our focus is therefore different from recent studies about other central banks interventions, which have emphasized unintended consequences (see Acharya and Steffen (2015) and Crosignani et al. (2017) among others), and can inform the debate about 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 may respond faster than quantities after a policy change and 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 most 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; Corbae and Levine, 2018; Wang et al., 2019), but the empirical evidence about the relationship between market power and pass-through is ambiguous (Berger and Hannan, 1989; Neumark and Sharpe, 1992; Petersen and Rajan, 1995; De Graeve et al., 2007). On the one hand, in more competitive markets the pass-through of borrowing rate to lending rates can be larger, as a result of higher elasticities of firms' loan demand and the absence of smoothing coming from relationship lending. On the other hand, the response of lending rates can be higher in more concentrated markets, if banks pass-through cost efficiency or exploit market power from holdup situations to adjust their markups. 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). Understanding the role of bank competition for the transmission of policy changes in the

corporate loan market is important given the role firms play for investment and employment. Furthermore, banks' market power may play a different role for sticky and opaque bank-firm relationships relative to more homogeneous and standardized mortgage lending and bank deposits. In terms of identification, our approach to the evaluation of targeted unconventional targeted monetary policy has the unique advantage that the treatment variable is by design heterogeneous across banks, which allows us to disentangle differences across banks from differences in market structure.

The rest of the paper is organized as follows. Section 2 describes the institutional background of TLTRO-I and the Italian banking system. Section 3 summarizes the data. Section 4 explains the identification strategy and presents the results for the direct effects of targeted monetary policy. Section 5 explains the identification strategy and presents the results about the effect of competition for the transmission mechanism of targeted monetary policy. Section 6 discusses some further heterogeneity results.Section 7 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 (TLTRO-I). 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 updated the rules on borrowing limits, maturities and early repayment options have been updated. Afterwards, the ECB announced in March 2016 a second series of four auctions starting in June 2016 (TLTRO-II) and most recently in March 2019 a third series of seven operations starting in September 2019 (TLTRO-III); the design of TLTRO-II and TLTRO-III is partially different from that of TLTRO-I.

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 (LTRO), 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 LTRO 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.

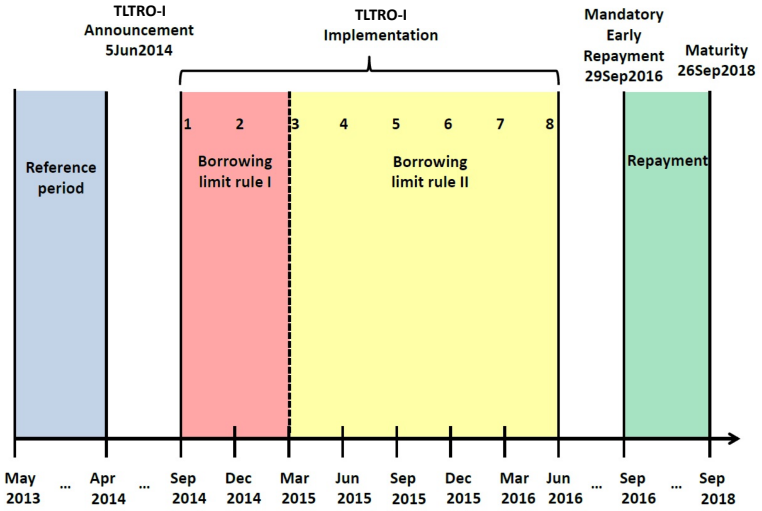
TLTRO-I come within the framework of increasing support by the ECB, but with some novelties about both goals and rules. While previous operations were designed to support the banking sector, all the series of TLTRO explicitly target lending to the real economy. For this reason, this policy represents 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. LTRO), and to roll over existing debt.[6]

Figure 1 shows the timeline of TLTRO-I. Participation to the operations was possible both on an individual basis and as a "TLTRO-I group" of banks, not necessarily all part of

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

Figure 1: TLTRO-I timeline

The figure shows the timeline of TLTRO-I. On the 5th of June 2014, the ECB announced the first series of Targeted Longer-Term Refinancing Operations (TLTRO-I). This 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 auctions cannot exceeds 7% of the outstanding amount of eligible loans on 30 April 2014. All the auctions matured in September 2018, but banks had the option to repay any part of the amounts they were allotted in a TLTRO-I after 24 months at a biannual frequency. The ECB imposed a mandatory early repayment in September 2016, if some lending requirements was not satisfied. Two further series of operations (TLTRO-II and TLTRO-III), respectively starting in June 2016 and September 2019, have been announced afterwards.



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 TLTRO-I is 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 auctions.

The main news in TLTRO-I rules relative to previous LTRO are on borrowing limits and repayments. The borrowing limits rules are different for the first two auctions 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 bids 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 TLTRO-I auctions 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.[7] 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 rule regarding the borrowing limit for the first two TLTRO-I auctions in our identification strategy, while in Appendix B we describe the repayment rules and the calculation of the borrowing limit for the last six TLTRO-I auctions.

2.2 The Italian Banking System

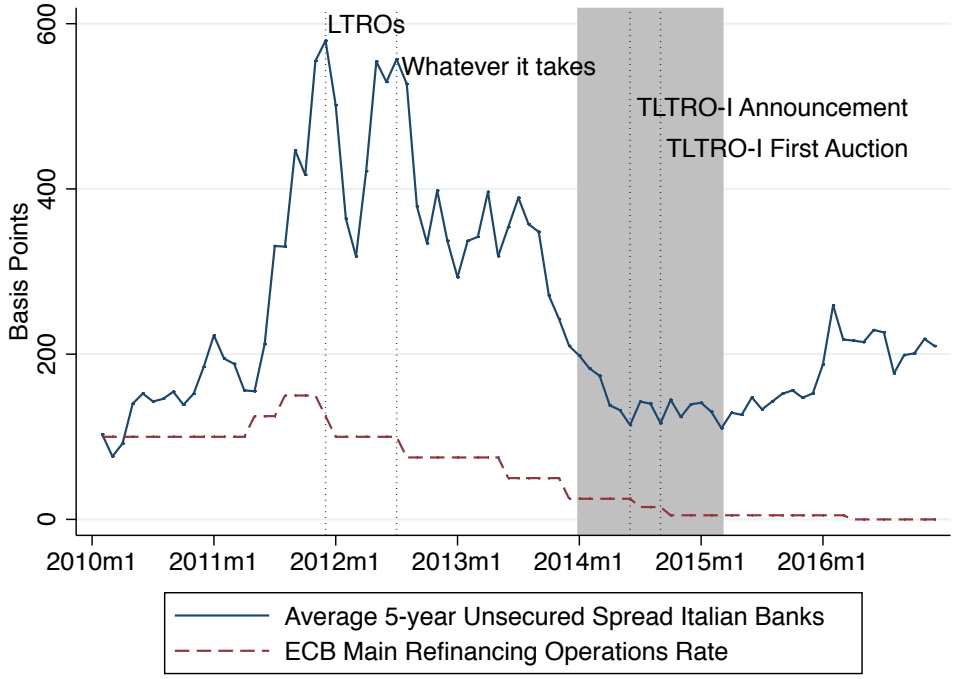
Two aspects make the Italian banking system an ideal laboratory to investigate the effects of targeted monetary policy for firms and the role of bank competition for the transmission mechanism. First, the importance of TLTRO-I for the liquidity of Italian banks. Second, the local and bank-centered corporate loan market. We discuss them in turn.

Italian banks' funding has experienced significant changes during the European sovereign crisis. Figure 2 plots the average 5-years unsecured CDS spread for Italian banks in the period 2010-2017. Banks marginal funding costs are difficult to observe in the data and the 5-years unsecured CDS spread is commonly used as a proxy. The CDS spread reaches almost 600 basis points toward the end of 2011, fluctuates around 400 basis points during 2012 and starts declining to about 200 basis points through 2013, after the several ECB interventions and the implementation of structural reforms. Figure 2 shows also the Main Refinancing Operation rate, the benchmark interest rate for the operations conducted by the ECB.

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

Figure 2: Sovereign crisis, policy and banks' funding costs

The figure shows one measure of funding costs for Italian banks in the period 2010-2017 (solid line), the average 5-year unsecured CDS spread for Italian banks. The dashed line is the Main Refinancing Operation rate by the ECB, which is also the baseline rate for TLTRO-I funding. The dotted vertical lines indicates the months of: LTRO; the "whatever it takes" speech in London by Mario Draghi; the TLTRO-I announcement; the first TLTRO-I auction. The grey shaded area shows the period under analysis.



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

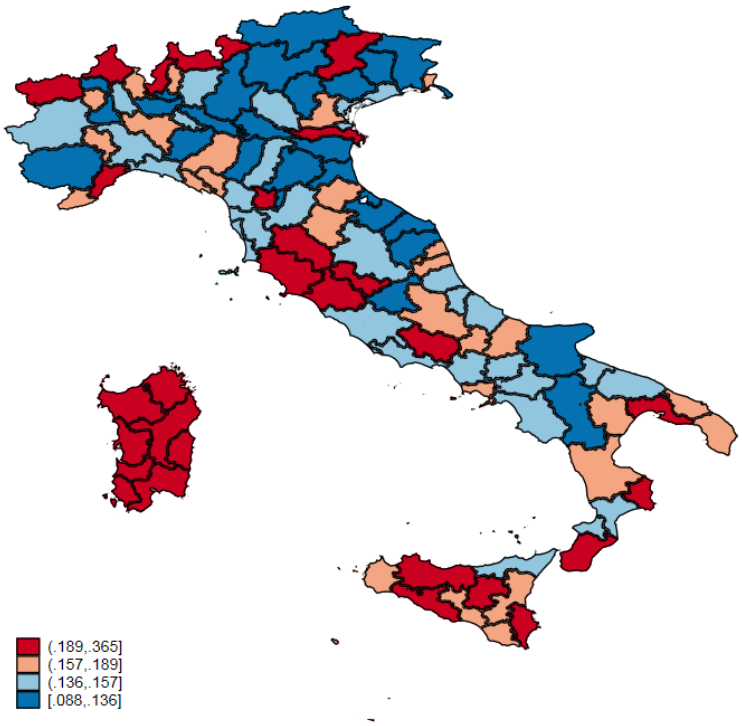
source of funding for banks. The reliance of Italian banks on ECB funding, measured as a percentage of assets, grew from less than 1% at the end of 2010 to more than 6% at the end of 2012 (Van Rixtel and Gasperini, 2013). The new TLTRO-I by the ECB strengthen this trend, by providing additional long-term liquidity to banks in the euro area, with the explicit goal of promoting loan to firms. In the first two TLTRO-I auctions, the banks of the euro area borrowed collectively 212 billion euros, with Italian institutions in the first place borrowing 57 billion euros. The transmission of TLTRO-I could have therefore important implications for lending to the Italian economy.

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 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 3 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. 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. Competition is slightly stronger in the north-east,

generally there is a lot of variability among geographically neighboring provinces.[8]

Figure 3: 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).



3 Data

In this work we construct a unique dataset at the bank-firm-time level, combining four different sources of data.[9] The main one is the Italian Credit register, which collects indi-

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

[9]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 and in the analysis of the strategic choices of a bank.

vidual data on borrowers with exposure above 30 thousand euros from all the intermediaries operating in Italy. From this source we extract information at a quarterly 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 of information includes confidential data about participation and the amounts lent from the central bank to the Italian banks after the first two TLTRO-I auctions.

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 overall interest rate (r_{bfmt}), including the accessory expenses, on the stock of term loans charged by bank b to firm f in market m at time t. 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. Moreover we show the bank level statistics about the

interest rate on mortgages without expenditures, which is used in a placebo test.

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.[10] 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 6 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).[11] The statistics for the HI of the two segmented markets are very similar both among them and to those of the HI by province. Panel B of Table 1 also shows summary statistics for two historical variables that we use in our robustness tests for the role of bank competition. The normalized index of financial development at the region level, that we borrow directly from Guiso et al. (2004), and the total number of pawnshops opened during the Italian Renaissance across Italian province, that we compute aggregating the city level data from Pascali (2016). The normalized index of financial development is 0.35 on average and it ranges from 0 to 0.6. The average number of pawnshop by province is about one and it ranges from zero to eight.

Panel C of Table 1 shows the variables regarding the first two TLTRO-I auctions; 78 banks in our sample participated at either the first or the second bid 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 exposure to central bank coming from these two auctions, netting out the debts towards the Eurosystem expiring in the same quarter of

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

[11] See Altman et al. (1994) for a description of the credit quality index reported in CADS. We also segmented the credit market in three categories instead of two, but the final results were the same as those presented here.

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, the interest rate including expenditure for the flow of new term loans and the bank level interest rate without accessory expenses for mortgages. In Panel B, the 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). Financial development is a normalized measure of financial development at the region level from Guiso et al. (2004). 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 TLTRO-I auctions; additional amount borrowed is the corrected amount of the exposure to central bank coming from the first two TLTRO-I auctions, 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).

	Obs	Mean	Std. Dev.	Min	Median	Max
Panel A: Dependent variables (1st quarter 2014-2nd quarter 2015)						
Interest rate incl. expenditures (stock, transactions; %)	671951	4.06	1.96	0.49	3.85	12.10
Interest rate w/out expenditures (stock, transactions; %)	671951	4.05	1.95	0.49	3.85	11.83
Interest rate incl. expenditures (flows, transactions; %)	58098	4.85	2.30	0.50	4.56	14.31
Rate on mortgages (bank level)	259	3.02	0.62	0.05	3.00	5.17
Panel B: Local 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
Financial development (index)	20	0.35	0.18	0	0.39	0.59
Pawnshops (number)	103	1.02	0.50	0.00	0.0	8.00
Panel C: TLTRO-I variables (1st-2nd auction, 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%	

the bid. 43 banks still had a positive net amount after this correction (and are considered therefore treated banks in our framework), with an average net borrowed amount 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 TLTRO-I auctions, calculated for the whole sample of 104 banks was on average of about 550 million euros too, but it is more skewed to the left. From the comparison of the raw amount borrowed from the 78 banks participating to the first and second TLTRO-I auctions with their borrowing limit we find that more than 90% of those banks borrowed more than 95% of their limit.

In panel D of Table 1 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 of Table 1 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 6. 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 larger firms have more credit relationships and therefore their weight is bigger when the statistical unit is the relationship.

4 The Effects Of Targeted Monetary Policy

4.1 Identification Strategy

To study the effect of a targeted unconventional monetary policy measure 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). Our empirical strategy proceeds in several steps to address the key identification challenges: simultaneous causality, selection into treatment and omitted variables.

TLTRO-I 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. For example, an upward bias in the evaluation of the effects of the policy would result if safer firms mainly demand from banks borrowing from TLTRO-I and increase their loans more than the riskier ones; while a downward bias would emerge if are riskier firms to increase their loan demand by more. To control for changes in lending opportunities we include in our specification interacted firm-time fixed effects as pioneered by Khwaja and Mian (2008). 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 (total assets and ratio of government bonds, total loans, bad loans and capital), 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.[12] 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:

$$Y_{bfmt} = \alpha_t \times TLTRO_{bt} + \gamma_{ft} + \gamma_b + \theta X_{bt} + \varepsilon_{bfmt}, \tag{2}$$

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. We estimate two versions of equation (2): one where we define $TLTRO_{bt}$ as a dummy equal to one for banks borrowing a positive net amount in the first two TLTRO-I auctions (binary treatment specification) and a second in which we define $TLTRO_{bt}$ as the log of the net amount in euros of the expiring previous debt, if positive, borrowed in the same bids (continuous treatment specification).

Even controlling for endogenous timing of TLTRO-I, 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* net borrowing from the first two TLTRO-I auctions with the *maximum* borrowing limit rule described in equation (1) of Section 2. Our first stage regression is:

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

[12]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 $TLTRO_{bt}$ is the *actual* treatment variable; $Rule_b$ is the allocation rule for bank b from equation (1) (excluded instrument) and $Post_t$ is a dummy equal to one after the implementation of the first TLTRO-I auction. 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.[13] The identifying assumption is that the borrowing limit established by the ECB for the first two TLTRO-I auctions is a valid instrument for bank access to central bank liquidity, after controlling for unobservable time-varying demand heterogeneity (firm-time fixed effects), unobserved bank heterogeneity (bank fixed effects) and time-varying bank characteristics. The relevance of our instrument is supported by the fact that Italian banks exploited the ECB facilities borrowing the vast majority of their allowances.[14]

The resulting IV empirical specification is:

$$Y_{bfmt} = \alpha_t \times \widehat{TLTRO}_{bt} + \gamma_{ft} + \gamma_b + \theta X_{bt} + \varepsilon_{bfmt}, \tag{4}$$

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

To address further concerns about selection into treatment and time-varying omitted variables potentially correlated with our instrument, we perform three additional tests. First, we compare treated and control banks before the policy intervention and we show that they do not differ significantly along many observable characteristics. Second, we focus on the subsample of banks borrowing a positive net amount in the first two TLTRO-I auctions and exploit variation in the intensity of treatment within this narrow group. Most notably, we estimate a version of equation (4) splitting these banks above and below the median net amount borrowed in the first two auctions. In this way we allow for non-linear effects within the group of treated banks depending on the intensity of treatment. Third, we run

[13] 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.

[14] In Appendix A we report the first stage regressions and the standard tests for the significance of the instruments.

a placebo test using bank level information on mortgage rates, which were excluded in the calculation of the benchmarks by the TLTRO-I rules. Even within the narrower group of banks borrowing a positive amount from the first two auctions there can be unobservable pre-trends between banks that can affect the allocation rule and the subsequent pricing behavior. If changes in loan rates to firms that we attribute to TLTRO-I are instead driven by unobservable changes in banks characteristics (e.g. marginal costs) we should observe similar patterns for mortgage rates. Even if with mortgage rates we cannot implement our fully saturated empirical model, we study whether treated lenders change mortgage rates differently from other banks. We estimate the following IV model at the bank-time level:

$$Y_{bt} = \alpha_t \times \widehat{TLTRO}_{bt} + \gamma_t + \gamma_b + \theta X_{bt} + \varepsilon_{bt}, \tag{5}$$

where Y_{bt} is the average mortgage rate by bank b at time t, γ_t are time fixed effects, all other variables are as in equation (4) and $\widehat{TLTRO}_{bt}$ is once again instrumented using equation (3). The main difference relative to the empirical model for corporate loan rates is that for mortgages we cannot implement the within-firm across banks analysis to controls for demand side factors.

4.2 Main Results

The first empirical result of interest is the identification of the causal effect of the targeted monetary policy measure on the dynamics of the overall cost of credit for firms. We estimate both versions of equation 4, respectively with the binary and the continuous treatment variable.

Table 2 presents our results for the OLS model. Column (1) shows the results for the full sample, controlling for bank, firm and time fixed effects separately. Treated banks decrease interest rates relative to other 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 a positive additional amount from the ECB in the first two TLTRO-I auctions decrease lending rate relative to banks not doing it 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, but the economic magnitude is small. In the last three columns of Table 2 we estimate the same model with the continuous treatment variable, rather than the binary dummy. The results are still similar.

Table 3 presents our results for the IV model.[15] When we instrument the binary TLTRO-I treatment in column (1) of Table 3, we find that treated banks decrease interest rates relative to other banks. Most notably, we find a statistically significant negative coefficients in the first and second quarter of 2015, therefore immediately after the implementation of the second round of the policy.

In column (2) of Table 3 we use in the estimates interacted firm-time fixed effects, to capture differences in firms credit demand, but we do not include yet time-varying bank controls. Treated banks decrease rate to the same firm on average by about 23 basis points relative to control banks in the first and second quarter of 2015. Finally, in the benchmark specification of column (3) we also 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 2 and 3 shows that IV estimates are stronger than the OLS ones, suggesting that endogeneity concerns are likely to bias OLS 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.

In columns (4) to (6) of Table 3 we repeat the analysis using as treatement variable the

[15] In Appendix A we show the first stage regressions for the benchmark case with interacted firm-time fixed effects and time-varying bank controls. The *theoretical* borrowing limit established by the ECB for the first two TLTRO-I auctions is strongly correlated with both the *actual* TLTRO-I treatment variables. The overall Kleibergen-Paap F-statistics for the first stages, approximately 42 and 56 for binary and continuous treatments respectively, are well above the 10% Stock and Yogo (2002) weak identification test critical values of about 16.

Table 2: 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 a positive additional amount from the first two TLTRO-I auctions. Continuous treatment is a continuous variable equal to the logarithm of the actual (positive) additional amount the bank borrows from the first two TLTRO-I auctions. Bank-time controls include total assets and ratio of government bonds, total loans, bad loans and capital. 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)
TLTRO ×						
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

logarithm of the actual (positive) additional amount the bank borrows from the first two TLTRO-I auctions. Consistent with the results with a binary treatment, we find that treated banks decrease rate to the same firm relative to control banks. The effects are statistically significant in the first and second quarter of 2015 in which treated banks decrease rates

Table 3: 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 a positive additional amount from the first two TLTRO-I auctions. Continuous treatment is a continuous variable equal to the logarithm of the actual (positive) additional amount the bank borrows from the first two TLTRO-I auctions. Both the binary and the continuous treatment are instrumented. Bank-time controls include total assets and ratio of government bonds, total loans, bad loans and capital. 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)
TLTRO ×						
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

relative to control banks by about 15 basis points.[16] Overall, our results on the dynamic of lending rates suggest an outward shift after the second TLTRO-I auction in the supply of loan by banks receiving additional liquidity by the ECB, which pass-through their lower

[16]We compute the magnitude by multiplying the coefficients on column (6) for the first and second quarter of 2015 with the logarithm of the average (positive) additional amount borrowed in the the first two TLTRO-I auctions.

funding cost to corporate borrowers by lowering interest rates, relative to other banks.

4.3 Additional Results and Robustness Checks

We perform several checks and robustness to test our main mechanism going through a causal effect of additional borrowing from the first two TLTRO-I auctions on loan rates for firms. The biggest treat to our identification strategy is that treated banks could be different from other banks along dimensions that we cannot control for and that could be correlated with variables that affect not only the choice to use TLTRO-I, but also banks' initial allowance. We provide additional evidence that this is unlikely to happen in the short window that we focus on. The baseline results of the previous section are also implicitly confirmed by the additional robustness checks discussed in section 5.3, where we replicate the analysis using different definitions of the main variables and complementary data.

First, in Table 4 we compare the characteristics of the banks borrowing a positive additional amount of resources from the first two TLTRO-I auctions and of their customer firms (treated) with those of the other banks and firms (controls). 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 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.

Second, we re-estimate our IV specification on the sample of banks borrowing an additional amount from the ECB in the first two TLTRO-I auctions.[17] Table 5 shows the results.

[17]Because of the inclusion of the firm-time fixed effects, our estimates in this exercise are based on the sample of firms borrowing from more then one treated bank.

Table 4: 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 overall interest rate, with and without accessory expenses, on the stock of term loans, the interest rate including expenditure for the flow of new term loans and the bank level interest rate without accessory expenses for mortgages. 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: Dependent variables (1st-3rd quarter 2014)						
Interest rate incl. expenditures (stock, transactions; %)	220776	4.23	2.04	115046	4.14	1.84
Interest rate w/out expenditures (stock, transactions; %)	220776	4.22	2.03	115046	4.12	1.82
Interest rate incl. expenditures (flows, transactions; %)	21243	5.21	2.27	7806	4.74	2.16
Rate on mortgages (bank level; %)	62	3.17	0.67	70	3.27	0.67
Panel B: TLTRO-I variables (1st-2nd auction, 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%

In column (1) the TLTRO variable is equal to one if the banks net borrowing is above the median, and zero otherwise. Within the sample of borrowing banks, we find that those borrowing above the median decrease rates to the same firms by about 28 basis points relative to the banks below the median in the first and second quarter of 2015.

Third, we collected additional data on mortgage rates at the bank-time level to construct a placebo test based on the fact that mortgage lending is explicitly excluded by TLTRO-I rules. If the effect we capture with TLTRO-I treatment is due to other unobservable factors affecting all banks pricing policies we may find a contemporaneous differential effect for

Table 5: Targeted monetary policy - Additional results

The table reports the estimated parameters and their standard errors from additional robustness tests. Column (1) reports the IV estimates of equation (4) in the subsample of banks borrowing a positive additional amount from the first two TLTRO-I auctions. The dependent variable is the interest rate including expenditure on the stock of loan from bank b to firm f in quarter t. In the dummy specification, treatment is a dummy equal to one if the bank additional borrowing from the first two TLTRO-I auctions is above the median, and zero otherwise. Column (2) to (5) report the OLS and IV estimates of a regression of mortgage rates by bank b in quarter t on TLTRO variables controlling for bank and time fixed effects, and time-varying bank variables. In columns (2) and (4) TLTRO is a dummy equal to one if the bank borrows a positive additional amount from the first two TLTRO-I auctions. In columns (3) and (5) TLTRO is a continuous variable equal to the logarithm of the actual (positive) additional amount the bank borrows from the first two TLTRO-I auctions. Bank-time controls include total assets and ratio of government bonds, total loans, bad loans and capital. All standard errors are double clustered by firm and bank-quarter. *,**, *** indicates significance at the 0.10, 0.05 and 0.01 levels, respectively.

	Only Borrowers	Placebo: Mortgages			
	IV	OLS		IV	
	(1)	(2)	(3)	(4)	(5)
TLTRO ×					
2014 - Q3	-0.15	-0.025	-0.002	-0.13	-0.005
	(0.10)	(0.097)	(0.005)	(0.58)	(0.023)
2014 - Q4	-0.04	-0.054	-0.003	0.43	0.018
	(0.44)	(0.098)	(0.005)	(0.59)	(0.026)
2015 - Q1	-0.27***	0.14	0.006	0.39	0.017
	(0.054)	(0.996)	(0.005)	(0.58)	(0.025)
2015 - Q2	-0.29***	0.11	0.005	0.61	0.027
	(0.11)	(0.100)	(0.005)	(0.59)	(0.025)
Time f.e.	No	Yes	Yes	Yes	Yes
Bank f.e.	Yes	Yes	Yes	Yes	Yes
Firm-time f.e.	Yes	No	No	No	No
Bank-time controls	Yes	Yes	Yes	Yes	Yes
Observations	184,332	259	259	259	259
Adjusted R^2	0.62	0.83	0.83	0.84	0.85

mortgages of treated banks. Table 5 shows the results from the estimation of equation (5). Columns (3) and (5) report the parameters for the binary treatment and columns (4) and (6) for the continuous treatment. We do not find a significant different effect on mortgage rates for banks whose net borrowing from the first two TLTRO-I auctions is positive relative

to other banks neither in the OLS nor in the IV specification. If anything, the rates for mortgages offered by treated banks are higher in the same quarter when the rates offered to corporate are lower, but in this case the differences are not statistically significant and are low in terms of economic magnitude. The absence of an impact of the policy on mortgage rates lower concerns about omitted time-varying bank-level variables correlated with our instrument for the TLTRO-I treatment.

5 The Effects of Bank Competition on the Transmission Mechanism

5.1 Identification

In this section we study the role of competition in the local banking system for the pass-through of TLTRO-I. To study the effect of bank competition on the pass-through of a targeted monetary policy measure, ideally one would like that both the bank receiving the additional liquidity injection and the bank not receiving it would operate in two identical markets, which only differ on the level of bank competition. Any differential change in the lending rate by the treated bank in the market with high bank competition will come from differences in bank competition and not from other banks characteristics (we are considering the same banks) or other markets characteristics (the two markets are identical).

To identify the effect of competition among lenders on the pass-through of the targeted monetary policy measure here analysed, 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 as already shown in Figure 3. We do not observe in the data from which branch of the bank the firm is borrowing. Therefore, we make the assumption that the firm is borrowing from branches located in the same province, following previous work (Guiso et al., 2004; Felici and Pagnini, 2008; Crawford et al., 2018). To avoid endogenous changes in the local level of competition as a result of TLTRO-I we fix

the HI at the beginning of 2014.

We augment our empirical model given by equation (4) with time-varying coefficients on the interaction between TLTRO treatment and the HI. In this way we capture the dynamic effect of market power on the transmission mechanism:

$$Y_{bfmt} = \alpha_t \times \widehat{TLTRO}_{bt} + \beta_t \times \widehat{TLTRO}_{bt} \times HI_m + \gamma_{ft} + \gamma_b + \theta X_{bt} + \varepsilon_{bfmt}. \tag{6}$$

As in Section 4, 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 bank controls. Our approach compares corporate loan rates across branches of the same treated bank located in areas with different bank competition to corporate loan rates for the same firms across branches of control banks. In this way, we combine the within-firm estimation of Section 4 that controls for unobservable firms demand shocks, with a within-bank estimation that control for unobservable bank-specific lending opportunities.

To account for endogeneity in local market power and omitted variables that can affect the differential pass-through of the first two TLTRO-I auctions within bank across market, we test the robustness of our results using two sources of exogenous variation coming from the historical development of banking markets in Italy. First, Guiso et al. (2004) show that a banking law that limited entry in 1936 continued to affect the supply of credit even 50 years later because of regulatory reasons. Second, 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 two sources of historical variation to instrument for the level of competition in the banking sector today.[18] The first source of variation has the advantage to be directly related to bank competition by limiting entry and relatively more recent, but the disadvantage to vary only

[18] In Appendix A we show a map with the number of pawnshops during the Renaissance in the currently established provinces. A comparison with Figure 3 reveals that provinces with a high number of pawnshops during the Renaissance tend to have a less concentrated banking sector today. The correlation coefficient is -0.27. Similar relationships exist with the index of financial development from Guiso et al. (2004), where the correlation coefficient is -0.25. We also report the first stage estimates and tests for the relevance of our instrument.

at the region level. The second source of variation is less directly related to bank competition today, but it has the advantage to vary at a more granular level. For these reasons we test the robustness using both measures as instruments for bank competition today.

To capture jointly the causal effects of unconventional monetary policy and of competition on the transmission mechanism, we estimate the following IV empirical specification:

$$Y_{bfmt} = \alpha_t \times \widehat{TLTRO}_{bt} + \beta_t \times \widehat{TLTRO_{bt} \times HI_m} + \gamma_{ft} + \gamma_b + \theta X_{bt} + \varepsilon_{bfmt}, \tag{7}$$

where the interaction term $\widehat{TLTRO_{bt} \times HI_m}$ is the predicted interaction between the policy treatment and the HI and captures the causal effect of competition on the pass-through of the unconventional monetary policy measure. It is estimated from the first stage regressions,[19] of the actual interaction on the exogenous variables and the excluded instruments (the allocation rule and the historical instruments):

$$TLTRO_{bt} \times HI_m = \psi Rule_b \times Post_t \times Hist_m + \gamma_{ft} + \gamma_b + \theta X_{bt} + \epsilon_{bfmt}, \tag{8}$$

where $Hist_m$ is either the number of pawnshops across Italian provinces during the Renaissance or the financial development index from Guiso et al. (2004).

5.2 Main Results

Our second set of results shows how bank competition affects the transmission mechanism of the first two TLTRO-I auctions to the cost of credit for firms. Table 6 presents the results.

The coefficients of interest capture the interaction between TLTRO treatment and bank competition, measured by the local HI. Our estimates in column (1) of Table 6 imply that high concentration reduce the pass-through of unconventional monetary policy to firms through the cost of credit. In competitive markets 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

[19] The first stage regressions and the diagnostic tests of the instruments are reported in Appendix A.

Table 6: The effect of bank competition on targeted monetary policy

The table reports the estimated parameters and their standard errors from the IV estimation of equation (6). 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 a positive additional amount from the first two TLTRO-I auctions. Continuous treatment is a continuous variable equal to the logarithm of the actual (positive) additional amount the bank borrows from the first two TLTRO-I auctions. Bank-time controls include total assets and ratio of government bonds, total loans, bad loans and capital. 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)
TLTRO ×		
2014 - Q3	-0.48**	-0.018**
	(0.23)	(0.0088)
2014 - Q4	-0.44*	-0.016*
	(0.25)	(0.009)
2015 - Q1	-0.38*	-0.014*
	(0.24)	(0.0086)
2015 - Q2	-0.42*	-0.016*
	(0.24)	(0.0086)
TLTRO × HI ×		
2014 - Q3	2.61*	0.097*
	(1.56)	(0.058)
2014 - Q4	3.72**	0.13**
	(1.91)	(0.065)
2015 - Q1	1.29	0.052
	(1.81)	(0.064)
2015 - Q2	1.66	0.065
	(2.02)	(0.071)
Firm-time f.e.	Yes	Yes
Bank f.e.	Yes	Yes
Bank-time controls	Yes	Yes
Observations	354,060	354,060
Adjusted R^2	0.36	0.36

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. Overall 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. We can compute the hypothetical case of perfect competition by setting the HI equal to zero. With perfect competition the treated bank will decrease the rate by about 40 basis points on average. Thus, higher concentration reduces the transmission mechanism of targeted monetary policy to firms by approximately 32% relative to the theoretical case of perfect competition.[20]

Figure 4 shows the differential effects of TLTRO treatment on interest rates for corporate loans in markets with different level of concentration. There is an increasing monotonic relationship between concentration and interest rate changes. For the same decline in cost, a lender pass through the ECB liquidity injection by lowering corporate loan rates in more competitive markets, while the same lender leave rates almost unaffected in highly concentrated markets. As a result of this differential behaviour, firms borrowing from a treated lender in the 10th rather than the 90th percentile of HI experience an additional decline in rates of about 20 basis points. This result has important implications for the heterogeneous transmission of monetary policy across different geographical areas. As a result of differential levels of local bank competition, targeted monetary policy could increase credit access inequality across markets, widening the interest rate gap that similar firms pay in different location.

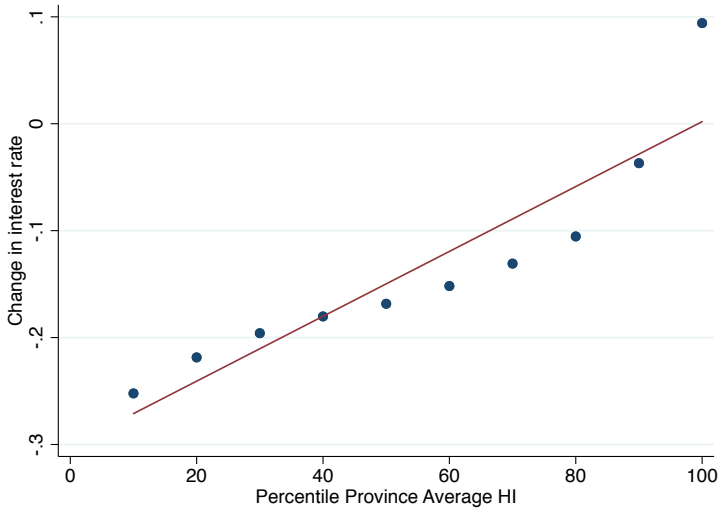
Is the estimated effect of bank market power on the pass-through of TLTRO-I to corporate loan rates large or small? Our estimates are slightly larger than the ones from recent works on the role of bank competition for the pass-through of monetary policy to mortgage and deposits rates (Scharfstein and Sunderam, 2014; Drechsler et al., 2017).[21] There are many

[20] We compute the effect using the estimates from column (1) of Table 6 and taking the average of the effect of a standard deviation increase in concentration in each period.

[21] Scharfstein and Sunderam (2014) find that a standard deviation increase in concentration reduce the total monetary transmission mechanism through the mortgage market by almost 30%, compounding the effects on rates and the quantity of refinancing. Drechsler et al. (2017) compare high and low concentration areas and find that a 100 basis points increase in the Fed funds rate raise deposit spread of branches in high-concentration counties by about 14 basis point more than in low-concentration counties, which accounts for

Figure 4: Competition and pass-through

The figure shows the relationship between market concentration and the sensitivities of interest rate to targeted monetary policy. We construct for each province the predicted change in interest rate in the second quarter of 2015 using our estimates from equation (6). We then take averages for each decile of the HI in the first quarter of 2014. The solid line represents the linear fit.



possible reasons for the stronger effect of bank competition that we find in our setting. First and foremost, relationship lending, information frictions and market power may play a more important role for corporate lending than for mortgage lending and bank deposits. Mortgage and deposit products are more homogeneous and standardized than corporate loans, thus making it easier for a household than for a firm to switch banks. Furthermore, repeated interactions and dynamic considerations can limit the ability of firms to move banks, even in the presence of interest rate differential (Sharpe, 1990). Understanding the role of bank competition for the transmission of policy changes in the corporate loan market is therefore complementary to previous studies looking at different markets and our estimates can provide an upper bound to the impact of market power given the sticky and opaque nature of bank-firm relationships.

Second, both Scharfstein and Sunderam (2014) and Drechsler et al. (2017) focus on the

approximately 20% of the average increase in deposit spreads.

transmission of conventional monetary policy, while our focus is on targeted monetary policy. The difference in the nature of the policy itself may affect the role of bank competition for the transmission mechanism: conventional monetary policy via changes in the reference rate can directly affect both the assets and the liability side of banks' balance sheet; targeted, and in general unconventional, monetary policy may only directly affect part of the banks' balance sheet, while some items such as deposits are affected only indirectly through general equilibrium considerations. As a result, the importance of market power on the asset side can be different, because in the case of conventional monetary policy market power there are direct channels on the liability side which are missing in the case of targeted monetary policy. Understanding the interaction between different monetary policy interventions and the role played by bank competition would be an interesting avenue for future research.

5.3 Additional Results and Robustness

We perform several checks and robustness to test the effect of bank competition on the pass-through of the first two TLTRO-I auctions on loan rates for firms.

First, we replicate the analysis using different definitions of the main variables and complementary data. We run the analysis: 1) on the raw amounts borrowed by participating banks in the first two TLTRO-I auctions instead of the additional amount net of the rolled over already existing debts towards the Eurosystem, if positive; 2) using rates constructed with interest expenditures only, excluding accessory expenses from the calculation. The results are qualitatively similar to the previous ones. Furthermore, 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 they are 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 6 because of the loss of precision in the estimates due to the smaller number of observations.

Second, we test the robustness of our results using historical variation to instrument for variation in the HI. We show the results in Appendix A. We find that higher concentration in the local banking market, coming from exogenous historical variation, significantly reduces the pass-through of additional central bank liquidity to lending rates to firms, qualitatively confirming our baseline result.

Third, in Section 6 we look at heterogeneous treatment effects by firm size. The heterogeneity analysis serves as a specification check for the validity of both our instrument for TLTRO-I and the competition measure. Under the assumption, backed by both theory and evidence, that competition plays a more important role for smaller than for larger firms, the interaction between firm size and our measure of competition should have a stronger effect for small firms (Guiso et al., 2004; Chodorow-Reich, 2014).

6 Heterogeneous Effects

In this section we study whether there are heterogeneous effects in the pass-through of our targeted monetary policy measure and the impact of the competitive environment due to differences in some relevant banks' and firms' characteristics. In particular, we focus on riskiness of firms and size of both firms and banks, which both the theory and previous empirical evidence identify as important determinants of access to credit (Gertler and Gilchrist, 1994; Chodorow-Reich, 2014; Jiménez et al., 2014; Agarwal et al., 2018). In all cases we take ex-ante measures of credit risk and size, to deal with possible endogeneity concerns.

Table 7 shows the estimates of equation (6) in the different subgroups.[22] Columns (1)

[22] In Appendix A we report the estimates for the same specification using the continuous TLTRO treatment

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 (classes 7-9).[23] 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 our unconventional monetary policy measure to safer firms, but plays no role for riskier firms. This result corroborates the hypothesis that banks used their additional borrowing from the first two TLTRO-I auctions 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 7 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 TLTRO-I auctions, but the effect is stronger and only significant for small firms. Treated banks lowered the cost of credit to small firms located in a province with an average HI by about 20 basis point, while the decrease is about 10 basis points and not significant for large firms in the same province. Competition affects the pass-through of policy to the cost of credit for small firms, while it plays no significant role for large ones. 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 7 we study heterogeneity on the supply side and compare the largest five banks in Italy with other medium and co-operative banks. Large banks borrowing a positive net amount from TLTRO-I decrease their lending rate relative to other large banks lending to the same firm, while we do not find significant differences for banks of smaller size. This heterogeneity analysis serves as an additional check for selection

variable. Results are confirmed.

[23] 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.

Table 7: Targeted monetary policy and competition - Heterogeneity

The table reports the estimated parameters and their standard errors from the IV estimation of equation (6) 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. Binary treatment is a dummy equal to one if the bank borrows an additional amount from the first two TLTRO-I auctions. 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 total assets and ratio of government bonds, total loans, bad loans and capital. 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)
TLTRO ×						
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)
TLTRO × 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

into treatment based on bank size, because we are only exploiting variation in TLTRO-I net borrowing across banks within a more homogeneous group. Turning to the effect of competition on the pass-through, we find a positive significant interaction between the policy and the HI in the subsample of large banks. Competition affects the pass through of the policy to lending rates for large banks, but has no significant differential effects for small banks. 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.[24]

7 Conclusions

In this paper we empirically study the transmission mechanism of the first two TLTRO-I auctions 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 not borrowing additional funds in the auctions decrease on average loan rates to the same firm by approximately 20 basis points relative to other banks. Second, competition in the banking sector plays a significant role for the pass-through 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 our unconventional monetary policy measure by approximately 32% relative to a perfect competition

[24]The imprecise results for small banks can be due to several factors. The most important is that to estimate our empirical model we need a firm to borrow from more than one bank. This requirement is harder to satisfy once we split the sample by banks and more so for the case of small banks which tend to lend to firms with a lower number of relationships. Note that the total number of observations decreases once we divide the sample by bank size as a result of loosing some firms that end up with a single lender after the split. Furthermore, in order to identify the effect of competition given our set of firm-time and bank fixed effects we need a bank to operate in several markets with different level of competition which is less likely for local (and smaller) banks.

benchmark. Third, our effects are driven by large banks passing-through the ECB additional 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 the examined targeted monetary policy measure 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 its effects, 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 policymakers 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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Appendix

The appendix is structured as follows. Section A provides supplementary figures that shows the variation and tables with sample and robustness checks. Section B provides additional details about TLTRO-I.

A Additional Figures and Tables

Figure A1: Pawnshops and financial development index

The left 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). The right figure shows the geographical distribution of the index of financial development. The index comes from Guiso et al. (2004).

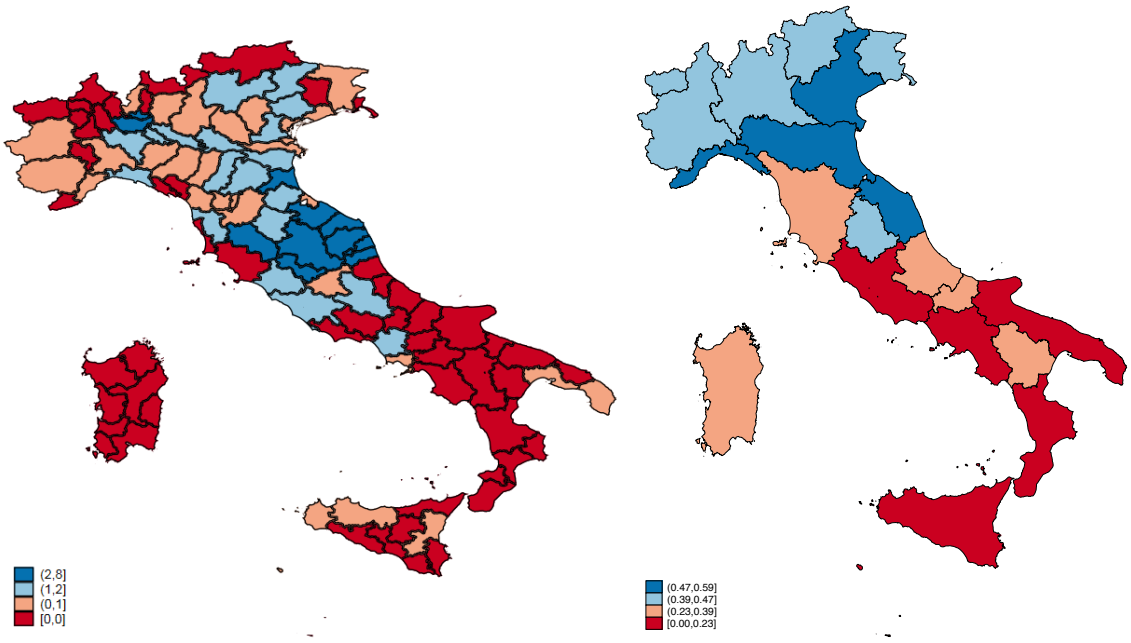

Table A1: Targeted monetary policy - First stage

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 TLTRO 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 first TLTRO-I auction. Bank-time controls include total assets and ratio of government bonds, total loans, bad loans and capital. 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 A2: Targeted monetary policy and competition - Main - Robustness

The table reports the estimated parameters and their standard errors from the IV estimation of equation (6) 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 a positive additional amount from the first two TLTRO-I auctions. Continuous treatment is a continuous variable equal to the logarithm of the actual (positive) additional amount the bank borrows from the first two TLTRO-I auctions. Bank-time controls include total assets and ratio of government bonds, total loans, bad loans and capital. 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 (1)	Continuous (2)	Binary (3)	Continuous (4)
TLTRO ×				
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)
TLTRO × 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 A3: 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 (6) 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 first two TLTRO-I auctions. Continuous treatment is a continuous variable equal to the logarithm of the actual additional amount the bank borrows from the first two TLTRO-I auctions. Bank-time controls include total assets and ratio of government bonds, total loans, bad loans and capital. 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)
TLTRO ×				
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)
TLTRO × 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 A4: Targeted monetary policy and competition - Main - 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 TLTRO 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 since the implementation of the TLTRO-I. Bank-time controls include total assets and ratio of government bonds, total loans, bad loans and capital. 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 × HI	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	15.57		10.49	
Kleibergen-Paap LM-statistic	12.46		9.81	
Observations	354,060	354,060	354,060	354,060
Adjusted R^2	0.82	0.81	0.82	0.81

Table A5: Targeted monetary policy and competition - Pawnshops - 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 TLTRO 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 since the implementation of the TLTRO-I. Bank-time controls include total assets and ratio of government bonds, total loans, bad loans and capital. 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	2.375***	0.387***	0.090***	0.015***
	(0.305)	(0.049)	(0.013)	(0.002)
Rule × Post × Pawnshop	-0.264***	-0.103***	-0.012***	-0.004***
	(0.068)	(0.016)	(0.003)	(0.001)
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	13.86		10.02	
Kleibergen-Paap LM-statistic	12.87		10.46	
Observations	354,060	354,060	354,060	354,060
Adjusted R^2	0.82	0.81	0.82	0.81

Table A6: Targeted monetary policy and competition - Financial development index - 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 TLTRO 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 since the implementation of the TLTRO-I. Bank-time controls include total assets and ratio of government bonds, total loans, bad loans and capital. 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	2.349***	0.426***	0.087***	0.016***
	(0.349)	(0.058)	(0.016)	(0.003)
Rule × Post × Fin. Dev.	-0.456***	-0.291***	-0.016***	-0.012***
	(0.317)	(0.063)	(0.015)	(0.003)
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	22.80		18.73	
Kleibergen-Paap LM-statistic	16.86		15.19	
Observations	354,060	354,060	354,060	354,060
Adjusted R^2	0.82	0.81	0.82	0.81

Table A7: Targeted monetary policy and competition - Pawnshops and financial development index - Robustness

The table reports the estimated parameters and their standard errors from the IV estimation of equation (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 a positive additional amount from the first two TLTRO-I auctions. Continuous treatment is a continuous variable equal to the logarithm of the actual (positive) additional amount the bank borrows from the first two TLTRO-I auctions. Bank-time controls include total assets and ratio of government bonds, total loans, bad loans and capital. All standard errors are double clustered by firm and bank-quarter. *,**, *** indicates significance at the 0.10, 0.05 and 0.01 levels, respectively.

	Financial Development		Pawnshops	
	Binary	Continuous	Binary	Continuous
	(1)	(2)	(3)	(4)
TLTRO ×				
2014 - Q3	-2.92***	-0.12***	-1.60**	-0.061**
	(0.74)	(0.029)	(0.69)	(0.025)
2014 - Q4	-2.20***	-0.093***	-1.38**	-0.054**
	(0.64)	(0.026)	(0.69)	(0.025)
2015 - Q1	-3.16***	-0.13***	-2.08***	-0.077***
	(0.76)	(0.03)	(0.8)	(0.028)
2015 - Q2	-2.82***	-0.12***	-1.71**	-0.063**
	(0.68)	(0.027)	(0.76)	(0.027)
TLTRO × HI ×				
2014 - Q3	20.3***	0.84***	10.8**	0.41**
	(5.43)	(0.21)	(4.87)	(0.18)
2014 - Q4	16.3***	0.68***	10.4**	0.40**
	(4.68)	(0.19)	(4.97)	(0.18)
2015 - Q1	21.3***	0.88***	13.6**	0.50**
	(5.40)	(0.21)	(5.68)	(0.20)
2015 - Q2	18.8***	0.78***	10.9**	0.40**
	(4.83)	(0.19)	(5.46)	(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	0.34	0.34	0.35	0.35

Table A8: Targeted monetary policy and competition - Heterogeneity - Robustness

The table reports the estimated parameters and their standard errors from the IV estimation of equation (6) 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. TLTRO is equal to the logarithm of the actual (positive) additional amount the bank borrows from the first two TLTRO-I auctions. 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 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 total assets and ratio of government bonds, total loans, bad loans and capital. 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)
TLTRO ×						
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)
TLTRO × 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

B Additional Features of TLTRO-I

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

$$\begin{aligned} BE_b^k &= 0 \qquad for\ k = 3, ..., 8 \quad if\ \overline{NL} \geq 0 \\ BE_b^k &= \overline{NL} \times n_k \quad for\ k = 3, ..., 8 \quad if\ \overline{NL} < 0 \end{aligned} \tag{9}$$

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 $k = 4, ..., 8$.[25] The additional borrowing limit is then computed as:

$$q_b^k \leq\ 3(CNL_b^k - BE_b^k) - \sum_{j=3}^{k-1} q_b^j\ for\ k = 3, ..., 8 \tag{10}$$

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 TLTRO-I on repayment. Even if all TLTRO-I auctions 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-I 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:

$$\begin{aligned} MR_b &= \textstyle\sum_{j=1}^{8} q_b^j \qquad\qquad\qquad if\ BE_b^8 > CNL_b^8 \\ MR_b &= \textstyle\sum_{j=3}^{8} q_b^j - 3(CNL_b^8 - BE_b^8) \quad if\ BE_b^8 \leq CNL_b^8. \end{aligned} \tag{11}$$

[25] "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 TLTRO-I 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 auctions 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.